FOUNDING OF A MONITORING NETWORK OF IMPACT OF CLIMATIC CHANGES ON FOREST CARABID ASSEMBLAGES IN SLOVAKIA: EVALUATION OF THEIR INITIAL STATE

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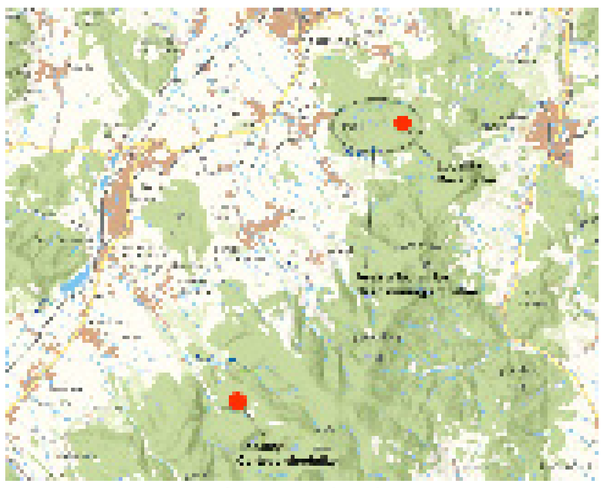

Fig. 1. Position of two study plots in the Vtáčnik Mts. near Prievidza

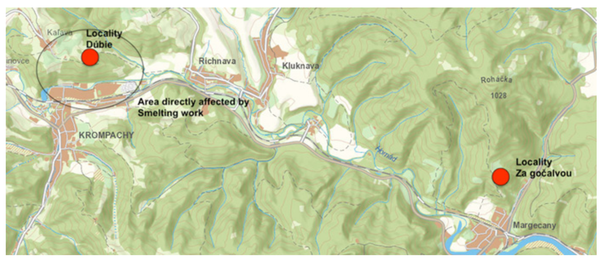

Fig. 2. Position of two study plots in the Čierna hora Mts. near to Krompachy and Prievidza

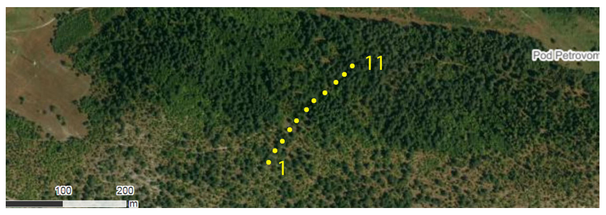

Fig. 3. Position of the trap transect in the plot in Dúbie near Krompachy

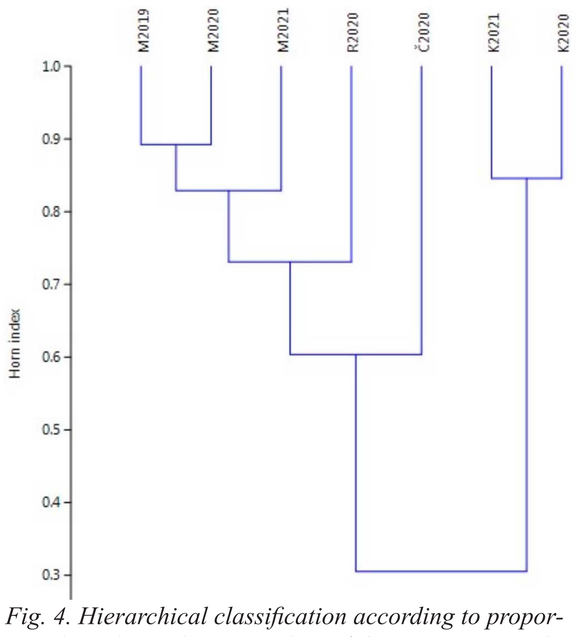

Fig. 4. Hierarchical classification according to proportional similarity (Horn´s index) of the one-year samples from the sites Za Gočalovou near Margecany(M), Dúbie near Krompahy (K), Čertove chodníky (Č) and Račkov laz (R) near Prievidza from 2019-2021

