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ORIGINAL ARTICLE

Efficiency of pitfall traps with funnels and/or roofs in capturing ground-dwelling arthropods

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Abstract. Pitfall traps are widely used for sampling ground-dwelling arthropods. Their sampling efficiency is affected by several factors, e.g. material, size and modification of parts of the trap and sampling design. Pitfall trap sampling is also affected by the accumulation of plant litter in the traps, rain fall and by-catches of small vertebrates, which may cause a bias in the catch by obstructing traps or attracting certain insects. A roof that prevents rain and plant litter entering a trap, prevents dilution of the preservative and escape of arthropods. The main goal of present study was to compare the effect of four types of differently combined funnel and roof pitfall traps on the capture efficiency of epigeal arthropods. We found that a funnel and/or a roof had no effect on spider catches. Total abundance of large carabids and thus the total abundance of ground beetles was lower in funnel pitfall traps without a roof than in other types of traps. However, funnel pitfall traps with roofs collected significantly more carabid beetles, especially individuals of those species that are large or good fliers. We conclude that funnel pitfall traps with roofs have no negative effects on capture efficiency of ground beetles and spiders, therefore application of this sampling technique is strongly recommended.

INTRODUCTION

Choosing the most efficient method of sampling is crucial in studies aiming to compare invertebrate assemblages (Ernst et al., 2015). Pitfall traps are the most widely used tools for sampling ground-dwelling arthropods in ecological studies and monitoring programs (Southwood & Henderson, 2000; Babin-Fenske & Anand, 2010; Da Silva et al., 2011; Isaia et al., 2015; Brown & Matthews, 2016). Pitfall traps are easy to transport and install; they cost little, cause relatively low disturbance and can yield a large number of individual invertebrates and species (New, 1998; Woodcock, 2005; Santos et al., 2007). Usually, traps consist of plastic or glass containers that are dug into the ground with the top flush with ground level (Brown & Matthews, 2016). In most studies, traps contain a preservative fluid to prevent arthropods from escaping and preserve the material collected (Jud & Schmidt-Entling, 2008; Knapp & Ruzicka, 2012). However, there are various types of pitfall traps, which also incorporate barriers, drift-fences, funnels, roofs or special components such as baits and time-sorters (Woodcock, 2005; Brown & Matthews, 2016).

Many studies demonstrate that catches of pitfall traps are influenced by a number of factors; the technical parameters, such as the diameter of the cup (Baars, 1979; Santos et al., 2007), preservative fluid (Pekár, 2002; Schmidt et al., 2006), trap material (Luff, 1975; Koivula et al., 2003) and spacing (Baker & Barmuta, 2006; Schirmel et al., 2010), which can be adjusted. Other factors are specific to the environment like habitat structure (Melbourne, 1999; Lang, 2000) or temperature (Saska et al., 2013) and the target group of invertebrates (like their typical abundance, activity and catchability) (Southwood & Henderson, 2000) and cannot be changed by the investigator. The optimal trap efficiently collects invertebrates with minimal bias and reduce by-catches of non-target animals (New, 1999; Buchholz et al., 2011; Lange et al., 2011). The aim of the present study was to compare the sampling efficiency of different types of pitfall traps. We specifically tested how the addition of a funnel and/or a roof to the traps affects the catches of two invertebrate predator taxa, carabids and spiders. We hypothesized that the use of funnel pitfall trap with a roof does not have a negative effect on the efficiency with which it captures invertebrates.

MATERIAL AND METHODS

This study was conducted in 2014, from May to October in a forest-wet meadow complex at Turjánvidék, Central Hungary (46°43´N, 19°20´E). The climate is continental; the annual precipitation is a 500–600 mm and the mean annual temperature is 10–11°C (Bíró et al., 2013; Tölgyesi et al., 2015). Grasslands were mowed once a year, at the beginning of July. The dominant species of trees in the forest patches include narrow-leafed ash (*Fraxinus angustifolia*) and English oak (*Quercus robur*).

We compared four types of pitfall traps: (1) conventional pitfall trap without a roof, (2) conventional pitfall trap with a roof,

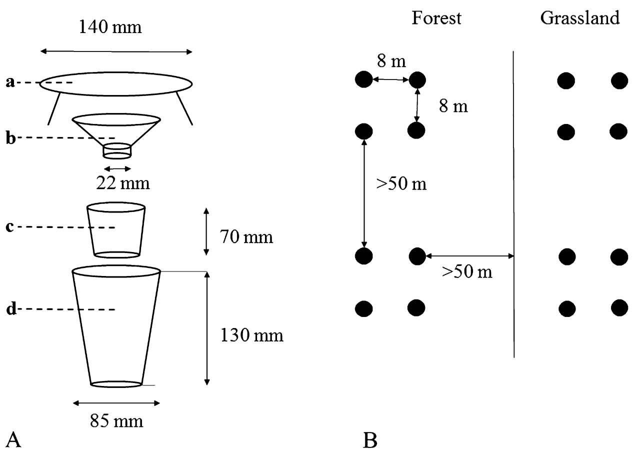

Fig. 1. Exploded view of a pitfall trap (a) and the layout of the sampling scheme (b). Conventional traps without a roof included only component d, conventional traps with a roof components d+a, funnel pitfall traps without a roof d + c + b, funnel pitfall traps with a roof d + c + b + a. Abbreviations of components: a – roof, b – funnel, c – small cup, d – large cup.

(3) funnel pitfall trap without a roof and (4) funnel pitfall trap with a roof (Fig. 1). All traps were 500 ml white plastic cups; the roofs were made of white plastic plates held in position, ca. 3–5 cm above the surface using 100 mm plastic sticks, and the funnels were cut out of 1500 ml transparent plastic bottles (PET, polyethylene terephthalate). The funnel pitfall traps also had an additional small transparent plastic cup for easier handling of the collected material and to prevent the funnel collapsing into the larger plastic cup.

We used 50% ethylene-glycol dissolved in water as a preservative and a few drops of odourless detergent to break the surface tension (Koivula et al., 2003; Schmidt et al., 2006). We established ten sampling sites in forest patches and ten in adjacent grassland. Four traps (one of each type) were placed at random in a quadrate at each site, with 8 m between the traps, this trap distance corresponds to the recommended minimum space between traps (Perner & Shueler, 2004; Zhao et al., 2013). As our aim was to directly compare the capture efficiency of different types of traps we chose a relatively short distance in order to minimize the influence of differences in microhabitat conditions within sites (Lange et al., 2011). Although a small distance between traps may have decreased the numbers of invertebrates captured (e.g.Ward et al., 2001), it would, however, have had a similar effect on all the traps due to the random design. The closest sites were at least 50 m apart to reduce spatial autocorrelation between samples (Fig. 1). In total, we installed 80 traps, two habitats × ten sampling sites × four traps. Sampling was conducted in three periods in 2014, between May 5 and 12, July 24 and August 1, and October 9 and 20 (further information is given in Table S1).

