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DIVERSITY OF CARABID BEETLES (CARABIDAE) IN QUARRIES OF PÁLAVA

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Abstract

NOVÁKOVÁ LUCIE, ŠŤASTNÁ PAVLA: *Diversity of carabid beetles (Carabidae) in quarries of Pálava*. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 6, pp. 1807–1815

During the vegetation period of 2012, a faunistic survey of carabid beetles was conducted with focus on selected limestone quarries in the Pálava PLA. In the Turold quarry, 39 species in the total number of 270 specimens were captured, while the most abundant species was *Carabus cancellatus*. In the Svatý kopeček quarry, a total of 36 species with the total number of 420 specimens were collected, the most numerous species here was *Pseudoophonus rufipes*. Four protected species under the Decree 395/1992 Coll., as amended by Decree No. 175/2006 Coll. – *Brachinus crepitans, B. explodens, Carabus ullrichii ullrichii,* and *Cylindera germanica* and 6 species listed in the Red List of the Czech Republic – *Licinus cassideus, Carabus cancellatus*, *Cylindera germanica, Cymindis axillaris, Notiophilus laticollis*, and *Poecilus sericeus* were recorded in the areas investigated. Typical xerothermophilous species preferred the medium-term quarry of Svatý kopeček to the Turold quarry, which has been closed for almost 70 years now.

Carabid beetles, limestone quarries, faunistic, Pálava PLA, South Moravia

A faunistic research was conducted in two closed limestone quarries which are located in Pálava PLA (South Moravia). The territory, that was declared a protected landscape area already in 1976, protects the most valuable habitats of species-rich rocks, grass turfs, meadow steppes, forest steppes, thermophilous oak woods and scree woods. In 1986 the Pálava protected landscape area was included in the international network of biosphere reserves by UNESCO and since 2003 it has been a part of the Lower Morava Biosphere Reserve.

The area is very well investigated in faunistic and botanical terms. Plant community mapping was performed by e.g. Grulich (1995). A complex study of fauna was conducted by Rozkošný & Vaňhara (1995a, 1995b, 1996, 1998, 1999), Opravilová *et al.* (1999), Řehák *et al.* (2002). Petrákova & Schlaghamerský (2011) studied the interactions between territorial ants; Šebesta *et al.* (2012) dealt with the distribution of mosquitoes in South Moravia. Laštůvka (1994) mapped the distribution of butterflies in the Pálava PLA. Studies on Carabid beetles in South Moravia and Pálava PLA were performed by Šustek (1994a), when he compared communities of Carabid beetles in flooded and non-flooded areas, and in other papers (Šustek, 1992, 1994b) he dealt with migration of Carabid beetles through different types of windbreaks; Šustek (2008) records the changes in Carabid beetle communities along the forest biocorridor of the Pavlov Hills. Monitoring the occurrence of Carabid beetles in limestone quarries of this area has not yet been conducted, and it could uncover significant findings of rare species, such as Tropek *et al.* (2010) point out in their study, which could support and enhance the ecological value of the area.

MATERIAL AND METHODS

The research was conducted in two quarries of South Moravia. The first quarry was the Turold quarry (48°49'0.248"N, 16°38'20.859"E), faunistic square 7165 (Pruner & Míka, 1996). The plot is situated at an altitude of 240 m.a.s.l. It is a limestone quarry, in which extraction definitely finished in 1945. It is the oldest nature reserve in the Pálava PLA, it has been protected by a decree since 1946. The second plot was the quarry of Svatý kopeček, (48°48'26.811"N, 16°38'55.906"E), faunistic square 7165. The plot is situated at an altitude of 240 m.a.s.l.

Extraction there was discontinued in 70s of the last century, and the quarry was revitalized.

In order to capture Carabid beetles, formaldehyde pitfall traps with a detergent as a wetting agent were used. In each quarry, pitfall traps were placed in three lines at six sites. Three sites were in habitats with early succession (one line directly in the quarry (plot 4), one at the edge of the quarry (plot 5) and one in the vicinity of the quarry (plot 6) and three other sites were in habitats with advanced succession (one line again directly in the quarry (plot 1), one at the edge of the quarry (plot 2) and one in the vicinity of the quarry (plot 3).