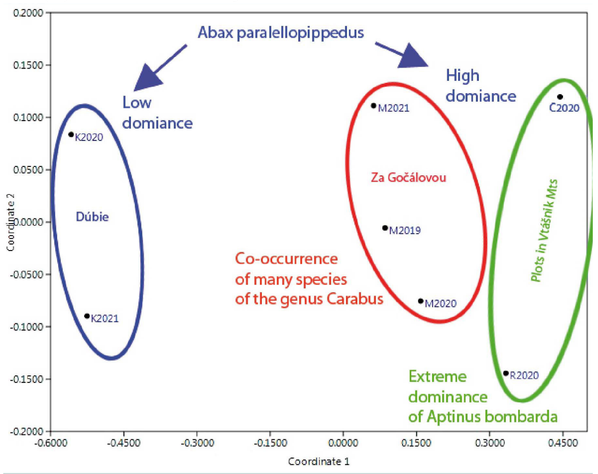

Fig. 5. Non-metric scaling according to proportional similarity (Horn´s index) of the one-year samples from the sites Za Gočalovou near Margecany(M), Dúbie near Krompahy (K), Čertove chodníky (Č) and Račkov laz (R) near Prievidza from 2019-2021

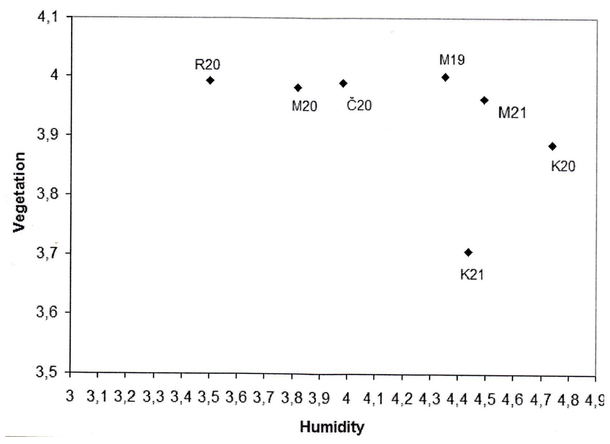

Fig. 8. Direct ordination of seven one-year samples of Carabids from plots Za Gočalovou near Margecany(M), Dúbie near Krompahy (K), Čertove chodníky (Č) and Račkov laz (R) near Prievidza from 2019-2021 according to humidity and vegetation cover preference (semiquantitative humidity scale: 1- xerophilous, 8 – polyhygrophilouus; vegetation cover scale 1 – open landscape withot tree shadowing, 4 – complete shadoving by tree canopy)

Table 1. Survey of Carabid species and numbers of individuals in four plots in the Vtáčnik Mts. and Čierna hora Mts. in 2019 – 2021 (Č. – Čertove chodníky, R. – Račkov laz, H – humidity preference [1-xeropholous, 8 – polyhygropilous] V – vegetation cover preference [1 open landscape, 4 – closed tree canopy)

