Weeds shift from generalist to specialist: narrowing of ecological niches along a north-south gradient

Polní plevele se mění z generalistů na specialisty – zužování ekologických nik podél severojižního gradientu

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There are changes in the realized niches of species along environmental gradients, especially at the edge of their distribution where they become more specialized. A classical case is weeds of the *Caucalidion* alliance that spread with agriculture from the Fertile Crescent and thrive in a wide range of climates that differ from that prevailing in their native area. We used large data sets of vegetation collected in central Europe (3383 plots) and north-western Balkans (4505 plots) and used a co-occurrence species algorithm to calculate the specialist/generalist status of weed species. The change in the width of the ecological niches was tested using target species. Our assumptions were confirmed as the same characteristic species of *Caucalidion* weed vegetation in the north-western Balkans are more specialized in central Europe, where they occupy more basic habitats that vary less in terms of soil reaction. Testing niche theory using real data is especially important for nature conservation because specialists are more prone to decline in abundance or to go extinct.

K e y w o r d s: Balkan, *Caucalidion*, central Europe, niche width, species co-occurrence, weed vegetation

Introduction

Ecological behaviour of plants has been of interest to community ecologists for a long time. It is well understood that ecological behaviour changes along ecological gradients (Hájková et al. 2008). Traditionally the term 'ecological behaviour' in central Europe has the same meaning as 'ecological niche'. Niche breadth varies depending on the environmental gradient and according to Diekmann & Lawesson (1999) there are three possible reasons for this: (i) The physiological demands of a species can differ as is the case for ecotypes in different regions; (ii) constant habitat rule of Walter & Walter (1953) that describes the change in the habitat of a species due to changes in environmental conditions and compensation of one ecological parameter by another; (iii) presence or absence of potential competitors and change in the competitive relationships between species.

Hutchinson (1957) defines species niche in terms of a combination of environmental characteristics of the hypervolume. Some species have wider niches (realized) than others, which results in the distributions of species in space and their presence in different habitats. It is

expensive to measure niche width using manipulative experiments (Pearman et al. 2008), therefore other approaches are needed. Fridley et al. (2007) propose an algorithm that calculates species co-occurrences and using this pattern we can describe the width of the niches plant species. This algorithm is based on the assumption that in a large data set, habitat specialization of an individual species corresponds to the β-diversity of vegetation plots in which the target species is present. They assume that generalists co-occur with many species within a given plot and therefore have wide ecological niches. Therefore, habitat generalists co-occur with many different species across their range while habitat specialists co-occur with relatively few different species. This approach is especially useful for analyzing large databases of vegetation plots.

Zelený (2009) and Manthey & Fridley (2009) further improved this approach using other β-diversity measures to avoid bias due to the effect of the species pool. Manthey et al. (2011) use modified approaches to assess habitat specialists and generalists in two regions with species pool of different sizes. Recently Botta-Dukát (2012) modified this approach by using species pool instead of raw data and excluding outliers. This gives robust and unbiased estimates of the co-occurrence-based niche width measurements, which are independent of the size of the species pool.

To detect variation in species niche breadth along a north-south gradient in Europe, we focused on weed vegetation. The majority of cereal weeds in Europe originate from the Mediterranean region and Near East and were transported with cultural plants as cultivation of crops spread into the Old World (di Castri 1989). These species are termed archaeophytes if they arrived in ancient times (Pyšek et al. 2012) and most arrived in central Europe approximately 7500 cal. yr BP (Chytrý 2012). Although they adapted to some degree to new ecological conditions (e.g. cultivation and climate) they are far from their old centre of distribution. Populations of species at the limits of their range usually have narrower niche widths and are more specialized, which results in the evolution of habitat specialists. Weeds of the alliance *Caucalidion* prefer basic and warm (calcareous) fields in the north but are widespread and indifferent to this type of soil in the south of central Europe (Holzner 1978). Compared to other weeds *Caucalidion* species are sensitive to temperature and moisture conditions (Lososová et al. 2006, 2009). This is the main reason why these species prevail in the lowlands in the Czech Republic, areas where the temperature is higher and most soils are base rich. In the Balkans *Caucalidion* alliance is the most widespread type of vegetation in cereals and is found also at high altitudes (Šilc et al. 2008).