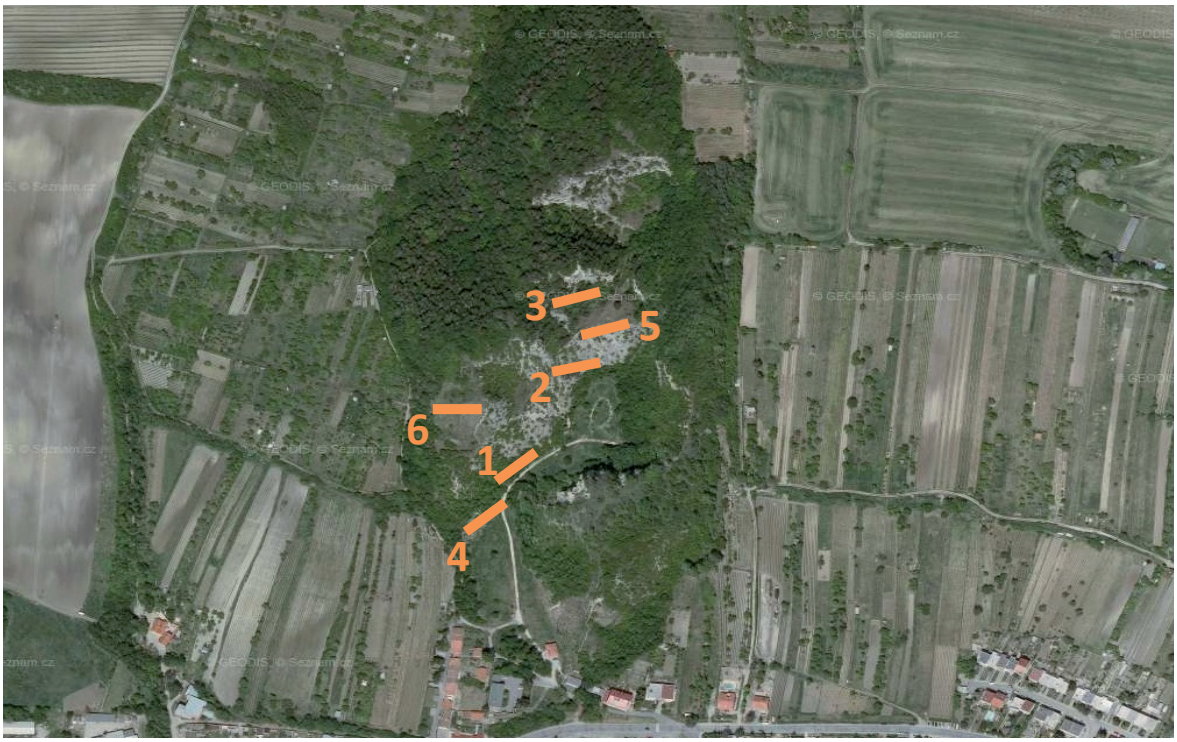
Description of individual plots in Turold quarry (Fig. 1, 2)

Plot 1 was a scree forest under a rock wall at the lower plateau, substrate was a combination of fallen stones and soil. The total coverage was 80%. Rather significant abundances of *Prunus mahaleb*, *Ligustrum vulgare*, and *Fraxinu sexcelsior.* Plot 2 was formed by sparse scrubs on steep scree slope with a minimum of soil and loose gravel dominated. The total coverage was 20%. Greater proportion of *Cornus sanguinea*. Plot 3 was formed by a small forest with protruding rocks. The total coverage was 75%. Greater proportion of *Prunus mahaleb*, *Viburnum lantana*, *Pinus nigra*, *Robinia pseudoacacia*, and *Fraxinus excelsior*. Plot 4 was a meadow on the lower plateau of the quarry, regularly mowed. The total coverage was 75%. Greater proportion of *Arrhenatherum elatius, Agropyrum repens*, and *Dactylis glomerata*. Plot 5 was a steep rockery and debris, vegetation was dry, sometimes landslides, substrate here was gravel and rocks with little soil. The total coverage was 50%. Greater proportion of *Koeleria macrantha*, *Sanguisorba minor*, and *Sedum album*. Plot 6 comprised of steep rocky slope with a thin layer of pouring soil with a total coverage of 15%. Greater proportion of *Euphorbia cyparissias*.