Adult spiders and carabid beetles were identified to species level according to Nentwig et al. (2014) and Freude et al. (2004) and were sorted into size classes in order to test the sampling efficiency for a bias according to size (large species >10 mm and small species <10 mm). Furthermore, spiders were classified according to hunting strategy (web builders and hunters) and main stratum (ground and vegetation) following Buchar & Ruzicka (2002) and Cardoso et al. (2011). It is generally accepted that flying ability decreases with increasing body size in carabid beetles (Blake et al., 1994; Ribera et al., 2001; Martinson & Raupp, 2013). Therefore, size and flying ability were not used as separate traits in this study. Alternatively, two body size categories (small (S) <10 mm and large (L) >10 mm) and three flight ability categories (brachypterous or dimorphic wings, no flight muscles (F1); polymorphic wings and polymorphic flight muscles (F2); macropterous species, functional flight muscles (F3)) were combined into six classes (S-F1, S-F2, S-F3, L-F1, L-F2, L-F3). The categories of flying ability were based on Hurka (1996), Freude et al. (2004) and the database carabids.org (Homburg et al., 2014). Designation of body length follows Brust (1990), Pihlaja et al. (2006) and Sint & Traugott (2015). Voucher specimens were deposited in the invertebrate collection of the University of Szeged.

Data from the three sampling periods were pooled prior to analysis. The effect of funnel and roof on spider and carabid species richness and the abundances of functional groups were tested using mixed-effect general linear models (GLMM) with a poisson error term, typically used for count data and with a quasipoisson error term if we detected overdispersion in the data (Crawley, 2007). (R, lme4 package: version 1.1.12, glmer function; MASS package: version 7.3.23, glmmPQL function). The effect of *roof* (present versus absent), *funnel* (present versus absent) and their interaction (*roof* × *funnel*) were treated as the fixed effects. To incorporate possible effect of spatial autocorrelation and differences in the structure of vegetation among sites, *sampling site* within *habitat type* (forest versus grassland) was used as the random effect. Separate models were run for forests and grasslands if the variability within a trap type was largely explained by the variance of the random effect. In this case, sampling site was the random effect. For goodness of fit, marginal and conditional R-squared values were estimated for the GLMM.

The statistical calculations were performed using the software R (version 3.3.2) (R Development Core Team, 2013).

RESULTS

In total, of 3279 spiders (2792 adults) and 2698 carabid beetles were collected, which belonged to 100 and 67 species, respectively (see Tables S2a–b and S3a–b). Distributions of the species and individuals caught by the different types of traps are given in Table 1. Furthermore, 45 vertebrates were caught, but pitfall traps with funnels caught fewer vertebrates: one amphibian and one mammal (see Table S4).

The species richness of spiders was not influenced by the type of trap (roof: z = 0.09, P = 0.929; funnel: z = –1.38, P = 0.166; funnel × roof: z = 0.86, P = 0.387, marginal R^2 = 0.028, conditional R^2 = 0.153). Furthermore, there was no

Table 1. The means (*μ*) and standard errors (*SE*) of the numbers of species and individuals caught by the different types traps. Abbreviations: conv – conventional, S – number of species, N – number of individuals, a – roof, b – funnel, c – small cup, d – large cup.

Type		conv. pitfall		pitfall + roof		funnel pitfall		funnel pitfall + roof	
Element		d		d + a		d + c + b		d + c + b + a	
		μ	*SE*	*μ*	*SE*	*μ*	*SE*	*μ*	*SE*
Spiders	S	12.50	0.87	12.40	0.77	11.00	0.83	12.20	0.80
	N	32.35	3.40	38.80	3.00	30.85	4.01	37.6	3.47
Carabids	S	7.45	0.83	6.60	0.82	6.90	0.92	7.40	0.92
	N	40.75	9.61	36.50	6.90	22.10	4.47	33.50	6.75

Table 2. The effect of roof and/or funnel and their interaction on the numbers of spiders and carabids caught by pitfall traps. Conventional pitfall traps were used as a control. Regression coefficients (*β*), *t* and *P* values are given. N – number of individuals, S – small (<10 mm), L – large (>10 mm), F1 – non-flying, F2 – flying possible, F3 – flying, f – forests, g – grasslands.

	Roof			Funnel			Roof : Funnel			R^2	
	β	*t*	*P*	*β*	*t*	*P*	*β*	*t*	*P*	marginal	conditional
Spiders											
N	0.181	1.535	0.130	–0.047	–0.379	0.705	0.016	0.094	0.924	0.002	0.015
Large N	0.037	0.186	0.852	0.074	0.369	0.713	–0.301	–1.031	0.306	0.009	0.151
Small N	0.193	1.606	0.113	–0.058	–0.459	0.647	0.040	0.236	0.813	0.003	0.021
Ground N	0.199	1.641	0.106	–0.026	–0.206	0.837	–0.009	–0.051	0.959	0.002	0.019
Vegetation N	0.210	1.689	0.096	–0.266	–1.898	0.062	0.300	1.645	0.105	0.033	0.107
Carabid beetles											
N	–0.110	–0.945	0.348	–0.611	–4.532	**<0.001**	0.585	3.236	**0.002**	0.009	0.151
L-F1	–0.099	–0.689	0.493	–0.749	–4.274	**<0.001**	0.584	2.500	**0.015**	0.025	0.233
L-F2	0.032	0.204	0.839	–0.531	–2.933	**0.005**	0.374	1.550	0.127	0.011	0.518
L-F3	–0.138	–0.689	0.494	–0.971	–3.727	**<0.001**	0.780	2.298	**0.025**	0.028	0.535
S-F1	–0.126	–0.518	0.606	–0.221	–0.882	0.382	0.630	1.855	0.069	0.010	0.283
S-F2	–0.288	–0.980	0.331	–0.575	–1.796	0.078	0.426	0.931	0.356	0.020	0.275
S-F3	–0.405	–1.663	0.102	–0.492	–1.966	0.054	0.939	2.696	**0.009**	0.020	0.419
L-F2 (f)	0.061	0.366	0.717	–0.524	–2.659	**0.013**	0.385	1.477	0.151	0.022	0.068
L-F2 (g)	–0.486	–0.942	0.355	–0.619	–1.151	0.260	–0.074	–0.084	0.934	0.080	0.474
L-F3 (f)	–0.084	–0.322	0.750	–0.949	–2.777	**0.010**	0.690	1.550	0.133	0.034	0.129
L-F3 (g)	–2.079	–1.903	0.068	–1.386	–1.702	0.100	3.332	2.433	**0.022**	0.309	0.620

difference in the total abundances of spiders or the abundance of the different functional groups (Tables 2 and S5).

The species richness of carabid beetles was also unaffected by type of trap (roof: z = –1.018, P = 0.309; funnel: z = –0.652, P = 0.515; funnel × roof: z = 1.141, P = 0.254, marg. $R^2 = 0.007$, con. $R^2 = 0.561$). The abundance of the carabid beetles caught was affected by the different types of traps (Tables 2 and S5). The total abundance of beetles was lower in funnel pitfall traps than in conventional traps. Roof alone had no effect, but the use of both roof and a funnel had a positive effect on the capture efficiency. Type of trap had no effect on the abundance of small beetles, except for the positive effect of funnel pitfall traps with a roof on the capture of the S-F3 group. Regardless of their flight ability, fewer large beetles were collected by funnel pitfall traps than by the other types of traps. In the two habitats, the type of pitfall trap had a different effect on the abundance of large carabids caught (Tables 2 and S5). In forests, funnel pitfall traps collected fewer L-F2 and L-F3 carabids, and in grasslands, traps with a funnel and a roof had positive effect on the capture of the L-F3 group.