The alliance *Caucalidion* includes the annual thermophilous weed vegetation of cereal crops in central and south-eastern Europe. It is a northward spread of Mediterranean cereal weeds that started with the spread of agriculture (Lososová & Grulich 2009). It is distributed from the Mediterranean to southern Scandinavia, Great Britain, the Iberian Peninsula and southern Urals, but with a clear centre in central Europe and the Balkans (Ferro 1990, Lososová et al. 2009). Five associations are known from the Czech Republic. They are *Caucalido platycarpi-Conringietum orientalis*, *Lathyro tuberosi-Adonidetum aestivalis*, *Euphorbio exiguae-Melandrietum noctiflori*, *Stachyo annuae-Setarietum pumilae* and *Veronicetum hederifolio-triphylli* (Lososová et al. 2009). In Balkan national surveys the latter two are classified differently. Delimitation of the alliance in the north-western Balkans at the association level is very variable: *Kickxietum spuriae* (Slovenia and Croatia), *Galio tricornuti-Ranunculetum arvensis* (Slovenia), *Consolido-Polygonetum avicularis*,

Consolido-Vicietum striatae, *Sinapi-Biforietum radians*, *Stachyeto-Ajugetum chamaepitys*, *Vulpio-Holcetum lanatis* (Serbia), *Caucalido daucoidis-Scandicetum pecten-veneris* (Macedonia) (Kojić et al. 1998, Hulina 2002, Kratovalieva 2002, Šilc & Čarni 2007, Trinajstić 2008).

Populations of some species of weeds are becoming ecologically very specialized in the new area and therefore *Caucalidion* species have experienced a profound decline in recent decades due to changes in agricultural management (Lososová 2003, Pinke 2004, Lososová & Simonová 2008). At the edge of a species distribution individuals are more sensitive and less vigorous (Holzner 1978). Also specialists are more prone to decline in abundance and become extinct than generalists (Rooney et al. 2004, Clavel et al. 2011) and a key trait in predicting the response of a population to environmental change is its degree of ecological specialization (Boulangeat et al. 2012).

Habitat generalists are those species that co-occur with many different species throughout their range while habitat specialists co-occur with relatively few different species. We hypothesize that populations of *Caucalidion* species are generalists in the south and specialists in central Europe and that populations of the same *Caucalidion* species perform differently in each region along a north-south gradient.

Material and methods

Species data

Two data sets of arable field weed vegetation were used; one collected in the Czech Republic (central Europe) and the other in the north-western Balkans, which here includes Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Montenegro and Macedonia. The first data set comprised 3383 relevés and the second 4505 relevés, with a total of 1149 species (Table 1). The Czech data set contains samples mostly collected from the second half of last century until present. The plot sizes vary from 2 m^2 to 100 m^2, the majority being 20 m^2. The north-western Balkans data set includes plots from 1938 till present, varying in area from 2 to 400 m^2, but mostly 50 m^2. Vegetation samples were stored in the TURBOVEG database (Hennekens & Schaminée 2001). The species nomenclature follows the Flora Europaea (Tutin et al. 1968–1980, 1993) except for the species *Oxalis dilenii* Jacq. Information about the planted crops and juveniles of trees and shrubs was not included in the analyses because such data were not recorded by all researchers. Finally taxa that were only determined to genus were deleted. We aggregated all subspecies to the species level and some critical taxa to a higher level.

Selection of species diagnostic of *Caucalidion* in central Europe was made based on Vegetation of the Czech Republic (Lososová et al. 2009) and for north-western Balkans according to Šilc et al. (2009). Both lists of diagnostic species of the *Caucalidion* alliance in the Czech Republic and Balkans were merged together and this total list of diagnostic species was used in subsequent analyses. Only species present in both data sets were used for comparison.