Description of individual plots in the Svatý kopeček quarry (Fig. 1, 3)

Plot 1 was a scree slope with unstable gravel and a minimum of soil with sparse herbaceous vegetation. The total coverage was 20%. Greater proportion of *Arrhenatherum elatius.* Plot 2 comprised of a grassland community on the central terrace without mowing. The total coverage was 85%. Greater proportion of *Arrhenatherum elatius, Campanula rapunculoides*, and *Clematis vitalba*. Plot 3 was a forest and scrub on the upper edge of the quarry. The total coverage was 90%. Greater proportion of *Prunus mahaleb*. Plot 4 comprised of the lower plateau, almost without soil, just stones. The total coverage was 15%. Greater proportion of *Arrhenatherum elatius*, and *Sedum album*. Plot 5 represented sparse scrub. The total coverage was 15%. Greater proportion of *Prunus mahaleb.* Plot 6 comprised of natural steppe, stones somewhere protruded the surface. The total coverage was 72%. Greater proportion of *Festuca valesiaca*, *Carex humilis*, *Dorycnium germanicum*, *Potentilla arenaria*, and *Stipa pennata*.

1: *Localization surveyed quarries (www.mapy.cz)*



2: *Turold quarry: approximate plot of pitfall traps, each line indicates the plot of three pitfall traps at a mutual distance of 5 m (www.mapy.cz)*

3: *Svatý kopeček quarry: approximate plot of pitfall traps, each line indicates the plot of three pitfall traps at a mutual distance of 5 m (www.mapy.cz)*

Samples were collected in monthly intervals in 2012 in the growing season. Pitfall traps were installed in both quarries in March (5 March 2012), collection were then performed (on dd.mm.yyyy 23. 3. 2012, 19. 4. 2012, 23. 5. 2012,22. 6. 2012, 23. 7. 2012, 22. 8. 2012, 24. 9. 2012, 31. 10. 2012). After collection, the material was converted into a permanent fixation in 70% alcohol. Determination of species of the Carabidae was performed by the authors hereof using Hůrka's (1996) monograph. The nomenclature is according to Vigna Taglianti (2012).

Pursuant to Hůrka *et al.* (1996), species were classified into three indication groups (R, A, E) according to their ecological valency and dependence on the habitat. Species in the R group are stenotopic species with the narrowest ecological valency, mostly rare and endangered species of native, intact ecosystems. Group A is characterized by adaptable species occurring in habitats close to natural state. The last bioindication group E includes eurytopic species that have no special demands on the quality of the environment (species of unstable and changing habitats, habitats strongly influenced by human activities).

RESULTS AND DISCUSSION

In the Turold quarry, a total of 39 species with a total number of 270 specimens were captured in 2012 (Tab. I). The most numerous species was *Carabus cancellatus* (36 specimens), the most specimens were captured at plot 1. The highest abundance of specimens and species was recorded at plot 4 (120 specimens, 29 species), next at plot 1 (111 specimens, 14 species), 3 (14 specimens, 6 species), 5 (13 specimens, 7 species), 2 (10 specimens, 8 species), and 6 (2 specimens, 2 species). The majority was eurytopic species (56%), adaptable species were represented by 41% and relict species by 3%. Only *Licinus cassideus* (2 specimens, plot 2 and 4) represented the relict species. According to Veselý *et al.* (2005), one species endangered (EN) *Licinus cassideus* and one species nearly threatened (NT) *Carabus cancellatus* were detected, the most specimens of each of them were caught at plot 1. From the species protected by Decree 395/1992 Coll., as amended by Decree 175/2006 Coll., *Brachinus crepitans, B. explodens*, and *Carabus ullrichii ullrichii* were detected.

