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THE ADEQUACY OF SOME COLLECTING TECHNIQUES FOR OBTAINING REPRESENTATIVE ARTHROPOD SAMPLE IN DRY GRASSLANDS

Jana Niedobová[1], Zdeněk Faltýnek Fric[2]

[1] Department of Forest Botany, Dendrology and Typology, Department of Zoology, Fisheries, Hydrobiology and Apiculture, Zemědělská 1, 613 00 Brno, Czech Republic

[2] Biology Centre AS CR, v.v.i., Institute of Entomology, Branišovská 31, 370 05 České Budějovice, Czech Republic

Abstract

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The number of remarkable species on a locality is an important indicator of locality value. The ecological requirements of the rare species may help to target correct landscape management activities. Our objective was to find out if standardly used capture methods for different group of invertebrate are able to detect really representative composition of species including rare taxa. Our experiment was carried out at the Moravský kras Protected Landscape Area (Macošská and Vilémovická stráň slope) where secondary dry grasslands are typical for each investigated locality. We used five groups of invertebrates (spiders, ground beetles, rove beetles, leaf beetles and weevils) and three capture methods (pitfall traps, sweeping on vegetation and yellow Möricke traps). Arthropods were determined and classified according to their rarity. Using the three capture methods, we obtained in total 127 spider species (Areneae), 31 ground beetle species (Carabidae), 29 rove beetle species (Staphylinide), 52 leaf beetle species (Chrysomelidae) and 55 weevil species (Curculionidae).
Results showed that the different capture methods significantly influenced number of detected remarkable species. It was statistically proved for spiders ($P = 0.025$), weevils ($P = 0.038$) and marginally also for rove beetles ($P = 0.051$). Spiders of climax (C species) and semi-natural (SN species) habitats were rather detected by pitfall traps, whereas spiders of disturbed habitats were collected by sweeping on vegetation and Möricke yellow pans eventually. Relict species of weevils (R species) were detected by pitfall traps, typical species (T species) were collected by Möricke yellow pans and expansive species (E species) were found by sweeping on vegetation.

Keywords: collecting techniques, ground beetles, spiders, rove beetles, leaf beetles, weevils

INTRODUCTION

Documentation of invertebrate diversity is an important component of the studies of biodiversity, community dynamics, global change and landscape evaluation (Ward & Larivière, 2004).

Conservation assessment of given locality and its affect on a future planning is dependent on many factors. Number of rare invertebrate species found on investigated locality is one of them. A lot of ecological works from central Europe are established on the basis of natural origin of habitat and invertebrates, classified according to natural origin of habitats categories (Tropek *et al.*, 2010; Franc and Korenko 2008; Samu *et al.*, 2008, etc.). Arachnologists evaluate spider communities according Buchar & Růžička (2002), who classified individual species into categories according to their occupied habitat. The same approach have Hůrka *et al.* (1996) on ground beetles, Boháč *et al.* (2006) on rove beetles and Strejček (2000, 2001) on leaf and weevil beetles.

Sampling the components of the diversity, however, depends on the ability to detect the species and rely on the capture method. Furthermore, it is not surprising that different taxa need different capture methods, e.g. pitfall traps for ground beetles or Möricke pans traps for Diptera or Hymenoptera (Majzlan & Rychlík, 2000; Toler *et al.*, 2005). We can call these techniques the "standard methods". For investigation of a specific area, these methods should meet three conditions: to be efficient, repeatable and representative (Popic *et al.*, 2013). On the other hand, is frequently far of reality and it was documented that capture methods may affect the results (Buffington & Redak, 1998; Lang, 2000; Popic *et al.*, 2013; Ward *et al.*, 2001). Therefore, many experts realized necessity to improve and modify capture methods (Majer, 1978; White *et al.*, 1990) and examine differences between new methods and traditional way (Alinvi *et al.*, 2007). Some entomologists compared effectiveness of sampling techniques for collecting in different type of habitats (Meissle & Lang, 2005; Standen, 2000). Standen (2000) compared several traditional methods for different taxa on limestone grasslands and she offered some recommendation for collecting techniques for species richness estimation. It was also documented that capture methods not usually used for the target taxa (hence "non-standard methods") may likely detect species otherwise considered to be rare (Niedobová *et al.*, 2011). Generally, "non-standard methods" bring some good data about particular species (Patrick & Hansen, 2013; Pekár, 1996; Růžička, 1982; Růžička, 2000; Szinetár *et al.*, 2012a, b).