DISCUSSION

Numerous factors bias pitfall trap catches (reviewed by Brown & Matthews, 2016), however, this method has several favourable attributes such as low labour-requirement and simultaneous sampling at many locations. In this study, we compared the effects of different combinations of funnel and roof types of pitfall traps. In support of our hypothesis there was no bias in the capture efficiency of arthropods by funnel pitfall traps with a roof in this study. We also showed that the suitability of different types of traps depends on the target taxa (spider vs carabids) and functional group (e.g. small vs large beetles). Type of trap did not affect significantly the number of spiders caught, however, funnel pitfall traps collected fewer large beetles. Moreover, we show, that funnel pitfall traps with roofs catch fewer small vertebrates (Table S4). Funnel pitfall traps perform better than conventional pitfall traps for several reasons. They can be more efficient in retaining invertebrates in the cups and thus collect more specimens (e.g. Vlijm et al., 1961; Baars, 1979; Obrist & Duelli, 1996), the use of a funnel prevents the evaporation of the preservative fluid (Gurdebeke & Maelfait, 2002), and greatly reduces catches of vertebrates (Pearce et al., 2005; Lange et al., 2011; Brown &Matthews, 2016). However, in the present study we also found a negative effect on the number of large carabids caught. The diameter of the funnel neck was only 22 mm and the slope of the lateral wall of the trap was lower than in traps without funnels, allowing a greater number to escape (Cheli & Corley, 2010; Knapp & Ruzicka, 2012).

Our results are in accordance with Brown & Matthews (2016), as they emphasize the benefits of using rain guards. Roofs may reduce the dilution of the preservative caused by rain and the accumulation of litter in the traps. Litter that accumulates in traps without a roof may increase the chance of escaping, which presumably decreases the catches of arthropods. Roofs may also intercept active flying beetles, thus preventing their escape. In accordance with our results, Cheli & Corley (2010) also report no effect of roofs on the sampling of spiders. On the other hand, Siewers et al. (2014) report that the largest carabids and spiders were more frequently recorded in pitfall traps with plastic covers, than in pitfall traps with other types of cover, e.g., wire mesh. Colour of the roof has no effect on the capture efficiency of carabid beetles and spiders (Buchholz & Hannig, 2009), however, opaque roofs may lower the sampling efficiency of species of day-active carabids (Baars, 1979; Bell et al., 2014).

Considering the random effects, we suggest that habitat has an important effect on the catching efficiency of different types of traps, particularly in the case of large beetles. Presumably, the higher amount of litter in forests compared to mowed grasslands, where dead plant material is removed, may increase the chance of their escaping from traps without roofs.

Compared to the other combinations, funnel pitfall traps with a roof are the most effective method for sampling. The accidental catching of vertebrates can be avoided by using funnels, and a roof may indirectly results in reducing the number of invertebrates that escape, by preventing litter from falling into the trap and retaining beetles that try to fly out of the trap. If the expectation is that a high number of large invertebrates will be caught, the diameter of the exit of the funnel has to be chosen carefully, especially if beetles are being sampled in a forest. Based on our results we emphasize that in addition to the sampling design, such as nested cross array (Perner & Schueler, 2004) or two-circle method (Zhao et al., 2013), the use of a suitable type of trap is also important for accurately estimating the density of ground-dwelling arthropods using pitfall traps.

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REFERENCES

Baars M.A. 1979: Catches in pitfall traps in relation to mean densities of carabid beetles. — *Oecologia* **41**: 25–46.

Babin-Fenske J. & Anand M. 2010: Terrestrial insect communities and the restoration of an industrially perturbed landscape: assessing success and surrogacy. — *Restor. Ecol.* **18**: 73–84.

Baker S.C. & Barmuta L.A. 2006: Evaluating spatial autocorrelation and depletion in pitfall-trap studies of environmental gradients. — *J. Insect Conserv.* **10**: 269–276.

Bell A.J., Phillips I.D., Floate K.D., Hoemsen B.M. & Phillips C.E. 2014: Effects of pitfall trap lid transparency and habitat structure on the catches of Carabid beetles (Coleoptera, Carabidae) in tame pasture. — *Environ. Entomol.* **43**: 139–145.

Biró M., Czúcz B., Horváth F., Révész A., Csatári B. & Molnár Z. 2013: Drivers of grassland loss in Hungary during the post-socialist transformation 1987–1999. — *Landsc. Ecol.* **28**: 789–803.

Blake S., Foster G.N., Eyre M.D. & Luff M.L. 1994: Effects of habit type and grassland management practices on the body size distribution of carabid beetles. — *Pedobiologia* **38**: 502–512.

Brown G.R. & Matthews I.M. 2016: A review of extensive variation in the design of pitfall traps and a proposal for a standard pitfall trap design for monitoring ground-active arthropod biodiversity. — *Ecol. Evol.* **6**: 3953–3964.

Brust G.E. 1990: Direct and indirect effects of four herbicides on the activity of carabid beetles (Coleoptera, Carabidae). — *Pestic. Sci.* **30**: 309–320.

Buchar J. & Ruzicka V. 2002: *Catalogue of Spiders of the Czech Republic*. Peres Publishers, Praha, 349 pp.

Buchholz S. & Hannig K. 2009: Do covers influence the capture efficiency of pitfall traps? — *Eur. J. Entomol.* **106**: 667–671.

Buchholz S., Kreuels M., Kronshage A., Terlutter H. & Finch O.D. 2011: Bycatches of ecological field studies, bothersome or valuable? — *Methods Ecol. Evol.* **2**: 99–102.

Cardoso P., Pekár S., Jocqué R. & Coddington J.A. 2011: Global patterns of guild composition and functional diversity of spiders. — *PLoS ONE* **6**(6): e21710, 10 pp.

Cheli G.H. & Corley J.C. 2010: Efficient sampling of ground-dwelling arthropods using pitfall traps in arid steppes. — *Neotrop. Entomol.* **39**: 912–917.

Crawley M.J. 2007: *The R Book*. John Wiley & Sons, Chichester, 1076 pp.

da Silva P.M., Aguiar C.A.S., Silva I.D.F.E. & Serrano A.R.M. 2011: Orchard and riparian habitats enhance ground dwelling beetle diversity in Mediterranean agro-forestry systems. — *Biodivers. Conserv.* **20**: 861–872.

Ernst C.M., Loboda S. & Buddle C.M. 2015: Capturing northern biodiversity, diversity of arctic, subarctic and north boreal beetles and spiders are affected by trap type and habitat. — *Insect Conserv. Divers.* **9**: 63–73.

Freude H., Harde K.W., Müller-Motzfeld G., Lohse G.A. & Klausnitzer B. 2004: *Die Käfer Mitteleuropas, Adephaga 1. Carabidae Laufkäfer*. Spektrum, Munich, 521 pp.

Gurdebeke S. & Maelfait J.P. 2002: Pitfall trapping in population genetics studies, finding the right "solution". — *J. Arachnol.* **30**: 255–261.

Homburg K., Homburg N., Schaefer F., Schuldt A. & Assmann T. 2014: Carabids.org – a dynamic online database of ground beetle species traits (Coleoptera, Carabidae). — *Insect Conserv. Divers.* **7**: 195–205.