Table. 1 – Basic data in the data sets (weed vegetation and *Caucalidion*). Crop and woody species are not included.

Dataset	Number of relevés	Species/plot	Species pool
North-western Balkan	4505	18.86 ± 8.13	797
Caucalidion	403	18.26 ± 6.49	380
Central Europe	3383	23.89 ± 9.97	615
Caucalidion	708	25.56 ± 10.32	498

Statistical analyses

To detect specialist and generalist *Caucalidion* species in both European regions we calculated theta (θ) values using the modified version of the procedure proposed by Manthey & Fridley (2009), using the statistical environment R (R Development Core Team 2008). Species with at least 10 occurrences were used and we selected 100 random samples for each species. Among five alternative measures of theta, which results average turnover, we used Whittaker's beta, as proposed by Zelený (2009). Low theta-value means that a species is a specialist and vice versa.

For comparison of niche breadth changes between data sets we divided the theta value for a particular species by the maximum theta in both data sets and compared their relative values. A difference in the ratios for the central-European and north-western Balkans data sets is taken to represent a change in the width of the ecological niche, with a negative difference indicating a decrease in width.

For each species we determined its ecological indicator value for soil reaction according to Pignatti (2005). Only soil reaction was used as an ecologically important factor for *Caucalidion* species, because the hypothesis predicts a shift in soil preference (Holzner 1978). We calculated mean ecological indicator values for each plot weighted by species cover using the Juice program (Tichý 2002). For each *Caucalidion* species we expressed amplitude of ecological values (Max-Min) for plots in which particular species were found in both data sets.

Results

Different species were indicated as specialists and generalists in weed vegetation of both regions (Table 2). Beside species that are considered typical weeds (e.g. *Lathyrus aphaca*, *Bifora radians*) there were other common species among the specialists (*Agrostis gigantea*, *Solanum dulcamara*) and generalists (*Ballota nigra*, *Festuca pratensis*); the latter species are more characteristic of other habitats like grassland or ruderal sites.

Most frequent species are very similar in both data sets (11 species out of 20 are the same), with weeds that thrive in all types of crops prevailing. Fifty one species were selected that are characteristic of the *Caucalidion* alliance and with at least 10 occurrences in the central-European and north-western Balkans data sets (Table 3). Species characteristic of the *Caucalidion* alliance have statistically significant different ratios of theta values in the central-European and north-western Balkans data sets (Wilcoxon paired test, $z = 6.205$, $P < 0.01$). In central Europe all species except *Reseda lutea* show shifts towards specialization. The highest niche width change was detected for *Bifora radians*, *Galium tricornutum* and *Lathyrus aphaca*.

Table 2. – Twenty most specialist and generalist species in the central-European and north-western Balkans data sets of arable field weed vegetation. Theta values according to Zelený (2009) are presented. Low theta value means that the species is a specialist and vice versa for generalist.