In the Svatý kopeček quarry, a total of 36 species with a total number of 420 specimens were captured in 2012 (Tab. II). The most numerous species was *Pseudoophonus rufipes* (126 specimens), the most specimens were captured at plot 3. The most specimens and species were detected at plot 3 (225 specimens, 22 species), followed by plot 2 (146 specimens, 11 species), 4 (20 specimens, 10 species), 5 (18 specimens, 7 species), 1 (10 specimens, 8 species), and 6 (1 specimens, 1 species). Eurytopic species (50%) dominated at sites, adaptable species were represented by 39% and relict species by 11%. Relict species found in the quarry included *Cymindis axillaris* (2 specimens, plot 4), *Licinus cassideus* (1 specimen, plot 3), *Notiophilus laticollis* (1 specimen, plot 3), and *Poecilus sericeus* (1 specimen, plot 3). According to Veselý *et al.* (2005), one endangered species (EN) *Licinus cassideus,* 4 vulnerable species (VU) *Cylindera germanica*, *Cymindis axillaris*, *Notiophilus laticollis*, and *Poecilus sericeus* were captured. From the species protected by Decree 395/1992 Coll., as amended by Decree 175/2006 Coll., *Brachinus crepitans, B. explodens, Carabus ullrichii ullrichii*, and *Cylindera germanica* were detected.

Species detected in this research were compared in particular with a summary of species by Hůrka & Šustek (1995) recorded in the so called extended Pálava PLA (at a time when a connection of the area of Soutok to the Pálava PLA was considered).

Hůrka & Šustek (1995) reported a total of 273 species of Carabid beetles throughout the Pálava Biosphere Reserve (about 240 sqkm). In the faunistic square 7165, there were 143 species of Carabid beetles, of which 34 species were identical to species found in our survey. In our study, in both quarries a total of 51 species were found, thus it follows that 17 species are for the faunistic square 7165 new. At the same plots, i.e. in the quarries of Turold and Svatý kopeček, Hůrka & Šustek (1995) reported 11 species at the forest steppe of Svatý kopeček and 3 species at the steppe of Turold except *Calosoma auropunctatum, C. inquisitor, C. sycophanta, Philorhizus crucifer crucifer*, and *Syntomus pallipes*, were species recorded in the paper by Hůrka & Šustek (1995) found in our present study. In our research, only three species were recorded at steppe habitats (plot 6) (1 species of *Pseudoophonus calceatus* at Svatý kopeček and 2 species of *Harpalus tardus* and *Ophonus azureus* at Turold). Moreover, we have detected three species of *Callistus lunatus*, *Carabus intricatus*, *Notiophilus laticollis* that had previously not been detected throughout the entire planned extension of the Biosphere Reserve. *Callistus lunatus* and *Notiophilus laticollis* are species of open habitats, the last mentioned is a relict (Hůrka, 1996) and vulnerable species (Veselý *et al.*, 2005) which occurs only rarely and locally.

Šustek (1983) undertook a study of Carabid beetles in the Pavlov Hills. The most abundant species in 1971 and 1981 were *Abax parallelepipedus*, *A. parallelus*, and *Carabus nemoralis*. These are representatives of typical forest species that were recorded in low abundances in our research. *Abax parallelepipedus* was captured the amount of one specimen in the quarry on the Svatý kopeček and in the amount of 34 specimens at Turold. *Carabus nemoralis* was found in the amount of 10 specimens in the Turold quarry. One specimen of *Abax parallelus* was captured in the Turold quarry and 1 specimen in the quarry of Svatý kopeček.

Šustek (2008) in a two-year research at the Pavlov Hills in 1988 and 1989 recorded a total of 7223 specimens belonging to 73 species. Among the most abundant was *Anchomenus dorsalis* which exceeded the 2000 found specimens, however, in our case it was only 8 specimens. In our research,

I: *Overview of species found in the quarry of Turold; Bioind. G. – species bioindication group by Hůrka et al. (1996) – E-eurytopic, A – adaptable, R – relict*

