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GROUND BEETLE (COLEOPTERA: CARABIDAE) COMMUNITIES AND MICROHABITAT DIVERSITY IN A MOUNTAIN VILLAGE HOUSE YARD – A CASE STUDY FROM THE WESTERN RHODOPE MOUNTAINS IN BULGARIA

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Abstract. This study explores the ground beetle (Coleoptera: Carabidae) diversity from an uncultivated house yard in a mountain hamlet in the Western Rhodope Mountains in southern Bulgaria. The sampling site was located at an altitude of 1340 m. A total of 2512 carabid specimens of 76 species were collected with only six pitfall traps between May 2016 and April 2021. They belong to 31 genera, 13 tribes, 21 zoogeographical categories and 15 life forms. Two species (*Olisthopus rotundatus* and *Ophonus brevicollis*) are new for the Rhodope Mountains. The findings reveal new highest altitude records for two species (*Ophonus brevicollis* and *Philorhizus notatus*). Along with the typical montane forest fauna, many ecotone and open habitat species were found. Nevertheless, carabid life forms and wing morphology structure indicate a stable environment in comparison with other regions in Bulgaria. Furthermore, this research demonstrates that even small natural habitat patches can keep a remarkable carabid diversity. Over the five-year study period, the carabid fauna in the studied house yard experienced some, both qualitative and quantitative, impoverishment, indicating some ecological "exhaustion".

INTRODUCTION

Ground beetles (Coleoptera: Carabidae) are known as voracious predators important for the biological control of many pests, both weeds and animals, and this makes them very welcome guests in gardens, farms, crop fields, etc. Unfortunately, carabids are highly sensitive to pesticides and other chemicals, and they cannot thrive in many human-related habitats (e.g. Kryzhanovskij 1983; Kromp 1999; Van Toor 2006; Snyder 2019; Teofilova 2021c).

Studies focusing on carabids in agro-landscapes and various crops are literally countless (e.g. Alexandrovitch 1979; Luff 1987; Kromp 1999; Kutasi et al. 2004; Lövei et al. 2005; Van Toor 2006; Porhajašová et al. 2008; Eyre et al. 2013; Habuštová et al. 2017; Teofilova 2021a), as are those that focus on the influence of urban-rural gradients on ground beetle communities (e.g. Niemelä and Kotze 2000; Niemelä et al. 2002; Varet et al. 2011; Gordienko et al. 2018; Belitskaya et al. 2019; Braschler et al. 2020; Magura and Lövei 2021). Davis and Gagné (2018) tried to identify boundaries in beetle community structure and composition at the edges of forest patches with residential developments in urban, suburban and rural sites. They found that boundaries in environmental variables, such as temperature, grass cover, and leaf litter depth, indeed occurred at or near the edges of all three studied sites.

Studies on urban carabid fauna are becoming very popular too, as the ground beetles are a particularly popular model group for many kinds of research (e.g. Czechowski 1981; Hůrka and Jedlickova 1990; Eversham et al. 1996; Magura et al. 2004; Avtaeva et al. 2019; Putchkov et al. 2020; Magura and Lövei 2021; Aleksanov et al. 2022; Bérces et al. 2022; Lövei and Magura 2022; Teofilova, in press), and sometimes surprisingly high species richness and the presence of some rare or stenotopic species are found in urban and suburban habitats (Eversham et al. 1996; Kosewska et al. 2013; Teofilova, in press).

However, there are only scarce data about ground beetles inhabiting house yards and gardens (e.g. Nield 1974; Wiedenmann et al. 2004; Braschler et al. 2020). Stančić et al. (2010) studied the carabid beetle fauna in a traditional family garden in NW Croatia, and between May and October 1991 they recorded 547 specimens belonging to 37 species, of which *Pterostichus* *niger* (Schaller, 1783), *Poecilus cupreus* (Linnaeus, 1758), *Harpalus rufipes* (De Geer, 1774), *Bembidion quadrimaculatum* (Linnaeus, 1761), and *B. properans* (Stephens, 1828) were dominant.

In 2018, during a survey of the faunal diversity of the Sarnena Sredna Gora Mts. in Central Bulgaria, only 17 species were collected from a yard in Hrishteni vill. (Teofilova and Kodzhabashev 2020b). In 2021, during a research of the fauna of the city of Plovdiv (south-central Bulgaria), 20 species were collected from a yard in Yagodovo vill. (Teofilova 2021b; Teofilova, in press). Nevertheless, most studies are directed to managed territories, and typical rural habitats still remain disregarded.

The aim of this study was to explore the diversity patterns over a five-year period of carabid communities occurring in a mountain hamlet house yard with no serious human impact and no chemical treatment of the soil and vegetation.

MATERIALS AND METHODS

The sampling site was located in an uncultivated house yard in the Grashtitsa Hamlet, in the land of the village of Stoykite (41°39'05"N, 24°37'04"E) at about 1340 m a.s.l. in the Western Rhodope Mts., southern Bulgaria. The sampling design and location of the study plot are given in Figure 1. The area of the yard was about 500 m^2 and was missing any agricultural treatment and processing, except of a few planted trees and not very regular (twice-a-year) mowing.

Figure 1. Sampling design and location of the study plot. Trap **1**: under a cherry plum (*Prunus cerasifera* Ehrh.) tree, Trap **2**: under a stone plate at the back corner of the house, Trap **3** and Trap **4**: at the lawn, near the estate border, Trap **5**: near a pile of trunks and wood at the front corner of the house; Trap **6**: under European spruce (*Picea abies* (L.) H. Karst) tree in front of the house.