The objective of the present study was to analyse capture methods and compare their effectiveness in each investigated invertebrates group with focusing on rare species. The investigated groups were spiders (Araneida), ground beetles (Carabidae), rove beetles (Staphylinidae), leaf beetles (Chrysomelidae) and weevil beetles (Curculionidae).

MATERIALS AND METHODS

Study area

The invertebrate sampling was conducted in the northern part of Moravský kras Protected Landscape Area on the west end of the Suchý žleb valley (Czech Republic). Collecting was performed on a total of four transects of the Macošská stráň and Vilémovická stráň slopes. Both localities are typical bysteep slopes, which originated in the limestone bedrock. Well developed limestone pavements with habitats of secondary dry grasslands are characteristic for them. The whole area was previously used as a communal pasture (Kotouč, 2006). In 2006, regular sheep grazing was restored. Individual transects (T1–T4) were given by GPS coordinates:

- Macošská stráň slope T1: 49°22'14"N, 16°44'13"E;
- Macošská stráň slope T2: 49°22'13"N, 16°44'21"E;
- Vilémovická stráň slope T3: 49°22'7"N, 16°44'32"E;
- Vilémovická stráň slope T4: 49°22'9"N, 16°44'38"E.

The entire site is located in the faunistic square 6666 (Pruner and Míka, 1996).

Sampling of the invertebrates

The investigation was conducted in 2008. We used three collecting methods: 1) pitfall traps, 2) yellow Möricke pans and 3) sweeping on vegetation.

Pitfall traps are standardly used as a capture method for epigeic invertebrate fauna (ground beetles, rove beetles and spiders). This capture method is widely used by many experts in the Czech Republic as well as in Europe for decades (Adis, 1979; Absolon *et al.*, 1994; Kůrka, 1982; Jonas *et al.*, 2002; Larsen *et al.*, 2003; Raemakers *et al.*, 2001; Kwiatkovski, 2011 etc.). On the other hand, this method is non-standard for weevils and leaf beetles.

Sweeping on vegetation is widely used as a standard method for beetles living on vegetation (i.e. leaf beetles and weevil beetles) (Novák, 1969; Meek *et al.*, 2001; Wąsowska, 2006; Scibor and Dunus, 2006; Raemakers *et al.*, 2001; Batáry *et al.*, 2007; Hall and Barney, 2011), but not used for ground beetles and rove beetles collecting.

Yellow Möricke traps are standardly used for collecting hymenoptera especially (Kula and Tyrner, 2003; Dvořák and Bogush, 2008; Santos and Aguiar, 2008; Aguiar and Santos, 2010; Ljubomirov, 2008). Yellow Möricke traps were nonstandardly used for collecting spiders, ground beetles, rove beetles, leaf beetles or weevils.

Five pitfall traps were placed in each of the four transects. We used plastic cups (capacity 500 ml) with 4% formaldehyde solution as a fixative medium. The traps were arranged in lines along the slope at about five-metre intervals.

Placement and emptying of traps took place on April 22, May 22, June 18, July 22, August 18, September 21, October 21 and November 28. Thus, pitfall traps were inspected and the trapped material was collected every month.

Yellow Möricke pans consisted of food boxes 10 × 10 cm with yellow acrylate colour spot number 6400 in the middle of each box. Five pans were placed in lines at five-metre intervals. Saline solution with the addition of few drops of detergent as a wetting agent served as killing and fixation medium. Yellow Möricke pans were installed at the locations on April 22, 2008 and the material was collected every two weeks; or every week in the hot summer months.

Sweeping on vegetation was also done every two weeks, always with frequency 200 sweeps per transect line.