Species	Preference		Dúbie		Za Gočalovou			Č.	R.
	H	V	2020	2021	2019	2020	2021	2020	2020
Abax paralelopipedus (Piller et	3	4	7	1	95	346	4	175	90
Abax ovalis (Duftschmidt, 1812)	4	4			7	7	3		1
Abax parallelus (Duftschmidt, 1812)	4	4	1		71	116	14	11	50
Amara bifrons (Gyllenhall, 1810)	3	1	1						
Amara ingenua (Duftschmidt, 1812)	2	1	1	3					
Amara littorea C. G. Thomson, 1857	3	1	7	11					
Aptinus bombarda (Illiger, 1800)	3	4						1	162
Calathus fuscipes (Goeze, 1777)	4	1	1						
Carabus arvensis Herbst, 1784	4	2	25	5					
Carabus auronitens Fabricius, 1792	4	4		1	23	44	2		
Carabus convexus Fabricius, 1775	4	4	28	7	7	4			
Carabus coriaceus Linnaeus, 1758	5	4	1	2	2	1			
Carabus hortensisLinnaeus, 1758	4	4	108	61	17	19	10		5
Carabus intricatus Linnaeus, 1762	4	4	12	6	2	6		1	1
Carabus linnei Panzer, 1810	5	4	120			1	3		
Carabus nemoralis D. F. Müller, 1764	4	4	2		7	4		9	3
Carabus scheidleri Panzer, 1799	5	4				1		8	
Carabus violaceus Linnaeus, 1758	5	4	60	26	12	40	8	23	5
Cychrus attenuatus (Fabricius, 1792)	5	4	0		60	45	6	2	
Cychrus caraboides (Linnaeus, 1758)	5	4	7		3	2			
Cymindis axilaris (Fabricius, 1794)	2	1				3	1		
Cymindis humeralis(Fouecroy, 1785)	3	1							1
Harpalus distinguendus (Duftschmidt,	3	1	1						
Leistus rufomarginatus (Duftschmidt,	5	4						3	3
Molops piceus (Panzer, 1793)	5	4			24	5	8	17	11
Nebria brevicollis (Fabricius, 1792)	5	2						2	
Ophonus nitidulis Stephen, 1828	2	1				1			
Platynus assimilis (Paykull, 1790)	7	4						1	1
Poecilus cupreus (Linnaeus, 1758)	4	1	2	2					
Poecilus virens (G. F. Müller, 17785)	3	1	3	1					
Pterositichus burmeisteri Heer, 1841	5	4	2		86	73	13	99	40
Pterostichus aethiops (Panzer, 1797)	5	4	1	1					
Pterostichus foveolatus (Duftschmidt,	5	4							1
Pterostichus melas (Creutzer, 1799)	4	4	4					1	
Pterostichus niger (Schuller, 1783)	5	4	205	11					1
Pterostichus oblongopunctatus	5	4	257	70	78	43	6	13	1
Pterostichus unctulatus (Duftschmidt,	5	4				3			
Synuchus vivalis (Illiger, 1798)	4	2				1			
Trichotichnus laevicollis (Duftschmidt,	5	4			6		1		
Number of species			23	15	16	21	13	15	16
Number of individuals			856	208	500	765	79	366	376

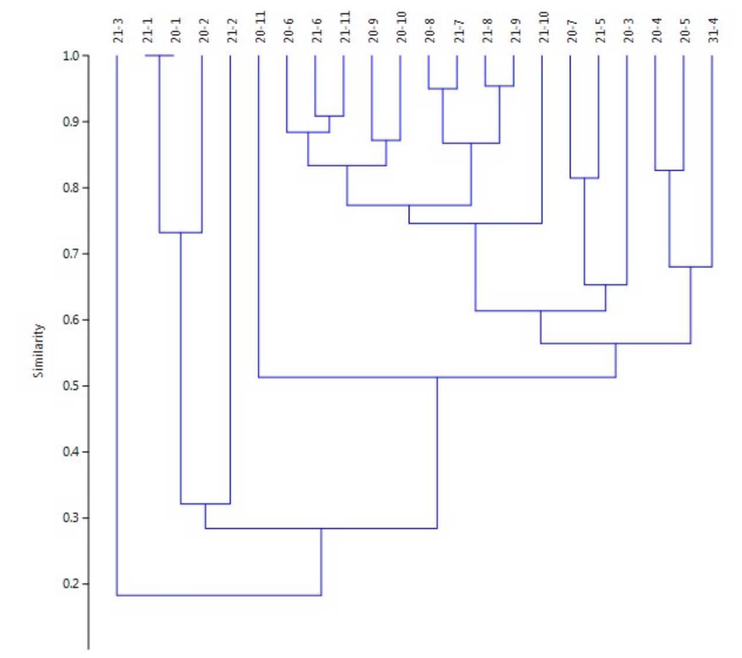

Fig. 6. Hierarchical classification of separate samples from 11 points of the transect in Dúbie near Krompachy from 2020 and 2021 according to proportional similarity (Horn´s index) (first two digits – two last digits of 2020 or 2021, digits after hyphen – number of individual point)