Central Europe		North-western Balkan	
Specialist species	Theta	Specialist species	Theta
Lathyrus aphaca	2.710	*Rhinanthus minor*	2.408
Veronica praecox	2.809	*Cyperus rotundus*	2.423
Crepis capillaris	2.849	*Juncus bufonius*	2.847
Myosotis discolor	2.902	*Erysimum repandum*	2.902
Ranunculus sardous	2.978	*Solanum dulcamara*	2.968
Conringia orientalis	2.982	*Ornithogalum narbonense*	2.981
Sagina procumbens	3.028	*Tribulus terestris*	2.985
Galeopsis ladanum	3.141	*Symphytum tuberosum*	3.014
Kickxia spuria	3.142	*Eragrostis pilosa*	3.023
Bifora radians	3.145	*Plantago crassifolia*	3.063
Bidens tripartita	3.161	*Panicum miliaceum*	3.077
Spergularia rubra	3.170	*Amaranthus powelii*	3.105
Galium tricornutum	3.195	*Valerianella locusta*	3.208
Juncus bufonius	3.224	*Oxalis dilenii*	3.319
Veronica opaca	3.226	*Veronica triphyllos*	3.324
Agrostis gigantea	3.235	*Chamomilla suaveolens*	3.341
Trifolium hybridum	3.240	*Stellaria nemorum*	3.395
Filaginella uliginosa	3.267	*Galinsoga ciliata*	3.414
Chenopodium glaucum	3.278	*Amaranthus cruentus*	3.430
Papaver dubium	3.283	*Oxalis acetosella*	3.446
Generalist species	Theta	Generalist species	Theta
Artemisia vulgaris	4.366	*Trifolium arvense*	5.293
Galium album	4.404	*Sanguisorba minor*	5.300
Arrhenatherum elatius	4.440	*Veronica hederifolia*	5.310
Lolium perenne	4.454	*Bromus sterilis*	5.313
Carduus acanthoides	4.468	*Melilotus officinalis*	5.319
Bromus japonicus	4.493	*Viola tricolor*	5.324
Lamium album	4.500	*Raphanus raphanistrum*	5.334
Echium vulgare	4.516	*Bromus arvensis*	5.340
Cirsium vulgare	4.524	*Coronila varia*	5.343
Conyza canadensis	4.533	*Hypericum perforatum*	5.350
Setaria verticillata	4.543	*Festuca pratensis*	5.355
Portulaca oleracea	4.624	*Lotus corniculatus*	5.382
Eragrostis minor	4.648	*Plantago lanceolata*	5.384
Cerastium arvense	4.662	*Filago arvensis*	5.405
Euphorbia cyparissias	4.770	*Tripleurospermum inodorum*	5.409
Agrostis capillaris	4.775	*Trifolium campestre*	5.453
Poa angustifolia	4.786	*Anthemis arvensis*	5.468
Digitaria sanguinalis	4.827	*Asperula arvensis*	5.584
Ballota nigra	4.913	*Medicago sativa*	5.633
Pimpinella saxifraga	5.015	*Anthemis cotula*	5.865
20 most frequent species	Frequency	20 most frequent species	Frequency
Viola arvensis	2225	*Convolvulus arvensis*	3081
Stellaria media	2216	*Chenopodium album* agg.	2663
Capsella bursa-pastoris	2021	*Cirsium arvense*	2612
Matricaria perforata	2010	*Setaria pumila*	1709
Cirsium arvense	1998	*Echinochloa crus-galli*	1678
Bilderdykia convolvulus	1944	*Stellaria media*	1677
Chenopodium album agg.	1889	*Amaranthus retroflexus*	1676

Galium aparine agg.	1843	*Polygonum aviculare* agg.	1634
Veronica persica	1756	*Bilderdykia convolvulus*	1458
Polygonum aviculare agg.	1724	*Capsella bursa-pastoris*	1438
Elymus repens	1694	*Veronica persica*	1176
Taraxacum officinale agg.	1570	*Elymus repens*	1164
Thlaspi arvense	1548	*Digitaria sanguinalis*	1036
Myosotis arvensis	1527	*Taraxacum officinale* agg.	1035
Lamium purpureum	1350	*Cynodon dactylon*	1027
Convolvulus arvensis	1296	*Sonchus arvensis*	982
Anagallis arvensis	1219	*Polygonum lapathifolium*	979
Euphorbia helioscopia	1041	*Galium aparine agg.*	961
Lapsana communis	1012	*Galinsoga parviflora*	950
Veronica arvensis	965	*Sinapis arvensis*	943

A shift of particular target species from habitat generalism to specialism is evident. There is also a clear difference in the number of species indicated as *Caucalidion* characteristic that are recorded in only one data set (eight in north vs 23 in south). In addition to the lower number of typical *Caucalidion* species (*Agrostemma githago*, *Turgenia latifolia*, *Scandix pecten-veneris*) in the central-European data set, there are also fewer widespread species (*Vicia narbonensis*, *Vicia pannonica*) with southern distributions. Other species that occur in weed communities in the north are widespread weeds (*Myosotis arvensis*, *Viola arvensis*) or ruderal species (*Arctium tomentosum*, *Lapsana communis*).