Material of all taxonomic group obtained from the study was preserved in 70% alcohol solution.

Evaluation methods

Arachnologists evaluate assemblages of spiders by the so called "natural origin" of habitats (Buchar and Růžička, 2002; Řezáč, 2009). They classified species to four groups: species of climax habitats (C), semi-natural habitats (SN), disturbed habitats (D) and artificial habitats (A). The advantage of this approach is that individual species may simultaneously occupy several categories and its fit to the four groups. Occupation of several categories was converted to the percentages.

Similar evaluation but with the other marking was assumed for some Coleoptera. Ground beetles were divided into three groups: The R-species, A-species and E-species (Hůrka *et al.*, 1996). R species have relic character. They are rare and endangered and we can find them in such natural habitats like screes, steppes and rocky steppes, heathlands, natural forests, spring areas, marshlands, natural river bangs, bottom lands and species with arcto-apline and boreoalpine occurrence etc. The A-species are characterised as adaptable species. They occur in altered habitats close to natural condition – forests, stagnant and running water banks, meadows, pastures etc. The E-species occur in naturally disturbed habitats and habitats influenced by man s activities. This group includes also expansive or invasive species.

The above mentioned classification was adapted with some distinction by Boháč *et al.* (2006) also on Rove beetles (Staphylinidae). His RI category included species living on well-preserved biotopes not influenced by human activity (or with weak human activity) like species with arcto-alpine, boreomontane and boreoalpine ocurrence, they inhabit mainly mountains and peatbogs, or only occur in remnants of forests stands, which resemble recent climax forests. The R2 category was for species living in biotopes moderately affected by human activity. The E category was for species of heavily affected anthropogenic sites and this category includes eurytopic species that successfully occupy deforested sites and are also found in areas strongly anthropogenic influenced.

Scales with the same meaning were used for leaf beetles (Chrysomelidae) (Strejček, 2000). The R-species were regarded as the relict species, the T-species were adapted to alternate biotops and the E-species adapted to secondary biotops (including artificial habitats). One year later he (Strejček, 2001) divided also the weevils (Curculionidae) into the same three categories (Strejček, 2001). The R-species are relicts occuring on naturaly relict localities only. The T-species are typical for specific biotopes and are able to adapt to alternate biotopes. The E-species are expansive, very adaptable species.

Data analyses

We classified each individual to the category of „relictness“ (in the case of Coleoptera) or „natural origin“ habitat category (in the case of Araneae) and we recorded the capture method.

Effects of species characteristic mentioned above were tested by Canonical Correspondence Analysis (CCA) from CANOCO for Windows v. 4.5 (Lepš and Šmilauer, 2003). We used Monte Carlo permutation test with 999 permutations. Capture methods of each individual species represented species data. Species of each invertebrates group according the classification categories were used as explanatory variables.

RESULTS

Using the three capture methods, we obtained in total 127 spider species (2076 individuals), 31 ground beetles species (2204 individuals) (Carabidae), 29 rove beetles species (239 individuals) (Staphylinide), 52 leaf beetles species (1044 individuals) (Chrysomelidae) and 55 weevil species (323 individuals) (Curculionidae).

CCA analysis showed significant results for spiders (F = 3.389, P = 0.025) and weevils (F = 2.838, P = 0.038), results for rove beetles were only marginally significant (F = 2.761, P = 0.051). It means that representative samples of these three groups of invertebrates were influenced by capture methods (Tab. I).