SPECIES	Bioind. G	1	2	3	4	5	6	In Total
Abax parallelepipedus (Piller & Mitterpacher, 1783)	A	33	1					34
Abax parallelus (Duftschmid, 1812)	A		1					1
Amara convexior Stephens, 1828	E				2			2
Amara equestris (Duftschmid, 1812)	A				6			6
Amara familiaris (Duftschmid, 1812)	E				1			1
Amara ovata (Fabricius, 1792)	E				1			1
Anchomenus dorsalis (Pontoppidan, 1763)	E				3			3
Metallina properans (Stephens, 1828)	E	1						1
Brachinus crepitans (Linnaeus, 1758)	E	2			7			9
Brachinus explodens Duftschmid, 1812	E				1			1
Calathus fuscipes (Goeze, 1777)	E		1					1
Callistus lunatus (Fabricius, 1775)	A				1			1
Carabus cancellatus Illiger, 1798	A	24	1	6	4	1		36
Carabus coriaceus Linnaeus, 1758	A	7	1	2	4	1		15
Carabus granulatus Linnaeus, 1758	E				2			2
Carabus hortensis Linnaeus, 1758	A		1					1
Carabus intricatus Linnaeus, 1761	A	5						5
Carabus nemoralis O. F. Müller, 1764	A	7			3			10
Carabus ullrichii ullrichii Germar, 1824	A	25		2	4			31
Harpalus atratus Latreille, 1804	A				27			27
Harpalus caspius roubali Schauberger, 1928	A				2			2
Harpalus distinguendus (Duftschmid, 1812)	E				1			1
Harpalus pumilus Sturm, 1818	A				2	1		3
Harpalus rubripes (Duftschmid, 1812)	E				2			2
Harpalus signaticornis (Duftschmid, 1812)	E				1			1
Harpalus tardus (Panzer, 1797)	E						1	1
Harpalus xanthopus winkleri Schauberger, 1923	A				1			1
Leistus ferrugineus (Linnaeus, 1758)	E	1			3			4
Licinus cassideus (Fabricius, 1792)	**R**		1		1			2
Microlestes maurus (Sturm, 1827)	E				3	1		4
Microlestes minutulus (Goeze, 1777)	E				1			1
Nebria brevicollis (Fabricius, 1792)	E	1						1
Ophonus azureus (Fabricius, 1775)	E				1	1	1	3
Ophonus rupicola (Sturm, 1818)	E				1			1
Poecilus cupreus (Linnaeus, 1758)	E	2	3	2	7	6		20
Pseudoophonus griseus (Panzer, 1797)	E	1			1			2
Pseudoophonus rufipes (De Geer, 1774)	E	1		1	27	2		31
Pterostichus melas (Creutzer, 1799)	A			1				1
Syntomus obscuroguttatus (Duftschmid, 1812)	A	1						1
In Total		**111**	**10**	**14**	**120**	**13**	**2**	**270**

the two most abundant species of open habitats were – *Pseudoophonus rufipes* (157 specimens) and *Brachinus crepitans* (129 specimens). Both species were recorded as relatively abundant by Šustek (2008). Given the nature of quarry sites investigated, no directly hydrophilic species were found in our research, as was the case with the above-mentioned study. Other abundant species recorded by Šustek (2008) included *Abax parallelepipedus* (1390 specimens), *Carabus coriaceus* (563 specimens), *Brachinus explodens* (482 specimens), *Pseudoophonus rufipes* (180 specimens), *Abax parallelus* (148 specimens), *Poecilus cupreus* (79 specimens). All of these species were also found in the quarries but in lower numbers. In contrast, species preferring dry habitats, such as *Harpalus pumilus* and *Amara convexior*

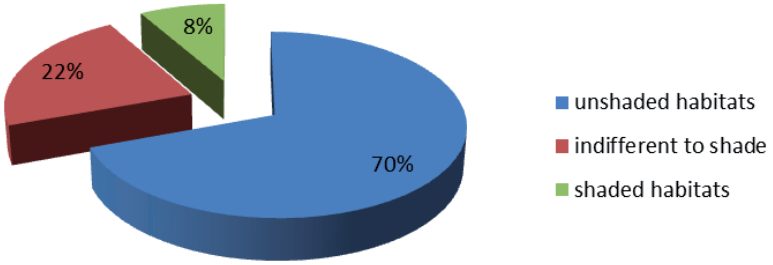
II: *Overview of species found in the quarry of Sv. kopeček; Bioind. G. – species bioindication group by Hůrka et al. (1996) – E-eurytopic, A – adaptable, R –relict*