Based on the theta ratios there are two distinct groups of *Caucalidion* species. In the central-European data set the amplitudes of the soil reaction ecological indicator for specialist species is also narrower (statistically significant) but not in the north-western Balkans data set (Figs 1, 2). Differences in the amplitudes in ecological values for soil reaction between data sets are statistically significant (Wilcoxon test, $z = 2.179$, $P < 0.05$).

Discussion

Our analysis of co-occurrence of species and incidence of specialists clearly support the hypothesis of an ecological shift in the strategies of *Caucalidion* species in the north as proposed by Holzner (1978). Species of weeds that are evolutionary adapted to disturbed and warm sites in the south have narrower ecological niches but are found in similar sites in northern areas. A warm climate is the most important factor determining a high species richness and abundance (Hyvönen et al. 2011).

Specialist species are generally declining and experiencing a high risk of extinction and global changes are responsible for their decrease in abundance (Devictor et al. 2010, Clavel et al. 2011). In the case of *Caucalidion* the specialization is a response of the species being "artificially" moved from their home range and not being adapted to the lower temperatures and higher precipitation in the new region. Therefore, in the new region they occupy calcareous substrates that are warmer and drier.

Compared to other types of vegetation, weed vegetation has one of the largest species pools in central Europe (Sádlo et al. 2007). Whereas the total species pool of weeds is higher in the north-western Balkans data set there is for *Caucalidion* vegetation a high species richness per plot in the Czech Republic (Table 1), which indicates a low level of competitive exclusion as is also documented by Lososová et al. (2009).

Table 3. – Ratio of theta values for *Caucalidion* species occurring in both data sets. A negative difference in the ratio in the two data sets indicates a narrowing of the species niche.