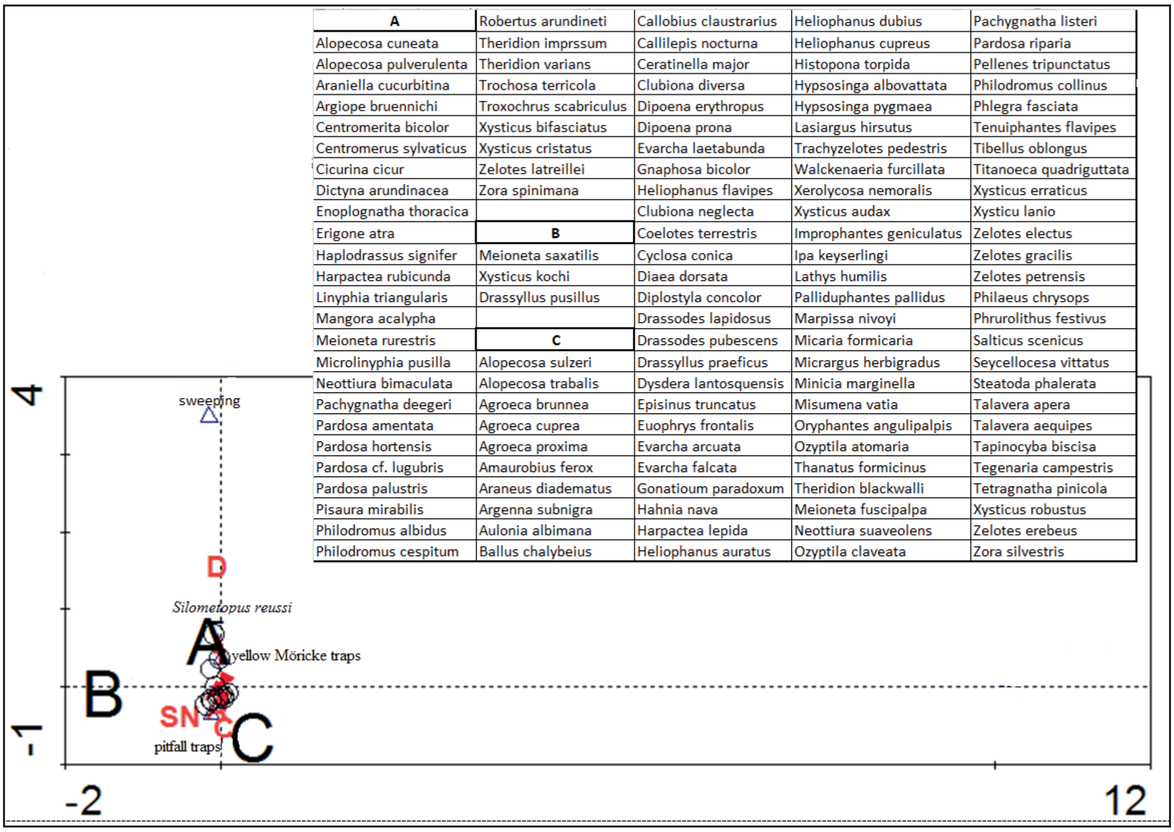
Spiders of climax (C species) and semi-natural (SN species) habitats were rather detected by pitfall traps (standard method), whereas spiders of disturbed habitats were collected by sweeping on vegetation and Möricke yellow pans eventually (nonstandard method) (Fig. 1).

Relict species of weevils (R species) were detected by pitfall traps (nonstandard method), typical species (T species) were collected by Möricke yellow pans (nonstandard method) and expansive species (E species) were found by sweeping on vegetation (standard method) (Fig. 3).

Marginally significant were data of rove beetles and their affinity to capture methods. We found that the relict species (RI species), namely *Ontholestes haroldi* (Eppelshheim, 1884) and *Eusphalerum semicoleoptratum* (Panzer, 1795) were found by sweeping on vegetation (nonstandard method) (Fig. 2). This findings is very important, because sweeping on vegetation is not used for rove beetles collecting.

I: *Results of Canonical Correspondence Analysis (CCA). Catching of spiders species, rove beetles and weevils, which have a real importance for natural protection depends significantly on capture methods (P < 0.05).*

Spiders	Groundbeetles	Rovebeetles	Leafbeetles	Weevils
Trace = 0.144	Trace = 0.072	Trace = 0.262	Trace = 0.016	Trace = 0.101
F = 3.389	F = 1.518	F = 2.761	F = 0.696	F = 2.838
P = 0.025	P = 0.305	P = 0.051	P = 0.512	P = 0.038