Hurka K. 1996: *Carabidae of the Czech and Slovak Republics*. Kabourek, Zlin, 565 pp.

Isaia M., Paschetta M., Gobbi M., Zapparoli M., Chiarle A. & Taglianti A.V. 2015: Stand maturity affects positively ground-dwelling arthropods in a protected beech forest. — *Ann. For. Sci.* **72**: 415–424.

Jud P. & Schmidt-Entling M.H. 2008: Fluid type, dilution, and bitter agent influence spider preservation in pitfall traps. — *Entomol. Exp. Appl.* **129**: 356–359.

Knapp M. & Ruzicka J. 2012: The effect of pitfall trap construction and preservative on catch size, species richness and species composition of ground beetles Coleoptera, Carabidae. — *Eur. J. Entomol.* **109**: 419–426.

Koivula M., Kotze D.J., Hiisivuori L. & Rita H. 2003: Pitfall trap efficiency, do trap size, collecting fluid and vegetation structure matter? — *Entomol. Fenn.* **14**: 1–14.

Lang A. 2000: The pitfalls of pitfalls, a comparison of pitfall trap catches and absolute density estimates of epigeal invertebrate predators in arable land. — *J. Pest Sci.* **73**: 99–106.

Lange M., Gossner M.M. & Weisser W.W. 2011: Effect of pitfall trap type and diameter on vertebrate by-catches and ground beetle (Coleoptera, Carabidae) and spider (Araneae) sampling. — *Meth. Ecol. Evol.* **2**: 185–190.

Longino J.T., Coddington J. & Colwell R.K. 2002: The ant fauna of a tropical rain forest, estimating species richness three different ways. — *Ecology* **83**: 689–702.

Luff M.L. 1975: Some features influencing the efficiency of pitfall traps. — *Oecologia* **19**: 345–357.

Martinson H.M. & Raupp M.J. 2013: A meta-analysis of the effects of urbanization on ground beetle communities. — *Ecosphere* **4**: 1–24.

Melbourne B.A. 1999: Bias in the effect of habitat structure on pitfall traps, an experimental evaluation. — *Aust. J. Ecol.* **24**: 228–239.

Nentwig W., Blick T., Gloor D., Hänggi A. & Kropf C. 2017: *Araneae – Spiders of Europe. Ver. 08.2017*. URL: http://www.araneae.unibe.ch.

New T.R. 1998: *Invertebrate Surveys for Conservation*. Oxford University Press, Oxford, 204 pp.

New T.R. 1999: By-catch, ethics, and pitfall traps. — *J. Insect Conserv.* **3**: 1–3.

Obrist M.K. & Duelli P. 1996: Trapping efficiency of funnel-and cup-traps for epigeal arthropods. — *Mitt. Schweiz. Entomol. Ges.* **69**: 361–369.

Pearce J.L., Schuurman D., Barber K.N., Larrivee M., Venier L.A., McKee J. & McKenney D. 2005: Pitfall trap designs to maximize invertebrate captures and minimize captures of non-target vertebrates. — *Can. Entomol.* **137**: 233–250.

Pekár S. 2002: Differential effects of formaldehyde concentration and detergent on the catching efficiency of surface active arthropods by pitfall traps. — *Pedobiologia* **46**: 539–547.

Perner J. & Schueler S. 2004: Estimating the density of ground-dwelling arthropods with pitfall traps using a nested-cross array. — *J. Anim. Ecol.* **73**: 469–477.

Phillips I.D. & Cobb T.P. 2005: Effects of habitat structure and lid transparency on pitfall catches. — *Environ. Entomol.* **34**: 875–882.

Pihlaja M., Koivula M. & Niemelä J. 2006: Responses of boreal carabid beetle assemblages (Coleoptera, Carabidae) to clear-cutting and top-soil preparation. — *Forest Ecol. Manag.* **222**: 182–190.

R Core Team 2016: *R, A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna. URL: https,//www.r-project.org/

Ribera I., Dolédec S., Downie I.S. & Foster G.N. 2001: Effect of land disturbance and stress on species traits of ground beetle assemblages. — *Ecology* **82**: 1112–1129.

Santos S.A.P., Cabanas J.E. & Pereira J.A. 2007: Abundance and diversity of soil arthropods in olive grove ecosystem (Portugal), effect of pitfall trap type. — *Eur. J. Soil Biol.* **43**: 77–83.

Saska P., van der Werf W., Hemerik L., Luff M.L., Hatten T.D. & Honek A. 2013: Temperature effects on pitfall catches of epigeal arthropods, a model and method for bias correction. — *J. Appl. Ecol.* **50**: 181–189.

Schirmel J., Lenze S., Katzmann D. & Buchholz S. 2010: Capture efficiency of pitfall traps is highly affected by sampling interval. — *Entomol. Exp. Appl.* **136**: 206–210.

Schmidt M.H., Clough Y., Schulz W., Westphalen A. & Tscharntke T. 2006: Capture efficiency and preservation attributes of different fluids in pitfall traps. — *J. Arachnol.* **34**: 159–162.

Siewers J., Schirmel J. & Buchholz S. 2014: The efficiency of pitfall traps as a method of sampling epigeal arthropods in litter rich forest habitats. — *Eur. J. Entomol.* **111**: 69–74.

Sint D. & Traugott M. 2015: Food Web Designer, a flexible tool to visalize interaction networks. — *J. Pest Sci.* **89**: 1–5.

Southwood T.R.E. & Henderson P.A. 2000: *Ecological Methods*. Blackwell Science, Oxford, 575 pp.

Tölgyesi C., Bátori Z., Erdős L., Gallé R. & Körmöczi L. 2015: Plant diversity patterns of a Hungarian steppe-wetland mosaic in relation to grazing regime and land use history. — *Tuexenia* **35**: 399–416.

Vlijm L., Hartsuyker L. & Richter C.J.J. 1961: Ecological studies on carabid beetles. — *Arch. Néerl. Zool.* **14**: 410–422.

Ward D.F., New T.R. & Yen A.L. 2001: Effects of pitfall trap spacing on the abundance, richness and composition of invertebrate catches. — *J. Insect Conserv.* **5**: 47–53.

Woodcock B.A. 2005: Pitfall trapping in ecological studies. In Leather S. (ed): *Insect Sampling in Forest Ecosystems*. Blackwell, Oxford, pp. 37–57.

Zhao Z.H., Shi P.J., Hui C., Ouyang F., Ge F. & Li B.L. 2013: Solving the pitfalls of pitfall trapping: a two-circle method for density estimation of ground-dwelling arthropods. — *Methods Ecol. Evol.* **4**: 865–871.

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Table S1. Details of sampling. Table follows recommendation of Brown & Matthews (2016).