Field work was carried out over a five-year period – from 2016 to 2020. Ground beetles were collected with terrestrial pitfall traps made of cut 2 l plastic bottles, buried at the level of the ground surface and filled with 8% formaldehyde. Six traps were set at about 10 m from each other in different parts of the yard, representing the main microhabitat conditions (see Fig. 1). The traps were emptied and re-set seasonally (in spring, summer, autumn, and winter) during the following sampling periods: 06 May – 18 June 2016, 18 June – 05 September 2016, 05 September – 06 November 2016, 06 November 2016 – 16 April 2017, 16 April – 09 September 2017, 09 September – 31 December 2017, 01 January – 06 May 2018, 06 May – 01 July 2018, 01 July – 06 September 2018, 06 September 2018 – 02 January 2019, 02 January – 05 May 2019, 05 May – 24 July 2019, 24 July – 22 September 2019, 22 September – 29 December 2019, 29 December 2019 – 20 April 2020, 20 April –15 June 2020, 15 June –20 September 2020, 20 September – 27

Table 1. List of the life forms of ground beetles from the Grashtitsa Hamlet, according to Sharova (1981). The first, second and third figures in the index show the class of life form, the subclass and the life form group, respectively. The figure in brackets after subclass indicates the series, when it exists. Only life forms established during the study are given.

Life form class 1	Zoophagous
Life form subclass	1.2 – Epigeobios
Life form groups	1.2.2 – large walking epigeobionts
	1.2.3 – running epigeobionts
Life form subclass	1.3 – Stratobios
Series	1.3(1) – crevice-dwelling stratobionts
Life form groups	1.3(1).1 – surface & litter-dwelling
	1.3(1).2 – litter-dwelling
	1.3(1).3 – litter & crevice-dwelling
	1.3(1).4 – endogeobionts
	1.3(1).5 – litter & bark-dwelling
	1.3(1).6 – bothrobionts
Series	1.3(2) – digging stratobionts
Life form groups	1.3(2).1 – litter & soil-dwelling
	1.3(2).2 – litter & crevice-dwelling
Life form subclass	1.4 – Geobios
	1.4.2(1) – small digging geobionts
Life form class 2	Mixophytophagous
Life form subclass	2.1 – Stratobios
Life form group	2.1.1 – crevice-dwelling stratobionts
Life form subclass	2.2 – Stratohortobios
Life form group	2.2.1 – stratohortobionts
Life form subclass	2.3 – Geohortobios
Life form group	2.3.1 – harpaloid geohortobionts

December 2020, and 27 December 2020 – 04 May 2021. The collected beetles were determined according to several literary sources, e.g. Hůrka (1996), Arndt et al. (2011), Kryzhanovskij (Fauna Bulgarica – Carabidae unpublished data) and are deposited in the author's collection in the Institute of Biodiversity and Ecosystem Research (Bulgarian Academy of Sciences, Sofia).

According to their zoogeographical belonging, the ground beetle species were classified into zoogeographical categories and complexes according to the classification adopted and explained in Teofilova and Kodzhabashev (2020a).

According to their ecological requirements in terms of humidity, the collected carabid species were divided into 5 categories (Teofilova 2018): hygrophilous, mesohygrophilous, mesophilous, mesoxerophilous, and xerophilous.

The categorization of species in respect of their life forms follows the classification of Sharova (1981). The used codes are given in Table 1.

Species were also classified into three groups with respect to hind wing development: winged or macropterous (always possessing wings), wing dimorphic/polymorphic (only part of the population being fully winged), and brachypterous (wingless), according to the commonly accepted classification of Den Boer et al. (1980).

For the mathematical processing of the data, MS Excel and the software product PRIMER 6 (Clarke and Gorley 2005) were used.

RESULTS AND DISCUSSION

During the study period, 2512 specimens were captured. The taxonomic structure of the established carabid fauna was quite diverse and consisted of 76 species, representatives of 31 genera and 13 tribes. This represents 10% of all established for Bulgarian carabid fauna species, 25% of the genera (Teofilova, in prep.), and 24% of the 320 species currently known from the Western Rhodopes (Teofilova 2018; Teofilova, in prep.). In a similar study, 26 ground beetle species were recorded in 35 domestic gardens in and near Basel, representing less than 5% of the species richness known for Switzerland (Braschler et al. 2020).

Two species (*Olisthopus rotundatus* and *Ophonus brevicollis*) are new for the Rhodope Mts. Furthermore, our findings give new highest altitude records in the distribution of two species, since *Ophonus brevicollis* was currently known from up to 750 m, and *Philorhizus notatus* from up to 1000 m (Teofilova, in prep.). A complete check list of the established species with their full name, author and year of description, ecological characteristics and presence over years is presented in the Appendix.

The richest tribe was Harpalini (15 species, 20% of all species), followed by Pterostichini (12 species), Zabrini (10 species), Bembidiini (9 species), Lebiini (7 species), tribes Carabini, Trechini and Sphodrini (5 species each), Platynini (4 species), and Nebriini, Notiophilini, Clivinini and Chlaeniini (with only one species each). This structure differs from the one found in the Eastern Rhodope Mts., where solely the tribes Harpalini and Amarini had 43% of all species (Teofilova and Kodzhabashev 2020a), and from the structure in the vicinities of the town of Plovdiv, where Harpalini and Zabrini constituted 42.5% of the species found (Teofilova, in press). Similarly as in a study of carabid complexes from different localities in the Western Rhodopes (Teofilova 2018), *Amara*, *Harpalus* (9 species each), *Bembidion* (8 species), and *Carabus* and *Trechus* (5 species each) were the species-richest genera.