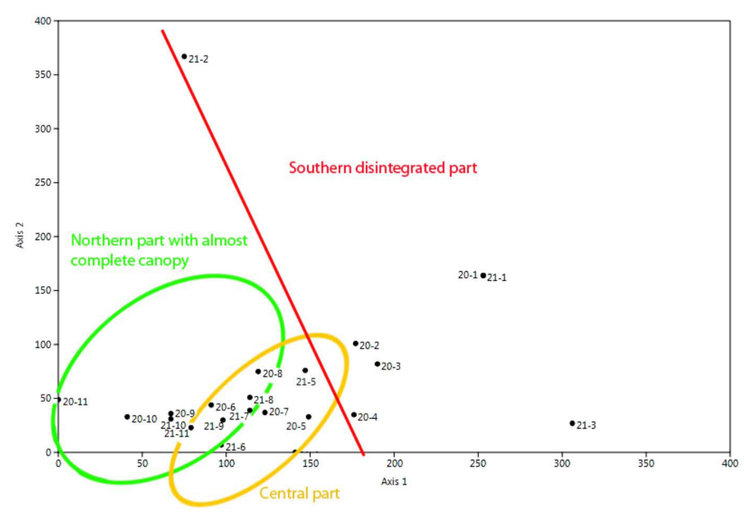

Fig. 7. Detrended correspondence analysis of separate samples from 11 points of the transect in Dúbie near Krompachy from 2020 and 2021 symbols as in Fig. 6)

INTRODUCTION

The climatic changes have potentially a deep influence on the composition of ecosystems and geographic and altitudinal distribution of plants and animals. The long-termed monitoring of Carabid assemblages in the forests on southern slopes High Tatra damaged by the windstorm of November 2004 has shown (Šustek & Vido 2015, Šustek et all. 2017, Vido et al. 2015), that irrespectively of momentary state of the studied sites and of the Carabid assemblages living in them, they simultaneously showed periodical changes of number of species, individuals and cumulative biomass correlated with about one- to two-year delay with fluctuations of humidity expressed by the SPEI-12 index. However, there arises question, whether these changes have a general character common for a larger area and different local conditions.

In order to answer this question, in 2019 and 2020 we founded four study plots in forests in relatively distant places near Prievidza, Krompachy and Margecany, in the beech vegetation tier (Raušek & Zlatník 1966, Zlatník 1976). Two plots near Prievidza were selected so to they potentially reflect also the influence of hydrological regime changed by extensive mining activity. The plots near Krompachy and Margecany were selected also to show the difference between an ecosystem heavily damaged by the heavy metal deposits originating from the already liquidated Smelting work in Krompachy. The aim of this contribution is a general coenological characteristic of the Carabid assemblages in these four sites and their comparison with other assemblages in analogical conditions.

RESULTS AND DISCUSSION

In all plots altogether 3,150 individuals of 39 species were collected (Tab. 1). In individual plots and years, number of individuals fluctuated between 79 and 856 and that of species fluctuated between 13 and 23. The sampling was partly influenced by destruction of some traps by animals.

The species spectra, in general, correspond to the composition of carabid communities in beech-oak to beech vegetation tiers (Holecová et al. 2012; Korbel 1966, 1973; Majzlan 1991, 2010; Majzlan et al. 2005; Šustek 1972, 1983, 1984, 1993a, 1993b, 2000, 2004a, 2004b) with Abax paralelopipedus, Abax paralleus, Pterostichus oblogopunctatus as Carabus hortensis as eudominant or dominant species with optimum of vertical distributions in lowlands. They are accompanied, also in dominant position, with Carabus violaceus, Pterostichus burmeisteri having optimum in beech to beech-fire-spruce vegetation tiers. There also appear, in subdominant position, Carabus auronitens, Carabus linei, Cychrus attenuatus, Cychrus caraboides, Abax ovalis that have same altitudinal distribution.

The assemblage from Za Gočalovou shows a remarkable co-occurrence of even nine species of the genus Carabus. A similar state was observed in Slovakia only in the assemblage from surroundings of Silická ľadnica (Šustek 1995).

A special case is the extreme eudominant position of Aptinus bombarda (43,1% !!!) in Račkov laz. However, such cases are known in the literature cited above. Further special and remarkable case is the eudominant (23,9%) occurrence of the strongly hygrophilous Pterostichus niger in relatively dry plot in Dúbie in 2020 and its dominant position (5,3%) in 2021. Such sudden changes in its position are known even in floodplain forests as its reaction on momentary fluctuations in humidity (Šustek 1993a). According to the authors´ observations in other localities, it seems that in recent years it is expanding into rather untypical habitats.