Date(s) traps were set	5–12 May 2014; 24 Jul–1 Aug 2014; 9–20 Sep 2014
Duration of each sample (in hours)	Approximately 168; 192; 264
Total number of traps used	80
Total number of samples actually collected	240
The number of trap nights on which the analysis is based	26
The minimum inter-trap spacing (m)	8 m
The diameter of pitfall traps (at the opening)	85 mm
The depth of the pitfall trap sample container (mm)	130
The colour of the pitfall trap components	White roof, transparent funnel, white cup
The use of a rain guard	Yes
Height above the trap rain guard was installed (mm)	3–5 cm
The volume of preservative used (ml)	500 ml
The concentration and type of preservative	50% Ethylene-glycol dissolved in water
The use of a funnel trap design	Yes
The use of a one or two cup pitfall trap design	Two cups were used

Table S2a. The codes for the combined category of size and flying ability of the different species of ground beetles caught in the pitfall traps. S – small (<10 mm), L – large (>10 mm), F1 – non-flying, F2 – flying possible, F3 – flying.

Species	Size and flying ability
Acupalpus luteatus (Duftschmid, 1812)	S-F3
Agonum duftschmidi (J. Schmidt, 1994)	S-F3
Agonum emarginatum (Gyllenhal, 1827)	S-F3
Agonum lugens (Duftschmid, 1812)	S-F3
Agonum permoestum (Puel, 1938)	S-F3
Amara aenea (De Geer, 1774)	S-F3
Amara communis (Panzer, 1797)	S-F3
Amara familiaris (Duftschmid, 1812)	S-F3
Amara ovata (Fabricius, 1792)	S-F3
Amara similata (Gyllenhal, 1810)	S-F3
Anthracus longicornis (Schaum, 1857)	S-F3
Badister bullatus (Schrank, 1798)	S-F3
Badister dorsiger (Duftschmid, 1812)	S-F3
Badister lacertosus (Sturm, 1815)	S-F3
Badister sodalis (Duftschmid, 1812)	S-F1
Badister unipustulatus (Bonelli, 1813)	S-F3
Calathus fuscipes (Goeze, 1777)	L-F2
Calathus melanocephalus (Linne, 1758)	S-F2
Calosoma inquisitor (Linne, 1758)	L-F3
Calosoma sycophanta (Linne, 1758)	L-F3
Carabus cancellatus (Illiger, 1798)	L-F1
Carabus clatratus (Linne, 1761)	L-F2
Carabus granulatus (Linne, 1758)	L-F2
Carabus violaceus (Linne, 1758)	L-F1
Chlaeniellus tristis (Schaller, 1783)	L-F3
Clivina fossor (Linne, 1758)	S-F2
Dyschiriodes globosus (Herbst, 1783)	S-F1
Harpalus caspius (Steven, 1806)	L-F2
Harpalus dimidiatus (P. Rossi, 1790)	L-F3
Harpalus luteicornis (Duftschmid, 1812)	S-F3
Harpalus picipennis (Duftschmid, 1812)	S-F3
Harpalus rubripes (Duftschmid, 1812)	L-F3
Harpalus serripes (Quensel in Schonherr, 1806)	L-F2
Harpalus tardus (Panzer, 1797)	S-F3
Licinus depressus (Paykull, 1790)	L-F1
Limodromus assimilis (Paykull, 1790)	L-F3
Limodromus krynickii (Sperk, 1835)	L-F3
Masoreus wetterhallii (Gyllenhall, 1813)	S-F2
Metallina lampros (Herbst, 1784)	S-F2
Microlestes maurus (Sturm, 1827)	S-F2
Microlestes minutulus (Goeze 1777)	S-F2
Nebria brevicollis (Fabricius, 1792)	L-F3
Notiophilus palustris (Duftschmid, 1812)	S-F2
Oodes helopioides (Fabricius, 1792)	S-F3
Oxypselaphus obscurus (Herbst, 1784)	S-F2
Panagaeus bipustulatus (Fabricius, 1775)	S-F2
Panagaeus cruxmajor (Linne, 1758)	S-F3
Paratachys bistriatus (Duftschmid, 1812)	S-F3
Parophonus dejeani (Csiki, 1932)	S-F2
Philochthus biguttatus (Fabricius, 1779)	S-F3
Philochthus inoptatus (Schaum, 1857)	S-F3
Platyderus rufus (Duftschmid, 1912)	S-F1
Poecilus cupreus (Linne, 1758)	L-F3
Poecilus versicolor (Sturm, 1824)	S-F3
Pseudoophonus rufipes (De Geer, 1774)	L-F3
Pterostichus anthracinus (Illiger, 1798)	L-F2
Pterostichus melanarius (Illiger, 1798)	L-F2
Pterostichus minor (Gyllenhal, 1827)	S-F2
Pterostichus niger (Schaller, 1783)	L-F2
Pterostichus nigrita (Paykull, 1790)	L-F2
Pterostichus ovoideus (Sturm, 1824)	S-F2
Pterostichus strenuus (Panzer, 1796)	S-F2
Pterostichus vernalis (Panzer, 1796)	S-F2
Stomis pumicatus (Panzer, 1796)	S-F1
Syntomus obscuroguttatus (Duftschmid, 1812)	S-F2
Syntomus truncatellus (Linne, 1761)	S-F2
Trepanes fumigatus (Duftschmid, 1812)	S-F3

Table S2b. The size category and stratum preferences of the different species of spiders caught in the pitfall traps. S – small (<10 mm), L – large (>10 mm), G – ground-dwelling, V – vegetation-dwelling.