A	Robertus arundineti	Callobius claustrarius	Heliophanus dubius	Pachygnatha listeri
Alopecosa cuneata	Theridion imprssum	Callilepis nocturna	Heliophanus cupreus	Pardosa riparia
Alopecosa pulverulenta	Theridion varians	Ceratinella major	Histopona torpida	Pellenes tripunctatus
Araniella cucurbitina	Trochosa terricola	Clubiona diversa	Hypsosinga albovattata	Philodromus collinus
Argiope bruennichi	Troxochrus scabriculus	Dipoena erythropus	Hypsosinga pygmaea	Phlegra fasciata
Centromerita bicolor	Xysticus bifasciatus	Dipoena prona	Lasiargus hirsutus	Tenuiphantes flavipes
Centromerus sylvaticus	Xysticus cristatus	Evarcha laetabunda	Trachyzelotes pedestris	Tibellus oblongus
Cicurina cicur	Zelotes latreillei	Gnaphosa bicolor	Walckenaeria furcillata	Titanoeca quadriguttata
Dictyna arundinacea	Zora spinimana	Heliophanus flavipes	Xerolycosa nemoralis	Xysticus erraticus
Enoplognatha thoracica		Clubiona neglecta	Xysticus audax	Xysticu lanio
Erigone atra	B	Coelotes terrestris	Improphantes geniculatus	Zelotes electus
Haplodrassus signifer	Meioneta saxatilis	Cyclosa conica	Ipa keyserlingi	Zelotes gracilis
Harpactea rubicunda	Xysticus kochi	Diaea dorsata	Lathys humilis	Zelotes petrensis
Linyphia triangularis	Drassyllus pusillus	Diplostyla concolor	Palliduphantes pallidus	Philaeus chrysops
Mangora acalypha		Drassodes lapidosus	Marpissa nivoyi	Phrurolithus festivus
Meioneta rurestris	C	Drassodes pubescens	Micaria formicaria	Salticus scenicus
Microlinyphia pusilla	Alopecosa sulzeri	Drassyllus praeficus	Micrargus herbigradus	Seycellocesa vittatus
Neottiura bimaculata	Alopecosa trabalis	Dysdera lantosquensis	Minicia marginella	Steatoda phalerata
Pachygnatha deegeri	Agroeca brunnea	Episinus truncatus	Misumena vatia	Talavera apera
Pardosa amentata	Agroeca cuprea	Euophrys frontalis	Oryphantes angulipalpis	Talavera aequipes
Pardosa hortensis	Agroeca proxima	Evarcha arcuata	Ozyptila atomaria	Tapinocyba biscisa
Pardosa cf. lugubris	Amaurobius ferox	Evarcha falcata	Thanatus formicinus	Tegenaria campestris
Pardosa palustris	Araneus diadematus	Gonatioum paradoxum	Theridion blackwalli	Tetragnatha pinicola
Pisaura mirabilis	Argenna subnigra	Hahnia nava	Meioneta fuscipalpa	Xysticus robustus
Philodromus albidus	Aulonia albimana	Harpactea lepida	Neottiura suaveolens	Zelotes erebeus
Philodromus cespitum	Ballus chalybeius	Heliophanus auratus	Ozyptila claveata	Zora silvestris

1: *Tendency of spiders groups (C, SN, D, A) to the capture methods (pitfall traps, yellow Möricke traps and sweeping). Red letters means category of spiders species evaluated by the origin of habitats (C – climax species, SN – semi natural species, D – species of disturbed habitats and A – species of artificial habitats). Big black letters represent concrete spiders species. There is list of this spider species in the table.*

DISCUSSION

When studying five groups of arthropods, which are often used for ecological assessment of protected areas and subsequent landscape management, we found that the capture method influenced number of caught ecologically important species of spiders, weevils and also marginally significantly rove beetles, especially in the terms of their rarity or specificity to natural habitats.

It is not surprising that different capture methods detect different composition of species because of their specific lifestyle, ecological or ethological differences or species'functional role. Cherrill and Sanderson (1994) proved that pitfall traps capture different composition of Hemiptera compared with sweep netting. Popic *et al.* (2013) evaluated common methods for sampling invertebrate pollinators. They found that net sampling is more effective that pan traps in the sense of number of species and abundance.

