Evaluation of Habitat Provision On the Basis of Carabidae Diversity in Slovak Permanent Grasslands

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Abstract. Biodiversity has an important role in creating and regulating ecosystem processes, functions, and services. Carabidae are considered to be suitable bio-indicators of environment. The aim of the study is to analyse the relationships between Carabidae and the ability of study sites to fulfil habitat provision. The research was conducted on permanent grasslands (PG) with different management at 2 study sites (Tajov - TA, Liptovská Teplička - LT) located in different climatic and natural conditions of Slovakia. At each study site, seven plastic traps were placed in spring 2015 for one month in line with 3 m distance. The habitat provision was identified by Biotope Valuation Method (BVM). The calculated values of both study sites were same (BVM = 41.67). One of the reasons can be the same type of habitat. According to the Catalogue of habitats in Slovakia, both study sites belong to mesophilic pastures and grazed grassland. Biodiversity was evaluated by Shannon-Weaver index. The calculated values were similar (H’ = 1.42 in TA, H’ = 1.25 in LT). In Tajov, a total of 220 individuals of soil arthropods were captured and 169 in Liptovská Teplička. In Tajov, three eurytopic species of Carabidae and one adaptable species (Abax Parallelepipedus) were captured. One order belongs to eudominant species: Poecilus cupreus (50%). In Liptovská Teplička, four eurytopic species of Carabidae and two adaptable species (Carabus cancellatus, Carabus violaceus) were captured. Two species belong to eudominat species: Carabus cancellatus (40.54%) and Carabus violaceus (13.51%). The relationship between Carabidae diversity and the ability of study site to fulfil habitat provision was not confirmed. Carabidae are not closely linked to structure of the vegetation cover, but their occurrence is influenced by habitat microclimate conditions.

1. Introduction
The term “biodiversity” was first used in its long version (biological diversity) by Lovejoy [1] and is most commonly used to describe the number of species [2]. The division of biodiversity into three spheres – genetic diversity (within-species diversity), species diversity (number of species), and ecosystem diversity (diversity of communities) – has seen wide use since its launch during the Convention of Biological Diversity at ‘The Earth Summit’ in 1992 [3].
The biodiversity probably plays a significant role in direct providing of goods and services as well as regulating and modulating ecosystem properties (this term is used here to include ‘processes’ and ‘functioning’) that underpin the delivery of ecosystem services [4]. The biodiversity is not considered as ecosystem service but serve as a prerequisite for all ecosystem services. Biodiversity may play three different roles in ecosystem services, namely as a regulator of ecosystem processes, as a final ecosystem service or as a good that is subject to valuation [5].

Although every organism contributes to ecosystem processes, the nature and magnitude of individual contributions vary considerably. Research in biodiversity places much emphasis on the uniqueness of individual species and their singular contributions to ecosystem services. Some studies have focused on the relationship between biodiversity and such ecosystem processes as production, decomposition and nutrient retention [6]. Researchers at global level have extensively studied recent unprecedented rates of biodiversity loss, which are to the direct result of increased human activities (e.g., climate change, pollution, deforestation, overexploitation of natural resources, habitat loss and the introduction of exotic species [3]).

For the economic evaluation of non-marketed environmental assets (biodiversity) and their life-supporting quality, an approach combining ecological benefits and revitalisation costs of respective biotope types has been developed in Germany and Czech Republic. It is an expert method for the expert ranking of biotopes by point values according to their capacity as an environment for living plant and animal species. This so called Hessian method was recommended in 2000 by the EU White Paper on Environmental Liability and has been used in Hessian land for assessing environmental damages caused by intervening into nature and landscape. The method can be utilized in implementing the EU environmental liability Directive 2004/35/CE of 21 April 2004. Biotope valuation method (BVM) ranks national biotopes by point values according to their capacity as specific environments for living plant and animal species (including NATURA 2000). Each biotope type has been valued by an interdisciplinary team of ecologists and economists from different scientific backgrounds using points according to eight ecological characteristics (maturity, naturalness, diversity of plant species, diversity of animal species, rareness of biotope, rareness of species, vulnerability, and threat to existence), each of them with a potential point value ranging from one to six points. Biotope point values are derived from the relative ecological significance of the respective biotope and are transferred into monetary terms by average national costs of restoration measures, necessary for one-point increase, i.e., for maintaining and improving the biotopes as environments for healthy ecosystems [7, 8].

2. Material and methods
Two permanent grasslands located in different natural and climatic conditions of Slovakia with different management were analysed. Study site Tajov (TA) belongs to the geographical location Kremnica Mountain, and it is located in 647 m a.s.l. with a long-term average temperature of 8.1°C. The soil type is Cambisol and permanent grassland is used as a pasture. Study site Liptovská Teplička (LT) belongs to the geographical location Low Tatras Mountain and it is located in 945 m a.s.l. with a long-term average temperature 6.2°C. The soil type is Rendzina and permanent grassland is mowed.