Species	Size	Stratum
Agroeca cuprea (Menge, 1873)	S	G
Agyneta mollis (O. P.-Cambridge, 1871)	S	G
Agyneta rurestris (C. L. Koch, 1836)	S	G
Allagelana gracilens (C. L. Koch, 1841)	S	G
Alopecosa pulverulenta (Clerck, 1757)	S	G
Altella lucida (Simon, 1874)	S	V
Arctosa leopardus (Sundevall, 1833)	S	G
Arctosa lutetiana (Simon, 1876)	S	G
Asagena phalerata (Panzer, 1801)	S	G
Aulonia albimana (Walckenaer, 1805)	S	G
Ceratinella brevis (Wider, 1834)	S	G
Ceratinella scabrosa (O. P.-Cambridge, 1871)	S	G
Clubiona lutescens (Westring, 1851)	S	V
Clubiona pseudoneglecta (Wunderlich, 1994)	S	V
Clubiona subtilis (L. Koch, 1867)	S	V
Clubiona terrestris (Westring, 1851)	S	G
Diplocephalus picinus (Blackwall, 1841)	S	G
Dolomedes fimbriatus (Clerck, 1757)	L	V
Drassodes pubescens (Thorell, 1856)	S	G
Drasyllus praeficus (L. Koch, 1866)	S	G
Drassyllus pusillus (C. L. Koch, 1833)	S	G
Enoplognatha thoracica (Hahn, 1833)	S	G
Euophrys frontalis (Walckenaer, 1802)	S	G
Euryopis flavomaculata (C. L. Koch, 1836)	S	G
Euryopis quinqueguttata (Thorell, 1875)	S	G
Evarcha arcuata (Clerck, 1757)	S	V
Evarcha falcata (Clerck, 1757)	S	V
Gibbaranea gibbosa (Walckenaer, 1802)	S	V
Glyphesis taoplesius (Wunderlich, 1969)	S	G
Gongylidiellum murcidum (Simon, 1884)	S	G
Hahnia pusilla (C. L. Koch, 1841)	S	G
Haplodrassus minor (O. P.-Cambridge, 1879)	S	G
Haplodrassus signifer (C. L. Koch, 1839)	S	G
Haplodrassus silvestris (Blackwall, 1833)	S	G
Hogna radiata (Latreille, 1817)	L	G
Hypsosinga sanguinea (C. L. Koch, 1844)	S	V
Lasaeola prona (Menge, 1868)	S	G
Linyphia hortensis (Sundevall, 1830)	S	V
Liocranoeca striata (Kulczyński, 1882)	S	G
Maso sundevalli (Westring, 1851)	S	V
Micaria pulicaria (Sundevall, 1831)	S	G
Microneta viaria (Blackwall, 1841)	S	G
Neon reticulatus (Blackwall, 1853)	S	G
Neriene clathrata (Sundevall, 1830)	S	V
Oedothorax apicatus (Blackwall, 1850)	S	G
Ozyptila claveata (Walckenaer, 1837)	S	G
Ozyptila praticola (C. L. Koch, 1837)	S	G
Ozyptila pullata (Thorell, 1875)	S	G
Ozyptila scabricula (Westring, 1851)	S	G
Ozyptila simplex (O. P. -Cambridge, 1862)	S	G
Ozyptila trux (Blackwall, 1846)	S	G
Pachygnatha degeeri (Sundevall, 1830)	S	G
Pachygnatha listeri (Sundevall, 1830)	S	G
Pardosa agrestis (Westring, 1861)	S	G
Pardosa alacris (C. L. Koch, 1833)	S	G
Pardosa lugubris (Walckenaer, 1802)	S	G
Pardosa palustris (Linnaeus, 1758)	S	G
Pardosa prativaga (L. Koch, 1870)	S	G
Pardosa proxima (C. L. Koch, 1847)	S	G
Pardosa pullata (Clerck, 1757)	S	G
Phlegra fasciata (Hahn, 1826)	S	G
Phrurolithus festivus (C. L. Koch, 1835)	S	G
Phrurolithus minimus (C. L. Koch, 1839)	S	G
Pirata piraticus (Clerck, 1757)	S	G
Pirata uliginosus (Thorell, 1856)	S	G
Piratula hygrophila (Thorell, 1872)	S	G
Piratula latitans (Blackwall, 1841)	S	G
Pisaura mirabilis (Clerck, 1757)	L	V
Pocadicnemis juncea (Locket & Millidge, 1953)	S	G
Prinerigone vagans (Audouin, 1826)	S	G
Robertus lividus (Blackwall, 1836)	S	G
Silometopus elegans (O. P.-Cambridge, 1872)	S	G
Silometopus incurvatus (O. P.-Cambridge, 1873)	S	G
Styloctetor stativus (Simon, 1881)	S	G
Syedra gracilis (Menge, 1869)	S	G
Talavera aequipes (O. P.-Cambridge, 1871)	S	G
Tapinocyba insecta (L. Koch, 1869)	S	G
Tenuiphantes flavipes (Blackwall, 1854)	S	G
Tenuiphantes tenuis (Blackwall, 1852)	S	G
Thanatus arenarius (L. Koch, 1872)	S	G
Thanatus formicinus (Clerck, 1757)	S	G
Tmarus piger (Walckenaer, 1802)	S	V
Trachyzelotes pedestris (C. L. Koch, 1837)	S	G
Trichoncus hackmani (Millidge, 1955)	S	G
Trochosa ruricola (De Geer, 1778)	L	G
Trochosa terricola (Thorell, 1856)	L	G
Walckenaeria alticeps (Denis, 1952)	S	G
Walckenaeria dysderoides (Wider, 1834)	S	G
Walckenaeria vigilax (Blackwall, 1853)	S	G
Xerolycosa miniata (C. L. Koch, 1834)	S	G
Xysticus erraticus (Blackwall, 1834)	S	V
Xysticus kochi (Thorell, 1872)	S	G
Xysticus lineatus (Westring, 1851)	S	G
Xysticus luctator (L. Koch, 1870)	S	G
Xysticus robustus (Hahn, 1832)	S	G
Zelotes apricorum (L. Koch, 1876)	S	G
Zelotes electus (C. L. Koch, 1839)	S	G
Zelotes latreillei (Simon, 1878)	S	G
Zora armillata (Simon, 1878)	S	G
Zora spinimana (Sundevall, 1833)	S	G

Table S3a. Numbers of each carabid species caught by each type of trap in each habitat. Abbreviations: g – grassland, f – forest.