Species	Central Europe		North-western Balkan		Δ
	Whittaker	Ratio	Whittaker	Ratio	
Adonis aestivalis	3.486	0.597	4.128	0.707	– 0.110
Aethusa cynapium	3.907	0.669	4.292	0.735	– 0.066
Ajuga chamaepitys	3.480	0.596	4.474	0.766	– 0.170
Anagallis arvensis	3.939	0.674	5.022	0.860	– 0.185
Anagallis foemina	3.656	0.626	4.659	0.797	– 0.172
Anthemis austriaca	3.774	0.646	4.339	0.743	– 0.097
Atriplex patula	3.765	0.644	4.648	0.796	– 0.151
Avena fatua	3.792	0.649	4.593	0.786	– 0.137
Bifora radians	3.163	0.541	4.965	0.850	– 0.308
Buglossoides arvensis	3.623	0.620	5.188	0.888	– 0.268
Camelina microcarpa	3.689	0.631	4.050	0.693	– 0.062
Capsella bursa-pastoris	4.175	0.715	4.956	0.848	– 0.134
Caucalis platycarpos	3.776	0.646	4.755	0.814	– 0.168
Centaurea cyanus	3.621	0.620	5.263	0.901	– 0.281
Cerinthe minor	3.636	0.622	5.125	0.877	– 0.255
Chenopodium album agg.	4.235	0.725	4.925	0.843	– 0.118
Cirsium arvense	4.205	0.720	5.186	0.888	– 0.168
Consolida regalis	3.927	0.672	5.085	0.870	– 0.198
Convolvulus arvensis	4.286	0.734	5.266	0.901	– 0.168
Descurainia sophia	4.033	0.690	4.166	0.713	– 0.023
Euphorbia falcata	3.516	0.602	4.626	0.792	– 0.190
Euphorbia helioscopia	4.034	0.690	4.617	0.790	– 0.100
Fumaria officinalis	3.718	0.636	5.114	0.875	– 0.239
Fumaria vaillantii	3.374	0.578	4.641	0.794	– 0.217
Galium tricornutum	3.269	0.559	5.020	0.859	– 0.300
Geranium pusillum	4.149	0.710	4.248	0.727	– 0.017
Lamium amplexicaule	4.046	0.693	4.986	0.853	– 0.161
Lamium purpureum	4.071	0.697	4.632	0.793	– 0.096
Lathyrus aphaca	2.715	0.465	4.896	0.838	– 0.373
Lathyrus tuberosus	3.835	0.656	5.089	0.871	– 0.215
Matricaria perforata	4.165	0.713	5.379	0.921	– 0.208
Medicago lupulina	3.763	0.644	5.295	0.906	– 0.262
Neslia paniculata	3.545	0.607	5.135	0.879	– 0.272
Papaver rhoeas	4.057	0.694	4.977	0.852	– 0.157
Polygonum aviculare agg.	4.125	0.706	5.235	0.896	– 0.190
Ranunculus arvensis	3.558	0.609	5.119	0.876	– 0.267
Reseda lutea	4.196	0.718	4.191	0.717	0.001
Setaria viridis	4.244	0.726	4.324	0.740	– 0.014
Sherardia arvensis	3.489	0.597	4.364	0.747	– 0.150
Sonchus arvensis	3.891	0.666	4.750	0.813	– 0.147
Sonchus asper	3.798	0.650	4.722	0.808	– 0.158
Stachys annua	3.880	0.664	4.737	0.811	– 0.147
Stellaria media	4.194	0.718	4.822	0.825	– 0.108
Thlaspi arvense	4.070	0.697	5.173	0.885	– 0.189
Valerianella dentata	3.481	0.596	3.993	0.683	– 0.088
Veronica hederifolia	3.975	0.680	5.258	0.900	– 0.220
Veronica persica	4.123	0.706	4.812	0.824	– 0.118
Veronica polita	4.039	0.691	4.453	0.762	– 0.071
Vicia sativa	3.727	0.638	5.196	0.889	– 0.251
Viola arvensis	4.153	0.711	4.703	0.805	– 0.094
Viola tricolor	3.762	0.644	5.216	0.893	– 0.249