According to proportional similarity (Horn´s index) the communities form two major clusters (Fig. 4) . One cluster includes assemblages from the plot Za Gočalovou, that form the core of this cluster, and the assemblages from Račkov laz and Čertove chodníky gradually attach to them. Ale these assemblages are characterized by a high co-dominance of Abax parallelopipedus, Abax parallelus, Pterostichus burmeisteri and Cychrus attenuatus, as well as by the common occurrence of Molops piceus and Abax ovalis. The decreasing representation of Abax parallelus, Carabus hortensis, Carabus auronitens, Carabus violaceus, Pterostichus oblongopunctatus and Cychrus attenuatus is responsible for separation of the samples from Za Gočalovou from 2021 form the samples from 2019 and 2020 and its association with sample from Račkov laz and the subsequent association with the sample from Čertove chodníky.

Other major cluster form the samples from the plot in Dúbie, which is characterized in both years by low representation of Abax paralelopipedus, absence of Molops piceus and increased representation of Carabus hortensis, Pterostichus oblongopunctatus, Pterostichus niger and Carabus linei and presence of Carabus arvensis and several open landscape species of the genus Amara. The same relation is also illustrated in the ordination diagram of the Non-metric scaling. (Fig. 5).

The samples from Dúbie are internally differentiated according to density of the tree vegetation (Fig. 6 and 7).The sparsest southern part is characterized by a low number of individuals and presence of there open landscape species of the genus Amara, among which occurrence of Amara ingenua is remarkable, and Poecilus cupreus and Poecilus virens. Samples from the southern part are highly variable to to fluctuating presence of individual species. This is clearly reflected by the wide dispersion of these samples in the ordination space (Fig. 7). In our samples, no individuals of Cicindela sylvicola were found in this part, but were recorded here by Machava et al. (2017) and their occurrence would well correspond to the character of this part of the transect. The more dense central part is characterized by isolated presence of Carabus arvensis. This palaearctic species prefers sandy habitats and is, for example, widely distributed in light pine forests in Poland (Szysko 1983), but in Slovakia its distribution is very discontinuous. In Dúbie it reflects simultaneous the sandy soil structure and discontinuous tree cover. The northern dense part is characterized my increased representation of the typical forest species Carabus hortensis, Carabus convexus, Pterostichus oblongopunctatus and the mountains species Carabus linnei. Remarkable is, in relation to a dry character of this locality, a high representation of hygrophilous Pterostichus niger.

In regard to the overall habitat preference of Carabids, the assemblages show a high predominance of forest species requiring the complete shadowing by tree vegetation (Fig. 8). Only in both samples from Dúbie near Krompachy, the proportion of these species decreases, especially in 2021, due to discontinuous tree vegetation in the southern part of this plot. in regard to humidity the assemblages are more differentiated. The dries plot is near Račkov laz (average humidity preference index 3.5, while the highest humidity preference (index 4,7) shows the sample from Dúbie from 2020 due to simultaneous high representation of the species with increased humidity requirement Pterostichus niger, Carabus linei, Carabus violaceus and Pterostichus oblongopunctatus. However, in spite of this all assemblage preserve character of mezohygrophilous assemblages. The driest character of the assemblage from Račkov laz in in conformity with our hypothesis that hydrological regime of this locality is damaged by mining

CONCLUSIONS

The Carabid assemblages in studied plots characterize the variability of number of individuals and species and of composition the assemblages in the in oak-beech to beech vegetation tiers. They consist predominantly of species with occurrence optimum in oak to beech-oak vegetation tiers, but with a considerable admixing of the species with occurrence optimum in beech-fire to beech-fire-spruce vegetation tier. Except the plot in Dúbie, which manifests high degree of long-termed heavy metal pollution and disintegration of the tree canopy, they almost exclusively consist of the typical forest species. The presence of the open landscape species is negligible in them. As to the average humidity preference, they all represent the mesohygrophilous communities, but they show certain between year variability within each plot. Some of them are subject of a striking expansion of the hygrophilous floodplain species Pterostichus niger. Adequate interpretation of this phenomenon is task of the future investigation.