Trap type	conv. pitfall		pitfall + roof		funnel pitfall		funnel pitfall + roof	
Habitat	g	f	g	f	g	f	g	f
Acupalpus luteatus (Duftschmid, 1812)	0	0	1	0	0	0	0	0
Agonum duftschmidi (J. Schmidt, 1994)	4	32	0	22	0	19	0	37
Agonum emarginatum (Gyllenhal, 1827)	1	8	0	2	0	1	1	1
Agonum lugens (Duftschmid, 1812)	0	1	0	0	0	0	0	0
Agonum permoestum (Puel, 1938)	0	0	0	8	0	2	0	2
Amara aenea (De Geer, 1774)	4	0	0	0	2	0	0	0
Amara communis (Panzer, 1797)	4	0	0	0	2	0	2	0
Amara familiaris (Duftschmid, 1812)	0	0	0	0	1	0	0	0
Amara ovata (Fabricius, 1792)	0	0	0	0	0	1	0	0
Amara similata (Gyllenhal, 1810)	0	0	0	0	0	0	0	1
Anthracus longicornis (Schaum, 1857)	0	1	0	1	0	2	0	1
Badister bullatus (Schrank, 1798)	0	0	0	2	0	2	2	0
Badister dorsiger (Duftschmid, 1812)	0	1	0	0	0	2	0	3
Badister lacertosus (Sturm, 1815)	0	0	0	1	0	1	0	0
Badister sodalis (Duftschmid, 1812)	0	0	0	0	0	0	0	2
Badister unipustulatus (Bonelli, 1813)	0	2	0	1	0	1	0	0
Calathus fuscipes (Goeze, 1777)	0	0	0	0	0	1	0	0
Calathus melanocephalus (Linne, 1758)	1	0	0	0	0	0	0	0
Calosoma inquisitor (Linne, 1758)	0	4	0	2	0	5	0	3
Calosoma sycophanta (Linne, 1758)	4	0	11	0	0	0	1	0
Carabus cancellatus (Illiger, 1798)	6	0	2	0	4	0	1	0
Carabus clatratus (Linne, 1761)	1	0	0	0	0	0	0	0
Carabus granulatus (Linne, 1758)	0	1	0	0	0	1	0	0
Carabus violaceus (Linne, 1758)	0	0	0	1	0	0	0	0
Chlaeniellus tristis (Schaller, 1783)	93	167	67	169	29	89	44	154
Clivina fossor (Linne, 1758)	0	1	0	0	0	1	0	0
Dyschiriodes globosus (Herbst, 1783)	2	135	0	130	1	72	0	117
Harpalus caspius (Steven, 1806)	11	2	5	6	6	3	12	1
Harpalus dimidiatus (P. Rossi, 1790)	0	0	0	0	0	1	0	0
Harpalus luteicornis (Duftschmid, 1812)	0	0	0	0	0	1	0	0
Harpalus picipennis (Duftschmid, 1812)	11	90	13	74	11	69	26	105
Harpalus rubripes (Duftschmid, 1812)	0	0	0	0	0	0	2	0
Harpalus serripes (Quensel in Schonherr, 1806)	0	0	0	0	0	0	1	0
Harpalus tardus (Panzer, 1797)	0	0	1	0	0	0	0	0
Licinus depressus (Paykull, 1790)	0	0	0	0	0	0	1	1
Limodromus assimilis (Paykull, 1790)	0	0	0	0	0	0	2	0
Limodromus krynickii (Sperk, 1835)	0	1	0	0	0	0	0	0
Masoreus wetterhallii (Gyllenhall, 1813)	0	0	0	1	0	0	1	0
Metallina lampros (Herbst, 1784)	1	1	2	0	0	3	0	0
Microlestes maurus (Sturm, 1827)	0	0	2	0	0	0	1	0
Microlestes minutulus (Goeze 1777)	5	0	8	0	4	0	0	0
Nebria brevicollis (Fabricius, 1792)	2	0	0	0	1	0	0	0
Notiophilus palustris (Duftschmid, 1812)	0	5	0	24	0	6	0	10
Oodes helopioides (Fabricius, 1792)	0	2	0	1	0	4	0	0
Oxypselaphus obscurus (Herbst, 1784)	1	4	0	2	0	1	0	0
Panagaeus bipustulatus (Fabricius, 1775)	3	23	0	2	0	4	0	10
Panagaeus cruxmajor (Linne, 1758)	1	0	1	0	0	0	0	1
Paratachys bistriatus (Duftschmid, 1812)	0	0	0	0	0	0	0	4
Parophonus dejeani (Csiki, 1932)	1	0	1	0	0	1	0	0
Philochthus biguttatus (Fabricius, 1779)	0	0	0	0	0	0	1	0
Philochthus inoptatus (Schaum, 1857)	0	0	0	0	0	0	0	2
Platyderus rufus (Duftschmid, 1912)	0	0	0	0	0	0	0	2
Poecilus cupreus (Linne, 1758)	6	67	0	53	0	31	0	42
Poecilus versicolor (Sturm, 1824)	2	50	1	36	1	9	3	34
Pseudoophonus rufipes (De Geer, 1774)	0	1	0	1	0	0	1	11
Pterostichus anthracinus (Illiger, 1798)	0	0	0	0	1	0	1	0
Pterostichus melanarius (Illiger, 1798)	4	36	6	45	2	25	1	40
Pterostichus minor (Gyllenhal, 1827)	1	2	0	7	0	4	0	1
Pterostichus niger (Schaller, 1783)	0	0	0	2	0	1	0	1
Pterostichus nigrita (Paykull, 1790)	0	1	0	3	0	0	0	3
Pterostichus ovoideus (Sturm, 1824)	0	0	0	0	0	1	0	0
Pterostichus strenuus (Panzer, 1796)	0	1	0	1	0	2	0	0
Pterostichus vernalis (Panzer, 1796)	0	3	0	3	0	1	0	6
Stomis pumicatus (Panzer, 1796)	0	3	0	1	0	6	0	3
Syntomus obscuroguttatus (Duftschmid, 1812)	0	0	0	2	0	1	0	1
Syntomus truncatellus (Linne, 1761)	0	0	0	1	0	0	0	2
Trepanes fumigatus (Duftschmid, 1812)	1	0	5	0	3	0	6	0

Table S3b. Numbers of each spider species caught by each type of trap in each habitat. Abbreviations: g – grassland, f – forest.

Trap type	conv. pitfall		pitfall + roof		funnel pitfall		funnel pitfall + roof	
Habitat	g	f	g	f	g	f	g	f
Agroeca cuprea (Menge, 1873)	1	0	1	3	1	2	1	1
Agyneta mollis (O. P.-Cambridge, 1871)	2	0	1	0	1	0	3	0
Agyneta rurestris (C. L. Koch, 1836)	8	0	16	0	6	0	16	0
Allagelena gracilens (C. L. Koch, 1841)	0	0	0	0	1	0	0	0
Alopecosa pulverulenta (Clerck, 1757)	6	0	11	0	8	0	6	1
Altella lucida (Simon, 1874)	16	0	15	0	13	0	22	0
Arctosa leopardus (Sundevall, 1833)	1	0	0	0	0	0	0	0
Arctosa lutetiana (Simon, 1876)	22	19	27	27	15	22	23	24
Asagena phalerata (Panzer, 1801)	2	0	0	0	2	0	0	0
Aulonia albimana (Walckenaer, 1805)	49	0	106	0	28	0	84	0
Ceratinella brevis (Wider, 1834)	1	0	0	0	0	0	0	0
Ceratinella scabrosa (O. P.-Cambridge, 1871)	0	2	0	0	0	3	1	2
Clubiona lutescens (Westring, 1851)	0	0	0	1	0	0	0	0
Clubiona pseudoneglecta (Wunderlich, 1994)	1	0	1	0	0	0	1	0
Clubiona subtilis (L. Koch, 1867)	0	0	1	0	0	0	0	0
Clubiona terrestris (Westring, 1851)	0	0	0	0	0	0	0	1
Diplocephalus picinus (Blackwall, 1841)	0	15	0	10	0	48	1	42
Dolomedes fimbriatus (Clerck, 1757)	1	0	0	1	0	0	0	0
Drassodes pubescens (Thorell, 1856)	0	0	0	0	1	0	3	0
Drassyllus praeficus (L. Koch, 1866)	1	0	2	0	1	0	0	0
Drassyllus pusillus (C. L. Koch, 1833)	7	0	2	0	4	0	1	0
Enoplognatha thoracica (Hahn, 1833)	0	3	0	2	1	9	0	4
Euophrys frontalis (Walckenaer, 1802)	0	0	6	0	1	0	1	0
Euryopis flavomaculata (C. L. Koch, 1836)	1	3	3	4	0	1	1	3
Euryopis quinqueguttata (Thorell, 1875)	1	0	1	0	4	0	3	0
Evarcha arcuata (Clerck, 1757)	2	0	0	0	0	0	0	0
Evarcha falcata (Clerck, 1757)	0	0	0	1	0	0	0	0
Gibbaranea gibbosa (Walckenaer, 1802)	0	1	0	0	0	0	0	0
Glyphesis taoplesius (Wunderlich, 1969)	1	5	1	3	1	17	3	27
Gongylidiellum murcidum (Simon, 1884)	0	0	0	0	1	1	0	0
Hahnia pusilla (C. L. Koch, 1841)	6	1	1	0	1	2	3	0
Haplodrassus minor (O. P.-Cambridge, 1879)	1	0	2	0	1	0	0	0
Haplodrassus signifer (C. L. Koch, 1839)	0	0	0	1	2	0	0	0
Haplodrassus silvestris (Blackwall, 1833)	0	5	0	0	0	1	0	2
Hogna radiata (Latreille, 1817)	6	0	8	0	5	0	1	0
Hypsosinga sanguinea (C. L. Koch, 1844)	0	0	1	0	0	0	0	0
Lasaeola prona (Menge, 1868)	0	0	1	0	0	0	0	0
Linyphia hortensis (Sundevall, 1830)	0	0	0	0	0	0	0	2
Liocranoeca striata (Kulczyński, 1882)	6	20	7	31	1	30	5	27
Maso sundevalli (Westring, 1851)	0	1	0	0	0	1	0	1
Micaria pulicaria (Sundevall, 1831)	1	0	2	0	0	0	2	0
Microneta viaria (Blackwall, 1841)	0	1	0	0	0	0	0	0
Neon reticulatus (Blackwall, 1853)	0	1	0	0	0	0	0	0
Neriene clathrata (Sundevall, 1830)	0	0	0	3	0	2	0	1
Oedothorax apicatus (Blackwall, 1850)	0	0	0	1	0	0	0	0
Ozyptila claveata (Walckenaer, 1837)	1	0	2	0	2	0	4	0
Ozyptila praticola (C. L. Koch, 1837)	0	56	0	26	0	48	0	49
Ozyptila pullata (Thorell, 1875)	3	0	8	0	1	0	1	0
Ozyptila scabricula (Westring, 1851)	0	0	2	0	0	0	1	0
Ozyptila simplex (O. P.-Cambridge, 1862)	0	0	1	0	0	0	0	0
Ozyptila trux (Blackwall, 1846)	1	0	10	0	2	0	0	0
Pachygnatha degeeri (Sundevall, 1830)	8	0	11	0	4	0	9	0
Pachygnatha listeri (Sundevall, 1830)	0	4	0	2	0	5	0	3
Pardosa agrestis (Westring, 1861)	0	0	2	0	0	0	0	0
Pardosa alacris (C. L. Koch, 1833)	0	5	0	3	1	7	0	4
Pardosa lugubris (Walckenaer, 1802)	4	49	4	40	4	55	4	32
Pardosa palustris (Linnaeus, 1758)	0	0	0	0	0	0	2	0
Pardosa prativaga (L. Koch, 1870)	10	0	7	0	3	0	6	0
Pardosa proxima (C. L. Koch, 1847)	1	0	0	0	0	0	6	0
Pardosa pullata (Clerck, 1757)	14	1	8	0	5	0	9	0
Phlegra fasciata (Hahn, 1826)	1	0	0	0	0	0	0	0
Phrurolithus festivus (C. L. Koch, 1835)	0	0	0	1	0	0	2	3
Phrurolithus minimus (C. L. Koch, 1839)	0	1	2	0	1	1	5	0
Pirata piraticus (Clerck, 1757)	1	0	0	0	0	0	0	0
Pirata uliginosus (Thorell, 1856)	0	4	0	9	0	13	1	2
Piratula hygrophila (Thorell, 1872)	0	134	0	206	1	111	0	156
Piratula latitans (Blackwall, 1841)	7	6	6	9	5	3	0	4
Pisaura mirabilis (Clerck, 1757)	10	2	2	3	3	1	2	0