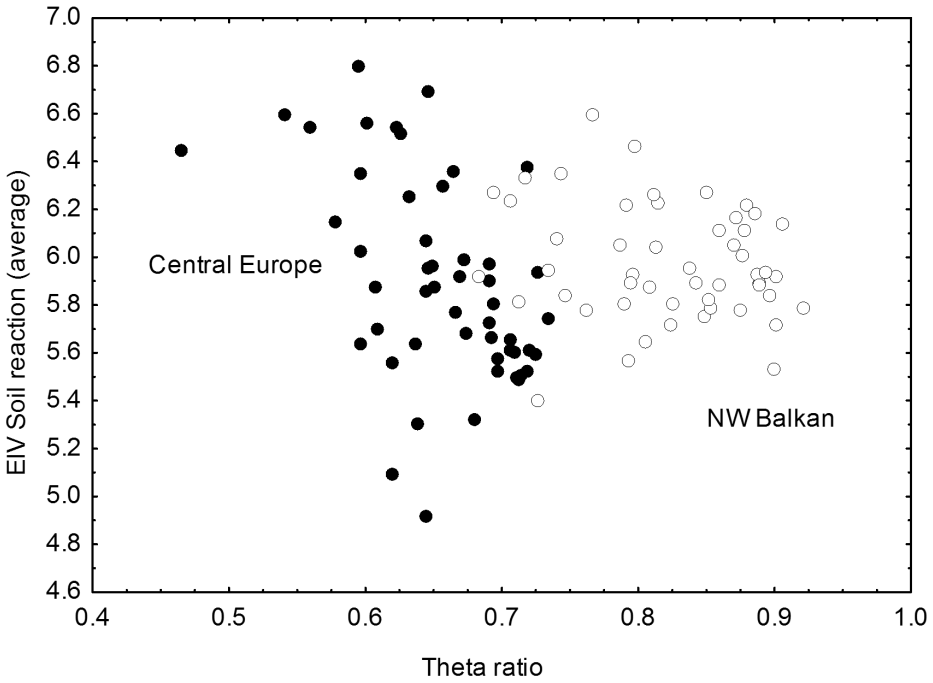


Fig. 1. – Scatter diagram of the relationship between the average ecological value for reaction of *Caucalidion* species in both data sets and the theta ratio.

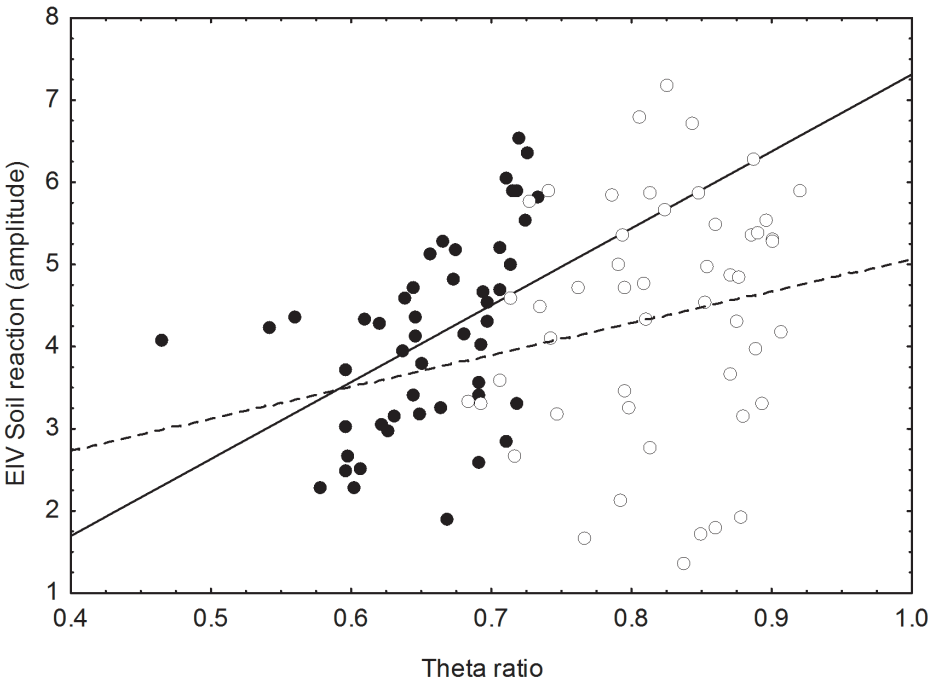


Fig. 2. – Scatter diagram of the relationship between the amplitude of the ecological reaction value for *Caucalidion* species in both data sets and the theta ratio.

Certainly, the results are affected by the differences in bedrock and soil conditions in central Europe and north-western Balkans. In central Europe base-rich habitats are restricted to a relatively small area compared to the Balkan Peninsula where such habitats prevail. Spatial isolation of suitable habitats results in greater specialization. Level of specialization would even increase if there were greater limitations to dispersal such as barriers to migration, which would result in different local communities becoming isolated. An example of this is the geographically isolated *Caucalidion* vegetation with *Lathyrus aphaca*, which occurs in only a few small arable fields in the Bílé Karpaty Mts (eastern part of the Czech Republic; Otýpková 2001).

Generalists are favoured in heterogeneous and disturbed environments, while specialists occur in more stable environments (Clavel et al. 2011). It is striking that *Caucalidion* species are generalists in their native range (if we assume the Balkans form part of their native range as these species were spread there earlier) and specialists in areas into which they spread more recently. The level of agricultural disturbance along the gradient is similar but the abiotic parameters, e.g. climate, change dramatically.