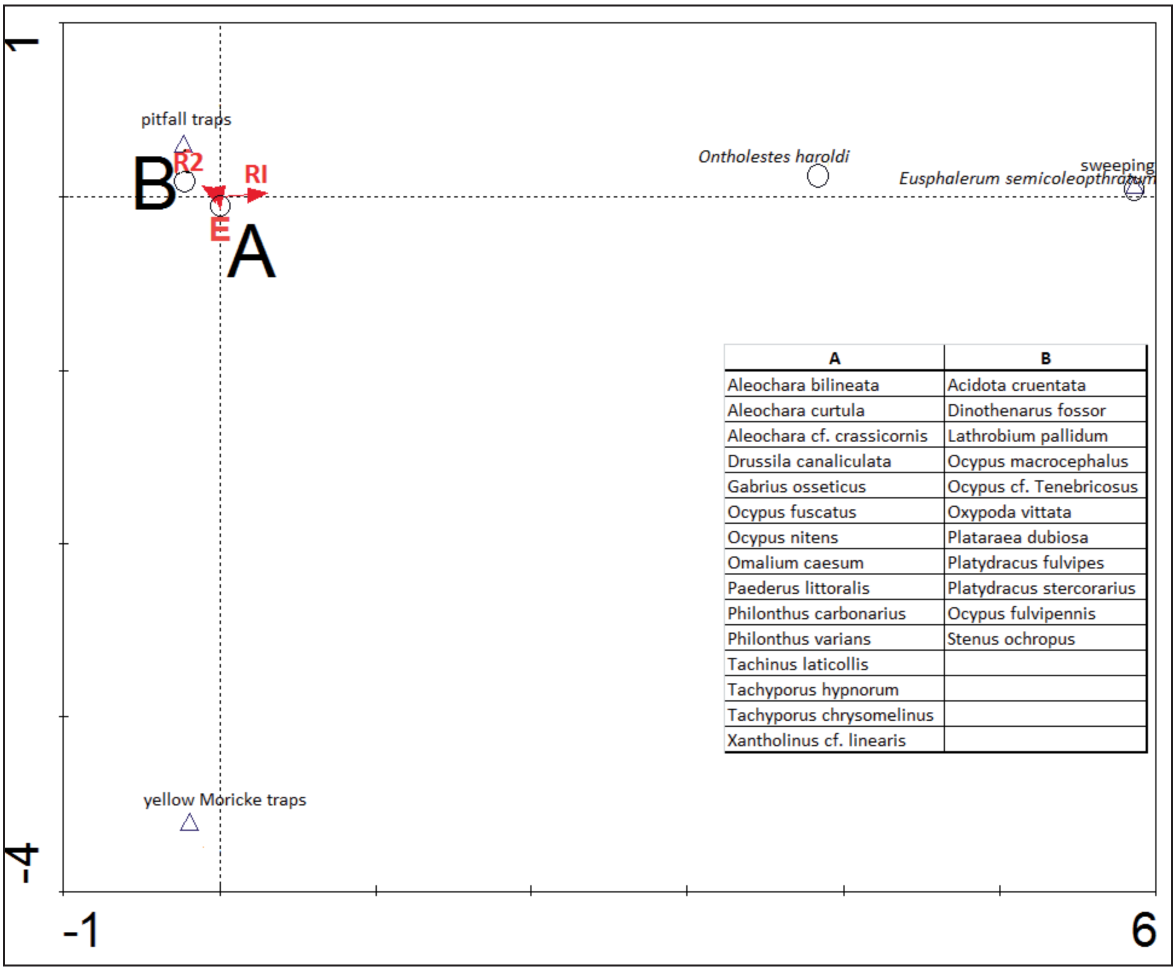
Standen (2000) solved the question of adequacy of collecting techniques for estimation of species richness of grassland invertebrates. He proved that root feeding weevils were captured predominantly by pitfall traps. Though, a lot of coleopterologists use sweeping for collecting of weevils (Batáry *et al.*, 2007; Raemakers *et al.*, 2001; Salsbury and Dinkins, 1979; Scibor and Dunus, 2006 etc.), our results showed that the weevils pitfall traps assemblages contained more "rare" species than the weevil composition from sweeping or yellow Möricke traps.