The biotic parameters (arthropod number and arthropod fresh body biomass) were measured. In the randomly placed transect, 7 plastic traps were placed in spring 2015 (April – May) for one month in line with 3 m distance. The captured individuals were preserved in formalin solution, their taxonomic level of order and family was identified, and the total number of each one was recorded and classified in taxonomic categories (orders). Coleoptera including Carabidae were collected and weighted separately. The biodiversity was evaluated by Shannon-Weaver index (H’). The arthropods were divided according to the percentage representation to class dominance: eudominant (over 10%), dominant (5 – 10%), subdominant (2 – 5%), recendent (1 – 2%) and subrecendent (less 1%). Consequently, Carabidae were categorised into groups according to Hůrka et al. [9]: group R (relict species), group A (adaptable species) and group E (eurytopic species).
It was used a modified Biotope Value Method [7] according to Cudlin [10] taken into account Carabidae. Cudlin [10] used coefficients ranged from 0.6 (minimum) – 1.4 (maximum) that were adjusted to our conditions.

3. Results and discussions
Insect including Carabidae is considered to be a suitable indicator of good environmental conditions [9]. We can evaluate anthropogenic influence on habitat by Carabidae occurrence in the environment and their distribution into the groups according to their tolerance of the anthropogenic influences [11].

Five classes (Arachnida, Isopoda, Diploda, Chilopoda, Insecta) at two study sites were determined in total. The class Insect was represented by five orders: Coleoptera, Hymenoptera, Diptera, Orthoptera, Heteroptera. In study site TA, 220 individuals of arthropods with total body biomass of 10.68 g were collected. In study site LT, only 169 individuals of arthropods were collected, but their total body biomass was greater (21.58 g). The Coleoptera was the eudominant order in both study sites (LT – 43.56%, TA – 25.45%), but in TA the order Arenedida predominated (41.82%) (Tab. 1). The Shannon-Weaver index values were similar (H´ = 1.42 in TA, H´ = 1.25 in LT).

| Table 1 Framing the arthropod orders within dominance in permanent grasslands (%) |
|-----------------------------------|-----------------|-----------------|-----------------|-----------------|
| eudominant | dominant | subdominant | recendent | subrecendent |
| Arendedida (41.82) | Heteroptera (1.36) | Diploda (0.45) |
| Coleoptera (25.45) | Orthoptera (1.36) |
| Hymenoptera (15) |
| Coleoptera (43.56) | Hymenoptera (9.2) |
| Diptera (14.55) |
| Coleoptera (36.8) | Diptera (8.59) |
| LT | Arendedida |

Further, order Coleoptera was evaluated with emphasis on family Carabidae as a bioindicator group. The most of carabids species is not directly linked to the structure of vegetation cover. Their occurrence depends more on climatic conditions, substrate, pH values, altitude, etc. [7]. Hůrka et al. [9] based on mentioned parameters proposed groups of adaptable, relict and eurytopic species typical for nature habitats. The relict species were not determined in this study. In study site LT, 2 adaptable species Carabus cancellatus (15 individuals totally) and Carabus violaceus (5 individuals totally) were determined. Both belonged to eudominant species (Carabus cancelatus 40.54%, Carabus violaceus 13.51%) (Tab. 2).

| Table 2. Carabidae distribution into groups according to Hůrka et al. [9] (number of individuals) |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| TA | LT |
| adaptable |
| Abax parallelepipedus (1) |
| Poecilus cupreus (12) |
| Pseudophorus ruifipes (1) |
| Carabus cancellatus (15) |
| Zabrus tenebroides (2) |
| Calathus fuscipes (2) |
| Poecilus cupreus (9) | `
| eurytopic |
| Broscus cephalotes (1) |
Carabus cancellatus is most widespread from lowlands to sub-mountain areas in open and enclosed habitats. They prefer bright woods, steppes, permanent grasslands, fields. They live under the bark or in heaps of straw [12]. Permanent grasslands in LT create favourable conditions for Carabus cancellatus because the study site is situated near to the forest and field. The second adaptable species (Carabus vialaceus) is also typical for bright woods and open habitat, which offer the study site in LT.

In TA, eudominant species was represented by Poecilus cupreus (50%), which is characterized as heliophilous species typical for fields, permanent grasslands and ruins. P. cupreus indicates degradation processes in ecosystems by Hůrka et al. [9] that could be caused by frequent drive of motorcycles.

Habitat provision was identified by BVM. The calculated values of both study sites were the same (BVM = 41.67). One reason could be attributed to the same type of habitat. According to the Catalogue of habitats in Slovakia, both study sites belong to mesophilic pastures and grazed grassland. To distinguish the habitats, was applied modified BVM method according to Cudlín [10] stressed on Carabidae. Cudlin [10] used coefficients ranged from 0.6 (minimum) – 1.4 (maximum). Because of low numbers of adaptable species in the localities, coefficient of 0.15 in TA and 0.31 in LT was used. The coefficients to recalculate biotope values were used (Tab. 3).

| Study site | Adaptable species (number) | Adjusted coefficient | Biotope value * | Modified biotope value |
|------------|----------------------------|----------------------|-----------------|-----------------------|
| TA         | 1                          | 0.15                 | 41.67           | 6.25                  |
| LT         | 2                          | 0.31                 | 41.67           | 12.92                 |

*according to Seják et al. [7]

The higher biotope value was calculated in LT (12.92) than in TA (6.25). One of the reasons can be that LT study site is located in the protected zone of the Low Tatras Mountain national park. Different anthropogenic areas are restricted in the area which has positive effect on biotope quality.

4. Conclusions
Our results demonstrated the usefulness of Carabidae as bioindicator of biotope quality. It can be confirmed that Carabidae increase biotope value which was reflected in final biotope values calculated for specific conditions of our study areas.

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