The most numerous species were *Pterostichus niger* (567 ex., 22.6% of all specimens), *Bembidion lampros* (407 ex., 16.2%), *Ophonus laticollis* (223 ex., 8.9%), *Molops dilatatus* (169 ex., 6.7%), and *Carabus violaceus* (114 ex., almost 5%), corresponding with the dominant montane carabid fauna in the Western Rhodopes (Teofilova 2018) and quite differing from that of the Sarnena Sredna Gora Mts. (Teofilova and Kodzhabashev 2021), for example. The super-dominant *Pt. niger* is typical of damp and shaded habitats (often in forest), but it also seems quite plastic, since it is commonly found in gardens and agricultural fields, too (e.g. Kryzhanovskij 1983; Kromp 1999; Stančić et al. 2010).

Zoogeographical analysis on species level reveals that elements from all five main zoogeographical complexes occur (Figure 2). The Northern Holarctic and European-Siberian faunal type (species distributed mainly in the northern regions of the Holarctic, mostly in Europe and Siberia) prevails (24 species, 31% of all). It is followed by the European complex (mostly forest-dwelling species connected to the middle and southern parts of Europe) (18 species, 24%). The Mediterranean (*sensu lato*; species distributed in the region of the so-called 'Ancient Mediterraneum') complex consists of 15 species (20%), the European-Asiatic complex (species with ranges lying between the Eurosiberian and Mediterranean zones) has 12 species (16%), and the Endemic complex (species with limited ranges) is represented by 7 species (9%). The greatest numbers of species are of European-Neareastern (11), European-Central Asian (8), and European-Siberian (7) zoogeographical elements (Figure 2). Endemic species are: *Molops alpestris* (Bulgarian), *Laemostenus plasoni*, *Molops dilatatus*, *Tapinopterus balcanicus, Trechus irenis* (all

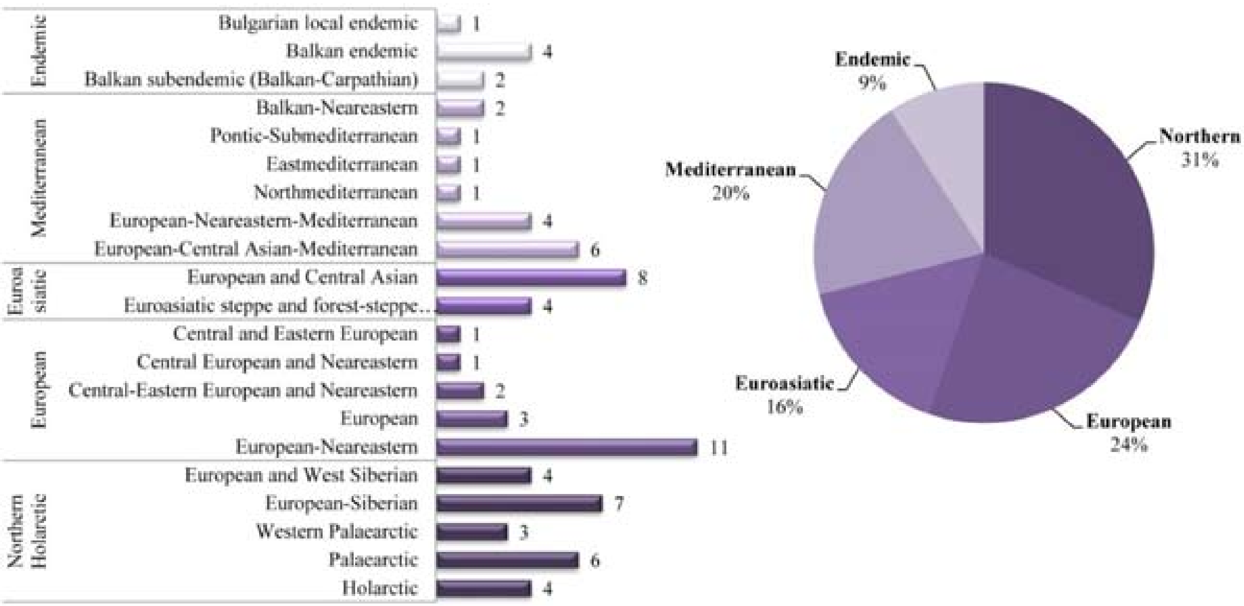

Figure 2. Shares of zoogeographical elements of ground beetles from the Grashtitsa Hamlet (on species level).

four Balkan), *Microlestes apterus* and *Xenion ignitum* (both Balkan-Carpathian).

According to their life forms, the ground beetles from the studied site relate to two classes of life forms proposed by Sharova (1981), with the predominance of the class of zoophagous beetles with 51 species (67%) (Figure 3). Mixophytophagous beetles join 25 species (33%). This ratio between the classes is characteristic of the forest-steppe zones of Eurasia (65%: 35%) and the Nemoral zone (70%: 30%) (Sharova 1981). Almost the same values (67%: 33%) were found for the carabid fauna of the whole Western Rhodope Mts. (Teofilova 2018). A similar ratio (61%: 39%) was also established in the Sarnena Sredna Gora Mts., and it seems characteristic of wooded areas with wide open spaces among or around them (Teofilova and Kodzabashev 2021b).