SPECIES	Bioind. G	1	2	3	4	5	6	In Total
Abax parallelepipedus (Piller & Mitterpacher, 1783)	A	1						**1**
Abax parallelus (Duftschmid, 1812)	A	1						**1**
Amara bifrons (Gyllenhal, 1810)	E			1				**1**
Amara equestris (Duftschmid, 1812)	A			1				**1**
Amara familiaris (Duftschmid, 1812)	E			1				**1**
Amara ovata (Fabricius, 1792)	E			1				**1**
Amara similata (Gyllenhal, 1810)	E		1					**1**
Anchomenus dorsalis (Pontoppidan, 1763)	E	2	1	2				**5**
Badister bullatus (Schrank, 1798)	A		2					**2**
Brachinus crepitans (Linnaeus, 1758)	E		120					**120**
Brachinus explodens Duftschmid, 1812	E		1					**1**
Calathus ambiguus (Paykull, 1790)	A			1	1			**2**
Calathus fuscipes (Goeze, 1777)	E			27	1			**28**
Carabus coriaceus Linnaeus, 1758	A		2	1				**3**
Carabus ullrichii ullrichii Germar, 1824	A		4					**4**
Cylindera germanica (Linnaeus, 1758)	A	1						**1**
Cymindis axillaris (Fabricius, 1794)	**R**				2			**2**
Harpalus atratus Latreille, 1804	A	1		2				**3**
Harpalus caspius roubali Schauberger, 1928	A					1		**1**
Harpalus pumilus Sturm, 1818	A			6	6			**12**
Harpalus rubripes (Duftschmid, 1812)	E	1	3	5	1	9		**19**
Harpalus tardus (Panzer, 1797)	E			2				**2**
Leistus ferrugineus (Linnaeus, 1758)	E			1				**1**
Licinus cassideus (Fabricius, 1792)	**R**			1				**1**
Microlestes maurus (Sturm, 1827)	E	2	5		1	1		**9**
Notiophilus laticollis Chaudoir, 1850	R			1				**1**
Ophonus azureus (Fabricius, 1775)	E			2				**2**
Ophonus puncticollis (Paykull, 1798)	A				2	4		**6**
Ophonus rufibarbis (Fabricius, 1792)	E					1		**1**
Ophonus rupicola (Sturm, 1818)	E					1		**1**
Poecilus cupreus (Linnaeus, 1758)	E		5	3				**8**
Poecilus sericeus Fischer von Waldheim, 1824	**R**			1				**1**
Pseudoophonus calceatus (Duftschmid, 1812)	A			14	1		1	**16**
Pseudoophonus griseus (Panzer, 1797)	E	1		29	4			**34**
Pseudoophonus rufipes (De Geer, 1774)	E		2	122	1	1		**126**
Stomis pumicatus (Panzer, 1796)	A			1				**1**
In Total		**10**	**146**	**225**	**20**	**18**	**1**	**420**

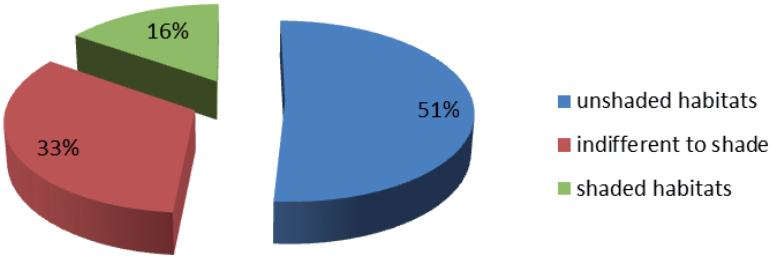
or xerothermophilous species, such as *Amara equestris*, *Harpalus rubripes* and a rare and vanishing species of *Licinus cassideus* were not recorded in the work of Šustek (2008).