We confirmed that pitfall traps are able to afford representative sample (with the most ecological important species) of spiders too. Rushton *et al.* (1989) proved with using pitfall traps that there were some resemblance of change in ground beetle and spider species among habitat types. Standen (2000) found out that ground beetles and spiders were more abundant in pitfall traps than in swipping net and D-vac samples. Therefore, we strongly recommend combining several collecting methods when inventorying an area.

Different capture methods collect different arthropod assemblages. Difference is in the quantity of habitat specialist and also in the arthropod assemblages in the sense of species rarity. It is likely that the problem is in arbitrary selection of appropriate taxa in the classification of all the investigated invertebrate groups. It is likely that some of the species obtained higher "rarity" rank only because of their lower detection rate by standard methods.

CONCLUSIONS

During our study, we found that different capture methods can affect not only composition of the



A	B
Aleochara bilineata	Acidota cruentata
Aleochara curtula	Dinothenarus fossor
Aleochara cf. crassicornis	Lathrobium pallidum
Drussila canaliculata	Ocypus macrocephalus
Gabrius osseticus	Ocypus cf. Tenebricosus
Ocypus fuscatus	Oxypoda vittata
Ocypus nitens	Plataraea dubiosa
Omalium caesum	Platydracus fulvipes
Paederus littoralis	Platydracus stercorarius
Philonthus carbonarius	Ocypus fulvipennis
Philonthus varians	Stenus ochropus
Tachinus laticollis	
Tachyporus hypnorum	
Tachyporus chrysomelinus	
Xantholinus cf. linearis	

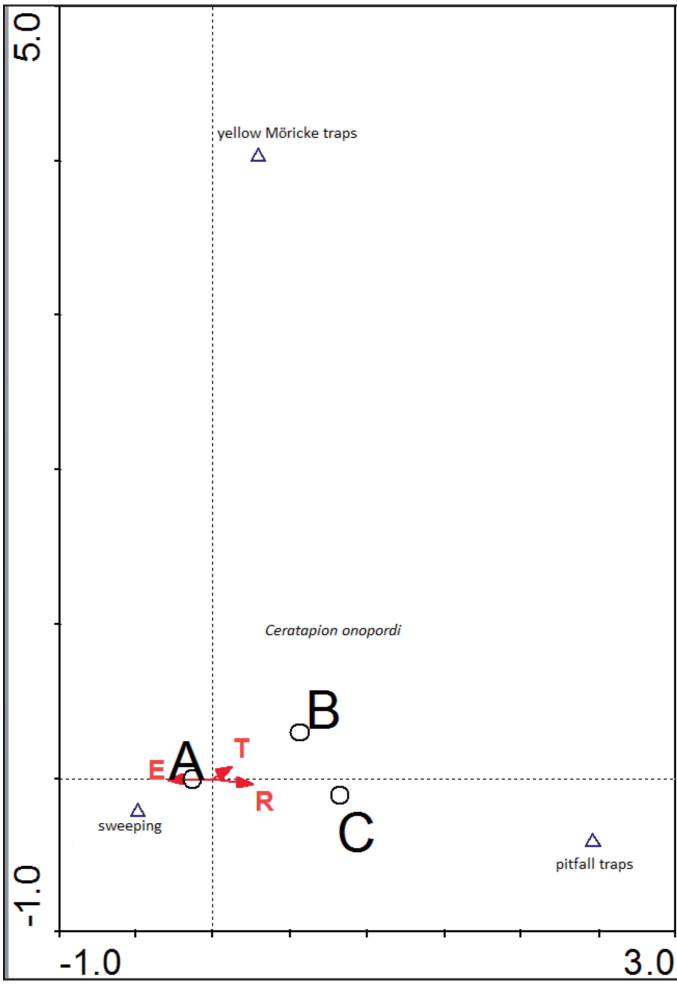
2: *Tendency of rove beetles groups (RI, R2, E) to the capture methods (pitfall traps, yellow Möricke traps and sweeping). Red letters means category of relictnees (RI – species are minimally influenced by anthropogenic factors, R2 – species are influenced by anthropogenic factors mediumly and E – group of species on hardly anthropogenic influenced biotops). Big black letters represent concrete rove beetles species mentioned in the table of Fig. 2.*