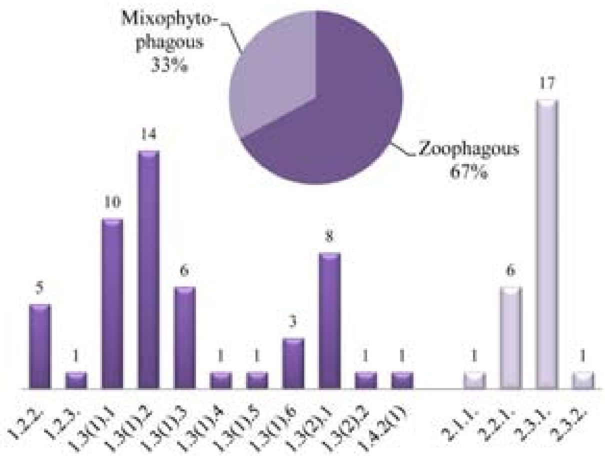

Figure 3. Shares of ground beetles' life form groups and classes. Explanations of codes are given in the Materials and Methods section, Table 1.

The degree of hind wing development of carabids from the study area allows distinguishing three groups: macropterous (winged) – 34 species (45%), dimorphic (some individuals have fully developed wings, others only vestigial ones) – 24 species (32%), and brachypterous (hind wings shorter than elytra, or missing) – 17 species (23% of all) (Figure 4). For one species, there is no data. As a comparison, the ratio between the winged, pteridimorphic and wingless species was, respectively, 73%, 17% and 10% in Bulgarian rapeseed (*Brassica napus* L.) fields (Teofilova 2021a), 69%, 22% and 8% in Zlatiya Plateau (Teofilova and Kodzhabashev 2020c), 67%, 21% and 6% in the region of the city of Plovdiv (Teofilova 2022), and 57%, 22% and 16% in the Sarnena Gora Mts. (Teofilova and Kodzhabashev 2021). While wingless carabid assemblages are characteristic of ecologically homogeneous and stable environments, where resources are sufficient for beetles' entire life cycle (such as mountain forest habitats), the proportion of flight-capable pioneer species increases with increasing disturbance (see Teofilova and Kodzhabashev 2020b). Therefore, the studied house yard appears to be a stable habitat in relation to the wing morphology of its ground beetle fauna.

Carabids' humidity preferences analysis shows that in the studied area the mesophilous carabids have the largest share (26 species, 34% of all). Nineteen species (25%) are mesoxerophilous, 17 (22%) are mesohygrophilous, 8 (11%) are eurybiontic, 5 (7%) are hygrophilous, and only 1 species is xerophilous (1%) (Figure 4). These results are in accordance with the mesophilic nature of other Bulgarian mountains, such as the Sarnena Sredna Gora Mts. (Teofilova and Kodzhabashev 2020b), whole Western Rhodope Mts. (Teofilova 2018) and Vrachanska Planina Mts. (Teofilova 2019), contrasting with the predominantly mesoxerophilic conditions in the Eastern Rhodope Mts. (Teofilova and Kodzhabashev 2020a), pseudomaquises in SW Bulgaria (Teofilova 2020), and the surroundings of the city of Plovdiv (Teofilova, in press). Habitat humidity certainly provides conditions for the occurrence of valuable and sometimes rare and stenotopic species. When studying urban forests, Kosewska et al. (2013) also found that open-area and forest-related, as well as eurytopic carabid species co-exist along with species with a strong hygropreference. Hygrophilous species prevailed over xerophilous and mesophilous in the study of Stančić et al. (2010), but the garden they investigated was located near a small marshland area.

Over the study period, an increasing number of species disappeared every year. At the same time, new species (missing in previous years) were also appearing, but their number was lower every year, and in the last year only two new species appeared. The largest number of species was collected in the first year of the study, and then their number gradually decreased. Similar is the pattern with the number of specimens, since in the last year carabids' numbers were almost half of those

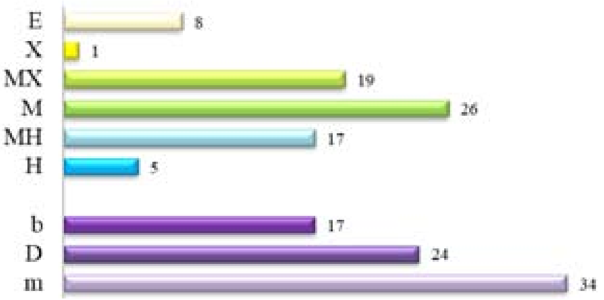

Figure 4. Number of species of carabids according to their humidity preferences (H – hygrophilous, MH – mesohygrophilous, M –mesophilous, MX – mesoxerophilous, X – xerophilous) and hind wing development (m – macropterous, D – wing dimorphic/polymorphic, b – brachypterous).

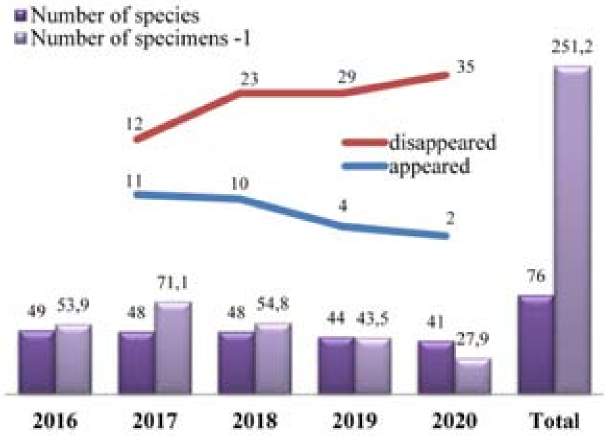

Figure 5. Dynamics of Carabidae species richness and abundance over the study period and numbers of species that disappeared or newly appeared by year.

during the first year (Figure 5). All those facts speak of some impoverishment of the carabid fauna in the studied house yard, both qualitatively and quantitatively. This "over trapping" phenomenon, with species richness and activity density of ground-dwelling arthropods decrease over time, seems not unusual, even though it is not linked to any treatment; it was documented in other studies too (e.g. Elek et al. 2022). The results achieved in our study differ from the findings of Porhajašová et al. (2008) in a field treated by organic fertilizers. During their investigation, the number of individuals increased in the third year and then dropped to the starting values, and this culmination was preceded by a warmer and more humid season. In our case, weather did not have such an impact due to more stable montane conditions over the years. The established dynamics probably reflects the microhabitat environment in this mountain village house yard.