Table S3b (continued).

Trap type	conv. pitfall		pitfall + roof		funnel pitfall		funnel pitfall + roof	
Habitat	g	f	g	f	g	f	g	f
Pocadicnemis juncea (Locket & Millidge, 1953)	1	0	1	0	0	1	2	3
Prinerigone vagans (Audouin, 1826)	0	0	0	0	0	1	0	0
Robertus lividus (Blackwall, 1836)	0	3	0	0	0	0	0	0
Silometopus elegans (O. P.-Cambridge, 1872)	0	1	0	0	0	3	0	3
Silometopus incurvatus (O. P.-Cambridge, 1873)	0	0	0	0	0	1	0	0
Styloctetor stativus (Simon, 1881)	5	0	4	0	6	0	11	0
Syedra gracilis (Menge, 1869)	3	0	3	0	1	0	4	0
Talavera aequipes (O. P.-Cambridge, 1871)	1	0	0	0	0	0	0	0
Tapinocyba insecta (L. Koch, 1869)	0	0	0	1	0	0	0	0
Tenuiphantes flavipes (Blackwall, 1854)	0	2	0	1	0	1	0	0
Tenuiphantes tenuis (Blackwall, 1852)	0	1	0	0	0	1	0	0
Thanatus arenarius (L. Koch, 1872)	2	0	2	0	1	0	0	0
Thanatus formicinus (Clerck, 1757)	0	0	0	0	0	0	2	0
Tmarus piger (Walckenaer, 1802)	0	1	0	0	0	0	0	0
Trachyzelotes pedestris (C. L. Koch, 1837)	2	5	5	5	3	8	6	1
Trichoncus hackmani (Millidge, 1955)	1	2	3	0	3	1	7	0
Trochosa ruricola (De Geer, 1778)	9	4	11	12	15	15	16	10
Trochosa terricola (Thorell, 1856)	11	9	13	4	11	6	11	3
Walckenaeria alticeps (Denis, 1952)	0	3	0	1	0	1	0	3
Walckenaeria dysderoides (Wider, 1834)	0	0	0	0	0	1	0	1
Walckenaeria vigilax (Blackwall, 1853)	0	0	0	0	0	0	0	1
Xerolycosa miniata (C. L. Koch, 1834)	0	0	2	0	0	0	0	0
Xysticus erraticus (Blackwall, 1834)	0	0	0	0	0	0	2	0
Xysticus kochi (Thorell, 1872)	6	0	4	0	5	0	7	0
Xysticus lineatus (Westring, 1851)	7	0	16	0	8	0	19	0
Xysticus luctator (L. Koch, 1870)	3	12	0	12	2	6	1	8
Xysticus robustus (Hahn, 1832)	1	0	0	0	0	0	0	0
Zelotes apricorum (L. Koch, 1876)	0	1	1	2	0	2	1	3
Zelotes electus (C. L. Koch, 1839)	3	0	3	0	0	0	2	0
Zelotes latreillei (Simon, 1878)	0	0	2	0	0	0	0	0
Zora armillata (Simon, 1878)	1	0	0	0	0	0	0	0
Zora spinimana (Sundevall, 1833)	0	4	0	0	0	0	0	1

Table S4. Number of vertebrates caught in each type of trap in each habitat. Abbreviation: S – small.

	Grassland				Forest			
	conv. pitfall	pitfall + roof	funnel pitfall	funnel pitfall + roof	conv. pitfall	pitfall + roof	funnel pitfall	funnel pitfall + roof
Amphibians	1	1	1	0	8	3	0	0
Reptiles	1	2	0	0	0	0	0	0
S. mammals	2	2	0	0	12	11	1	0

Table S5. Estimated residual variances and variances of the random intercept. S – small (<10 mm), L – large (>10 mm), F1 – non-flying, F2 – flying possible, F3 – flying, H – habitat, $\hat{\sigma}$ – residual variance, $\hat{d}$ – variance of the random intercept.

Carabids				Spiders			
		Habitat	H/Site			Habitat	H/Site
	$\hat{\sigma}$	$\hat{d}$	$\hat{d}$		$\hat{\sigma}$	$\hat{d}$	$\hat{d}$
N	2.227	0.782	0.464	N	2.168	0.184	0.165
S-F1	1.635	0.758	0.666	Large N	1.016	0.286	0.302
S-F2	1.298	<0.001	0.771	Small N	2.120	0.229	0.174
S-F3	1.276	0.832	0.652	Ground N	2.171	0.223	0.171
L-F1	1.605	0.439	0.711	Vegetation N	1.071	0.109	0.290
L-F2	1.468	1.452	0.393				
L-F3	1.529	1.413	0.745				