Fojtová (2003) conducted a research on Carabid beetles in Ranšpurk NNR in 1993–2001, which is already quite different habitat. The most abundant species were *Pterostichus niger, Nebria brevicollis*, and *Carabus ullrichii*. We have not found *Pterostichus niger* in Pálava quarries, it is a species that occurs in meadows, forests, and shores overgrown by plants and it indicates increased humidity (Šustek, 1995). *Nebria brevicollis* is a species that was captured in the amount of one specimen in the Turold quarry. It is a species occurring in forests, parks, and meadows (Hůrka, 1996). *Carabus ulrichii* was captured on the Svatý kopeček in an amount of 4 specimens and at Turold in the amount of 31 specimens.

Obrtel (1972) undertook a study of Carabid beetles in South Moravia near the pond called Nesyt, that is also a markedly different habitat. He caught a total of 1,663 specimens of 32 species. The most abundant species was *Agonum moestum* that occurs along vegetated banks of waters and marshes,



4: *Habitat preferences of species in the quarry of Svatý kopeček*



5: *Habitat preferences of species in the Turold quarry*

in the floodplain forests and salt marshes (Hůrka, 1996). Another abundant species was *Bembidion inoptatum* which is a typical inhabitant of swamps, water banks and floodplain forests (Hůrka, 1996), of other wetland species occurred *Oodes helopoides* and *Pterostichus nigrita*. None of these species have been detected in the quarries.

Nováková & Šťastná (2013) conducted a research on Carabid beetles in two quarries, specifically the quarry of Lesní lom at Hády (Brno-Líšeň) and Malá dohoda (Moravský kras PLA). In both quarries a total of 1682 specimens belonging to 66 species were collected – Malá dohoda: 847 specimens (49 species); Lesní lom: 835 specimens (40 species). The most abundant species of Lesní lom was *Anchomenus dorsalis* (467 specimens), in Malá dohoda *Carabus cancellatus* (226 specimens). *Anchomenus dorsalis* was captured in the amount of 3 specimens in the Turold quarry and in the amount of 5 specimens in a quarry of Svatý kopeček. *Carabus cancellatus* occurred only in the Turold quarry in the amount of 36 specimens. In terms of habitat preferences, the communities in Malá dohoda and Lesní lom quarries were of similar composition. Forest species preferred typically forest plot. Species of open habitats and generalists prevailed on the quarry terraces. Xerothermophilous species and species preferring unshaded places found refuge particularly at ecotonic quarry zones. A similar finding resulted also from monitoring of the quarries of Turold and Svatý kopeček. In our study, species of unshaded habitats preferred the medium-term quarry of Svatý kopeček (70%) to the Turold quarry (51%) closed for nearly 70 years. Forest species were recorded in greater amounts in the Turold quarry (16%), while in the quarry of Svatý kopeček only 8% (Fig. 4, 5).

SUMMARY

The research was conducted in 2012 in two limestone quarries in South Moravia. The first quarry was Turold quarry and the second one was the quarry of Svatý kopeček.

In both quarries a total of 690 specimens belonging to 51 species were collected. In the Turold quarry, a total of 39 species with a total number of 270 specimens were captured. The most numerous species was *Carabus cancellatus* (36 specimens), the most specimens were captured at plot 1. The highest number of specimens and species were also captured at plot 4. One endangered species (EN) *Licinus cassideus* and one nearly threatened species (NT) *Carabus cancellatus* were detected. From the species protected by Decree 395/1992 Coll., as amended by Decree 175/2006 Coll., *Brachinus crepitans, B. explodens*, and *Carabus ullrichii ullrichii* were detected. In Svatý kopeček, a total of 36 species with a total number of 420 specimens were captured. The most numerous species was *Pseudoophonus rufipes* (126 specimens), the most specimens were captured at plot 3. The highest number of specimens and species were captured at plot 3. One endangered species (EN) *Licinus cassideu* and 4 vulnerable species (VU) *Cylindera germanica*, *Cymindis axillaris*, *Notiophilus laticollis*, and *Poecilus sericeus* were collected. From the species protected by Decree 395/1992 Coll., as amended by Decree 175/2006 Coll., *Brachinus crepitans, B. explodens, Carabus ullrichii ullrichii*, and *Cylindera germanica* were detected.

Species of unshaded habitats preferred the medium-term quarry of Svatý kopeček to the Turold quarry. Forest species were recorded in large numbers in the Turold quarry.

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