Twenty-three species were present over all five years (see Appendix): *Amara montivaga*, *Anchomenus dorsalis*, *Asaphidion flavipes*, *Bembidion lampros*, *B. stephensii*, *B. guttula*, *Carabus violaceus*, *C. hortensis*, *Harpalus atratus*, *H. rubripes*, *H. rufipes*, *Leistus ferrugineus*, *Molops dilatatus*, *Ophonus laticollis*, *O. schaubergerianus*, *Poecilus cupreus*, *P. versicolor*, *Pterostichus oblongopunctatus*, *Pt. strenuus*, *Pt. niger*, *Stomis pumicatus*, *Tapinopterus balcanicus*, and *Trechus obtusus*. These are mostly species with larger distributional ranges (Northern or Euroasiatic elements), macropterous or wing-dimorphic. Some of these species are quite eurytopic (*A. dorsalis*, *P. cupreus*, and *Pt. niger*), but even more are typical forest stenobionts (*C. hortensis*, *M. dilatatus*, *St. pumicatus*, and *T. balcanicus*). Almost the same (22) is the number of the "rare" species caught during only one of the study years. These are species with various distributional ranges (incl. Mediterranean) and ecological requirements. According to the frequency of occurrence of separate species, the results showed that the number of species with the occurrence of 40%, 60% and 80% was 10, 11 and 10 species, respectively.

Different traps representing particular separate microhabitats had some differences in their catches during the study period (Figure 6, Table 2). Trap 1 had the greatest carabid species richness and abundance during the first year of research, while in other traps these were achieved during the second or third year. The lowest species richness and abundance were registered in the last year of research. The only exceptions were trap 2 and trap 5, where the lowest number of specimens was found during the first and fourth year, respectively, as well as traps 3 and 4 (joint data) and trap 5, where the lowest number of species was found during the fourth year of the study. Similarly, the local maxima and minima of occurrence of ground beetles in individual plots shifted independently and the number of occurring species slightly decreased in the study of Porhajašová et al. (2008). They also observed that those changes represent a part of long-term fluctuations in wider surroundings.

It is quite remarkable that, in spite of the joint data from traps 3 and 4, these traps had the greatest number of specimens caught, but the number of species was commensurable with those of other single traps, especially trap 1 and trap 5 (Figure 6, Table 2). This fact probably proves the importance of vegetation and the presence of hiding places (kind of beetle refuges) as factors for carabids' diversity, since traps 3 and 4 were the traps placed in an open grassy area of the yard. According to Evans (1975), tree trunks may be treated by the beetles as extensions of the woodland floor, resulting in higher diversity of forest dwellers (as in trap 5). A lower number of species in trap 6 probably resulted from the competition with a great number of ants (Hymenoptera: Formicidae) also constantly collected in this trap; such trends of aggressive interference competition had already been documented (e.g. Medeiros et al. 1986; Hawes et al. 2013). Furthermore, separate traps appear to act as specific microhabitats with their own set of microenvironmental conditions. Most similar to each other were traps 2 and 5, where some hiding places (refuges) were present. Traps 1 and 6 also separate, probably based on their locations under trees. Traps 3 and 4 (joint data) represented a single group of open habitat microbiotopes (Figure 7).

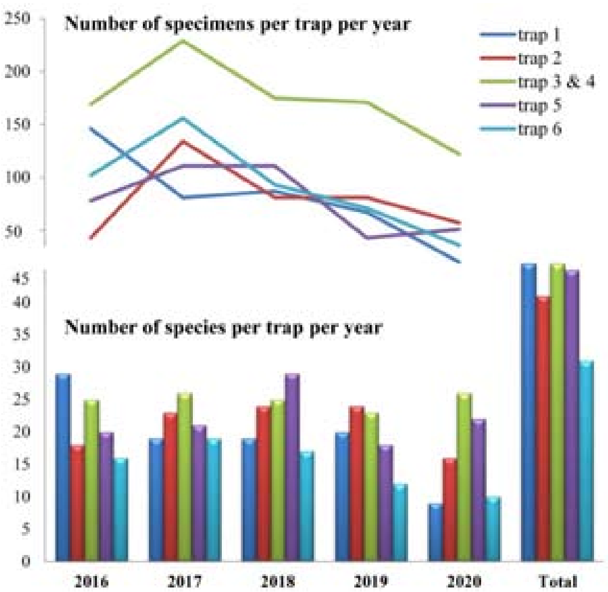

Figure 6. Differences in separate trap catches during the study period.