Archaeobotanical evidence of species composition of weed vegetation in Neolithic times indicates a gradual decrease in apophytes and increase of immigrants from the south and east (Rösch 1998). At that time *Caucalidion* species were newcomers and possibly invasive and analogous situations are currently occurring. Recent comparative analyses of introduced species show that generalists are more likely to become established than specialists (Clavel et al. 2011). They indicate that generalists are more abundant and therefore more likely to be introduced (number of introduced events and individuals are important). Since Neolithic times the climate in south-eastern Europe has not changed dramatically but previously may have been cooler and wetter (Kreuz et al. 2005), so we can assume that *Caucalidion* weeds were also specialists in this area at that time. Their successful establishment contradicts recent hypotheses that generalists are better invaders. In our case generalists became successful invaders by becoming specialists in these novel ecosystems. Possible explanation of this successful invasion by specialists could be a high number of introduced events in combination with the introduction of agriculture.

Changes in the ecology of the area could be blurred by the changes that have occurred in agricultural methods over the last few decades, most of all seed-cleaning. One could argue that *Caucalidion* species and most specialists in general are particularly endangered when at the limits of their distribution (Holzner 1978, Lososová et al. 2004). Specialists occupy a narrow ecological niche and a small change in ecological conditions can result in them becoming extinct.

Although intensive farming can cause a decline in *Caucalidion* weed vegetation (Hilbig & Bachthaler 1992, Lososová 2003, Pinke 2004, Kropáč 2006, Lososová & Simonová 2008, Cimalová & Lososová 2009), the data set analysed comprised vegetation plots from regions along the whole gradient with similar agricultural practices. Therefore, agriculture affects the weed vegetation similarly along the whole gradient. Currently, the same widespread species of weeds dominate the weed vegetation in both regions (Table 1). Nevertheless political changes in both regions after 1990 and changes in farming systems in recent years have endangered the weed vegetation, which adds another reason for the conservation of *Caucalidion* species (Hotze & van Elsen 2006). The expectation is that with climatic change and increase in temperature there will be more fields that are suitable for *Caucalidion* weed vegetation, but whether seeds of these species will continue to be present in the species pool (seed bank) is questionable.

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Souhrn

Šířka ekologické niky druhů se mění se změnou environmentálních podmínek. Zvláště na okraji svého areálu se druhy stávají specializovanějšími. Cílem práce je srovnání šířky ekologických nik diagnostických druhů plevelové vegetace svazu *Caucalidion* ve dvou oblastech střední Evropy, lišících se svými klimatickými podmínkami, České republice a zemích severozápadního Balkánu. Polní plevele svazu *Caucalidion* byly do Evropy zavlečeny s počátkem zemědělství. Pocházejí zpravidla z jihovýchodní Evropy a Eurasie, přesto tyto rostliny přežívají ve střední Evropě v klimatických podmínkách, které se liší od jejich původního areálu. Pracovali jsme s databází fytocenologických snímků plevelové vegetace České republiky, zahrnující 3383 snímků, a databází snímků severovýchodního Balkánu, zahrnující 4505 snímků. Stanovili jsme diagnostické druhy svazu, které jsou společné pro oba regiony, a testovali jsme míru specializace těchto diagnostických druhů svazu v obou regionech. Jako míru specializace jsme použili algoritmus výpočtu společných výskytů druhů. Prokázali jsme, že všechny diagnostické druhy svazu jsou specializovanější v České republice než na Balkáně, tedy že se na svých stanovištích setkávají s méně druhy a mají zde užší ekologickou niku. Stanoviště, která v České republice osídlují, jsou bazičtější než na Balkáně. Vedle toho, že jsme potvrdili dosavadní předpoklady, které však nebyly dosud nikdy doloženy na reálných datech, jsou naše výsledky významné pro aplikaci v ochranářské praxi.

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