detected species but also different communities in the sense of rarity and habitat specificity. Whereas no bias was observed in leaf beetles and ground beetles, the differences were strongly or at least marginally in rove beetles. Significant results were detected in all the other groups: spiders and weevils. Therefore, we urge to combine several collecting methods for locality inventories.

SUMMARY

Number of rare species on locality is a very important indicator of locality value. Furthermore, the ecological requirements of the rare species may help to target correct landscape management activities. Our objective was to investigate whether standardly used capture methods for different groups of arthropods are able to detect really representative composition of species (criteria were the rare species collected). Our experiment was situated at the Moravský kras Protected Landscape Area (Macošská and Vilémovická stráň slope) where secondary dry grasslands are typical for each investigated locality. We used five groups of arthropods (spiders, ground beetles, rove beetles, leaf beetles and weevils) and three capture methods (pitfall traps, sweeping on vegetation and yellow Möricke traps). The arthropods were determined and each species was classified according to its scarceness. Using the three capture methods, we obtained in total 127 spider species, 31 ground beetle species (Carabidae), 29 rove beetle species (Staphylinide), 52 leaf beetle species (Chrysomelidae) and 55 weevil species (Curculionidae).

Each capture method was evaluated in the context of scarce species. Results showed that the different capture methods significantly influenced number of detected rare species. It was statistically proved for spiders (P = 0.025), weevils (P = 0.038) and marginally also on rove beetles (P = 0.051).



A	B
Anthonomus rubi	Apion cruentatum
Catapion seniculus	Barynotus obscurus
Ceutorhynchus obstrictus	Brachysomus echinatus
Ceutorhynchus typhae	Hypera plantaginis
Cionus thapsus	Larinus pollinis
Eusomus ovulum	Parafoucartia squamulata
Hemitrichapion pavidum	Phyllobius maculicornis
Hypera nigrirostris	Sitona striatellus
Ischnopterapion loti	Synapion ebeninum
Otiorhynchus laevigatus	Trachyphloeus bifoveolatus
Otiorhynchus ovatus	
Otiorhynchus raucus	**C**
Otiorhynchus singularis	Cionus ganglbaueri
Otiorhynchus sulcatus	Graptus kaufmanni
Oxystoma cerdo	Otiorhynchus ligustici
Phyllobius pyri	Otiorhynchus orbicularis
Phyllobius vespertinus	Protapion gracilipes
Protapion apricans	Pseudocleonus grammicus
Protapion assimile	Trachyphloeus alternans
Protapion trifolii	Tychius lineatulus
Pseudoperapion brevirostre	Tychius stephensi
Pseudostenapion simum	
Sciaphilus asperatus	
Sitona hispidulus	
Sitona humeralis	
Sitona languidus	
Sitona lineatus	
Sitona macularius	
Sitona puncticollis	
Sitona sulcifrons	
Stenocarus ruficornis	
Stenopterapion tenue	
Tatianaerhynchites aequatus	
Trichosirocalus troglodytes	
Tychius picirostris	

3: *Tendency of weevil groups (R, T, E) to the capture methods (pitfall traps, yellow Möricke traps and sweeping). Red letters means category of weevils evaluated by the category of relictnees (R – relict weevils which are able to live in natural habitats only, T – weevils which are typical for some characteristic biotop, E – expansive and very adaptable weevils). Big black letters represent concrete weevils species mentioned in the table.*

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Contact information

Jana Niedobová: Naaudia@seznam.cz
Zdeněk Faltýnek Fric: fric@entu.cas.cz