In the studied mountain house yard, microhabitat diversity seems to support peculiar carabid coenoses, such as urban forests in the study of Kosewska et al. (2013), which were found to be habitats suitable for various ecological groups of carabids and their variety sustained and improved the ground beetles' species diversity. Stančić et al. (2010) have also proved that carabid species diversity and abundance in a traditional garden are markedly determined by the diversity of habitats found on a relatively small surface area. The study of Stančić et al. (2010) also shows that traditional gardens may enhance biodiversity on a small-scale level and that both species with a wide ecological niche and those that are highly specialized and rare live in villages. During the present study, many endemic, relict, stenotopic or rare species (*Agonum antennarium*, *Amara montivaga*, *Bembidion brunnicorne*, *Bradycellus caucasicus*, *Carabus hortensis, C. scabrosus*, *Laemostenus plasoni*, *Molops alpestris*, *Pterostichus quadrifoveolatus*, *Tapinopterus balcanicus*, *Xenion ignitum*, etc.) were collected, too. *Carabus scabrosus* is also included as Vulnerable in the Bulgarian Red Data Book.

It can be concluded that the present study complements research on the ground beetles inhabiting house yards, which are poorly known habitats. The studied yard had a diverse taxonomic structure and contained 76 species. Along with the typical montane forest fauna, many ecotone and open habitat species are found, as well as some endemic, relict, stenotopic or rare species. Representatives of Northern Holarctic and European-Siberian fauna prevailed, and carabids' life forms and wing morphology structure indicate a stable environment in comparison with other regions in Bulgaria. Nevertheless, over the five-year study period, the carabid fauna in the studied house yard experienced some, both qualitative and quantitative, impoverishment, indicating some ecological "exhaustion". Furthermore, the locations of the traps appear to reflect well the surrounding microhabitats, highlighting the importance of vegetation and

Table 2. Number of species and abundance of ground beetles from catches in separate traps during the study period.

	2016		2017		2018		2019		2020		Total	
	No sp.	No ex.	No sp.	No ex.	No sp.	No ex.	No sp.	No ex.	No sp.	No ex.	No sp.	No ex.
trap 1	29	146	19	81	19	87	20	67	9	20	46	399
trap 2	18	43	23	134	24	81	24	81	16	57	41	392
trap 3 & 4	25	169	26	229	25	175	23	171	26	122	46	866
trap 5	20	78	21	111	29	111	18	43	22	51	45	393
trap 6	16	102	19	156	17	93	12	71	10	36	31	463

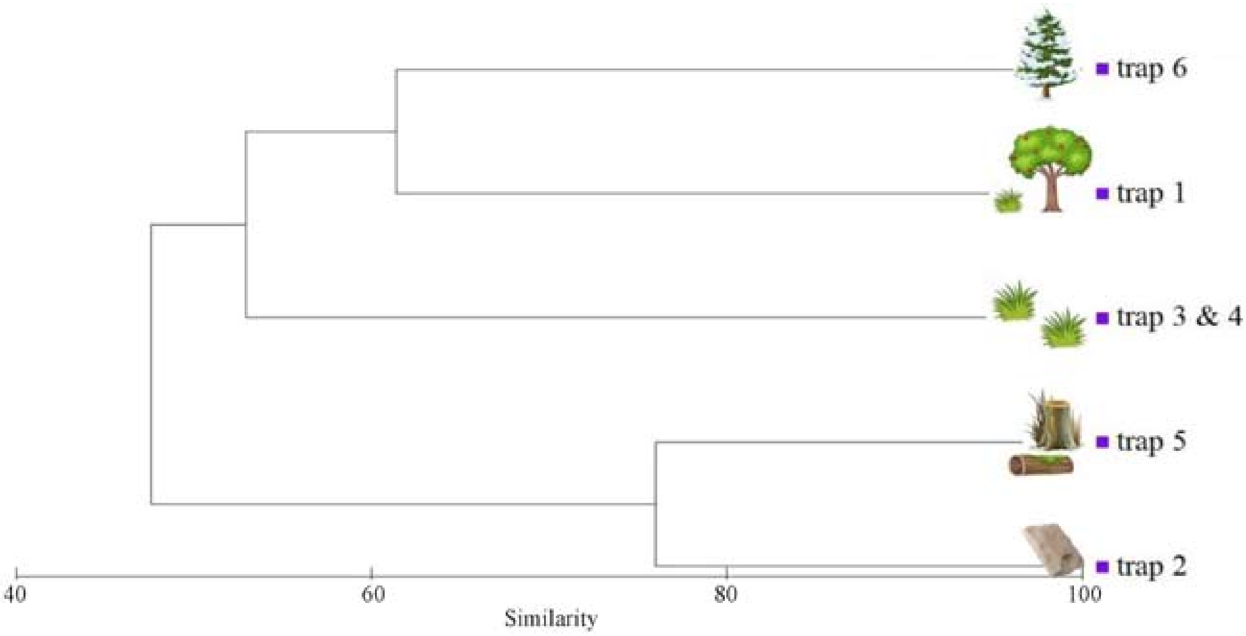

Figure 7. Group average cluster dendrogram based on Bray Curtis similarity of carabid communities from separate pitfall traps.

the presence of hiding places (beetle refuges) as factors for carabids' diversity. The results of this research demonstrate that even small natural habitat patches can harbour a remarkable carabid diversity.

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Appendix. Species list and ecological characteristics of carabids from Sarnena Sredna Gora Mts.: Zoog. – zoogeographical category (*on species level) (OLA – Holarctic, PAL – Palaearctic, WPAL – Western Palaearctic, E-SI – European-Siberian, E-WSI – European and West Siberian, E-PAS – European-Neareastern, EUR – European, CEE-PA – Central-Eastern European and Neareastern, CE-PAS – Central European and Neareastern, C-EE – Central and Eastern European, E-AS – Euroasiatic steppe and forest-steppe complex, E-CAS – European and Central Asian, E-CA-M – European-Central Asian-Mediterranean, E-PA-M – European-Neareastern-Mediterranean, NMED – Northmediterranean, EMED – Eastmediterranean, P-SMED – Pontic-Submediterranean, B-PAS – Balkan-Neareastern, BAL-K – Balkan subendemic (Balkan-Carpathian), BAL – Balkan endemic, BGE – Bulgarian endemic); WM – wing morphology (m – macropterous, D – wing di(poly)morphic, b – brachypterous, n.a. – no data); HP – humidity preferences (H – hygrophilous, MH – mesohygrophilous; M – mesophilous, MX – mesoxerophilous, X – xerophilous, E – eurybiont); LF – life forms (descriptions of life form codes are given in Materials and Methods section, Table 1); *F* **(%)** – occurrence of the species over the 5-years study.

Species	Zoog.*	WM	HP	LF	2016	2017	2018	2019	2020	*F*
Abax (Abacopercus) carinatus carinatus (Duftschmid, 1812)	C-EE	b	M	1.3(2).1	+	+		+	+	80
Agonum (Agonum) antennarium (Duftschmid, 1812)	EUR	m	H	1.3(1).2	+	+	+	+		80
Agonum (Agonum) muelleri (Herbst, 1784)	E-WSI	m	MH	1.3(1).1	+	+				40
Amara (Amara) communis (Panzer, 1797)	E-SI	m	M	2.3.1	+					20
Amara (Amara) convexior Stephens, 1828	E-CAS	m	MX	2.3.1			+	+	+	60
Amara (Amara) lucida (Duftschmid, 1812)	E-PA-M	m	M	2.3.1	+					20
Amara (Amara) montivaga Sturm, 1825	E-CAS	m	M	2.3.1	+	+	+	+	+	100
Amara (Amara) nitida Sturm, 1825	E-SI	m	MX	2.3.1		+				20
Amara (Amara) ovata (Fabricius, 1792)	PAL	m	E	2.3.1			+			20
Amara (Amara) similata (Gyllenhal, 1810)	E-CA-M	m	MX	2.3.1	+		+		+	60
Amara (Curtonotus) aulica (Panzer, 1797)	E-AS	m	M	2.3.1	+	+			+	60
Amara (Zezea) tricuspidata Dejean, 1831	E-CA-M	m	M	2.2.1					+	20
Anchomenus dorsalis dorsalis (Pontoppidan, 1763)	PAL	m	MX	1.3(1).1	+	+	+	+	+	100
Anisodactylus (Anisodactylus) binotatus (Fabricius, 1787)	E-AS	m	MH	2.3.1					+	20
Asaphidion flavipes (Linnaeus, 1760)	WPAL	m	MH	1.2.3	+	+	+	+	+	100
Bembidion (Metallina) lampros (Herbst, 1784)	OLA	D	M	1.3(1).2	+	+	+	+	+	100
Bembidion (Metallina) properans (Stephens, 1828)	WPAL	D	MH	1.3(1).2	+			+		40
Bembidion (Peryphanes) brunnicorne Dejean, 1831	E-PAS	m	H	1.3(1).1	+					20
Bembidion (Peryphanes) dalmatinum dalmatinum Dejean, 1831	CE-PAS	m	H	1.3(1).1			+			20
Bembidion (Peryphanes) deletum deletum Audinet-Serville, 1821	E-PA-M	m	H	1.3(1).1	+	+				40
Bembidion (Peryphanes) stephensii stephensii Crotch, 1866	EUR	m	MH	1.3(1).1	+	+	+	+	+	100

Species	Zoog.*	WM	HP	LF	2016	2017	2018	2019	2020	*F*
Bembidion (Peryphus) subcostatum vau Netolitzky, 1913	E-PAS	b	H	1.3(1).1			+	+	+	60
Bembidion (Philochthus) guttula (Fabricius, 1792)	PAL	D	MH	1.3(1).1	+	+	+	+	+	100
Bradycellus (Bradycellus) caucasicus (Chaudoir, 1846)	E-WSI	D	MH	2.1.1		+				20
Calathus (Calathus) fuscipes fuscipes Goeze, 1777	PAL	D	E	1.3(1).2	+	+		+	+	80
Calathus (Neocalathus) melanocephalus (Linnaeus, 1758)	PAL	D	M	1.3(1).2	+		+			40
Callistus lunatus lunatus (Fabricius, 1775)	E-CAS	m	MH	1.3(1).1		+				20
Carabus (Megodontus) violaceus azuresens Dejean, 1826	E-WSI	b	M	1.2.2	+	+	+	+	+	100
Carabus (Pachystus) hortensis hortensis Linnaeus, 1758	EUR	b	M	1.2.2	+	+	+	+	+	100
Carabus (Procerus) scabrosus bureschianus Breuning, 1928	B-PAS	b	M	1.2.2	+	+	+		+	80
Carabus (Procrustes) coriaceus cerisyi Dejean, 1826	E-PAS	b	E	1.2.2	+	+	+			60
Carabus (Tomocarabus) convexus dilatatus Dejean, 1826	E-PAS	b	MX	1.2.2		+	+	+		60
Clivina (Clivina) collaris (Herbst, 1784)	E-PAS	m	MH	1.4.2(1)			+	+		40
Cymindis (Cymindis) axillaris axillaris (Fabricius, 1794)	WPAL	D	MX	1.3(1).3				+		20
Harpalus (Harpalus) affinis (Schrank, 1781)	E-CAS	m	MX	2.3.1	+					20
Harpalus (Harpalus) atratus Latreille, 1804	E-CAS	D	MX	2.3.1	+	+	+	+	+	100
Harpalus (Harpalus) dimidiatus (P. Rossi, 1790)	E-PAS	m	MX	2.3.1	+					20
Harpalus (Harpalus) laevipes Zetterstedt, 1828	OLA	m	M	2.3.1		+	+	+	+	80
Harpalus (Harpalus) rubripes (Duftschmid, 1812)	OLA	m	E	2.3.1	+	+	+	+	+	100
Harpalus (Harpalus) rufipalpis rufipalpis Sturm, 1818	E-PAS	m	MX	2.3.1				+		20
Harpalus (Harpalus) tardus (Panzer, 1796)	E-CAS	m	E	2.3.1	+	+	+			60
Harpalus (Harpalus) xanthopus winkleri Schauberger, 1923	E-CAS	m	M	2.3.1		+		+		40
Harpalus (Pseudoophonus) rufipes (De Geer, 1774)	PAL	m	E	2.2.1	+	+	+	+	+	100
Laemostenus (Actenipus) plasoni plasoni Reitter, 1885	BAL	b	M	1.3(1).6	+	+		+	+	80
Laemostenus (Pristonychus) cimmerius weiratheri J. Müller, 1932	P-SMED	b	M	1.3(1).6			+	+		40
Laemostenus (Pristonychus) terricola punctatus (Dejean, 1828)	E-PAS	D	M	1.3(1).6	+	+			+	60
Leistus (Leistus) ferrugineus (Linnaeus, 1758)	E-SI	D	M	1.3(1).2	+	+	+	+	+	100
Microlestes apterus Holdhaus, 1904	BAL-K	b	MX	1.3(1).3	+	+	+	+		80
Microlestes maurus maurus (Sturm, 1827)	E-PAS	D	MX	1.3(1).3	+	+	+		+	80

Species	Zoog.*	WM	HP	LF	2016	2017	2018	2019	2020	*F*
Microlestes minutulus (Goeze, 1777)	OLA	D	MX	1.3(1).3	+				+	40
Molops (Molops) alpestris rhilensis Apfelbeck, 1904	BGE	b	M	1.3(2).1		+		+	+	60
Molops (Molops) dilatatus dilatatus Chaudoir, 1868	BAL	b	M	1.3(2).1	+	+	+	+	+	100
Notiophilus palustris (Duftschmid, 1812)	E-SI	D	MH	1.3(1).1			+			20
Olisthopus rotundatus rotundatus (Paykull, 1790)	E-PAS	D	X	1.3(1).2			+			20
Ophonus (Hesperophonus) azureus (Fabricius, 1775)	E-CA-M	D	MX	2.2.1		+	+		+	60
Ophonus (Metophonus) brevicollis (Audinet-Serville, 1821)	CEE-PA	m	MX	2.2.1				+		20
Ophonus (Metophonus) laticollis Mannerheim, 1825	E-CAS	D	MX	2.2.1	+	+	+	+	+	100
Ophonus (Metophonus) schaubergerianus (Puel, 1937)	CEE-PA	m	M	2.2.1	+	+	+	+	+	100
Paradromius (Manodromius) linearis linearis (Olivier, 1795)	E-PA-M	D	MH	1.3(1).5	+		+			40
Philorhizus notatus (Stephens, 1827)	E-CA-M	D	MX	1.3(1).3			+			20
Poecilus (Poecilus) cupreus cupreus (Linnaeus, 1758)	E-AS	m	E	1.3(2).1	+	+	+	+	+	100
Poecilus (Poecilus) versicolor (Sturm, 1824)	E-SI	m	M	1.3(2).1	+	+	+	+	+	100
Pterostichus (Bothriopterus) oblongopunctatus oblongopunctatus (Fabricius, 1787)	E-SI	D	MH	1.3(2).1	+	+	+	+	+	100
Pterostichus (Bothriopterus) quadrifoveolatus Letzner, 1852	E-WSI	m	MH	1.3(2).1	+					20
Pterostichus (Phonias) strenuus (Panzer, 1796)	E-SI	D	MH	1.3(1).2	+	+	+	+	+	100
Pterostichus (Platysma) niger niger (Schaller, 1783)	E-AS	D	MH	1.3(2).1	+	+	+	+	+	100
Stomis (Stomis) pumicatus pumicatus (Panzer, 1796)	E-PAS	b	MH	1.3(1).2	+	+	+	+	+	100
Syntomus pallipes (Dejean, 1825)	E-CA-M	D	MX	1.3(1).3				+		20
Tapinopterus (Tapinopterus) balcanicus balcanicus Ganglbauer, 1891	BAL	b	M	1.3(2).2	+	+	+	+	+	100
Trechus (Trechus) asiaticus Jeannel, 1927	B-PAS	D	MH	1.3(1).2	+					20
Trechus (Trechus) irenis Csiki, 1912	BAL	n.a.	M	1.3(1).2		+	+	+	+	80
Trechus (Trechus) obtusus obtusus Erichson, 1837	E-PA-M	D	M	1.3(1).2	+	+	+	+	+	100
Trechus (Trechus) quadristriatus (Schrank, 1781)	E-CA-M	m	E	1.3(1).2		+	+	+	+	80
Trechus (Trechus) subnotatus subnotatus Dejean, 1831	EMED	b	M	1.3(1).2		+				20
Xenion ignitum (Kraatz, 1875)	BAL-K	b	M	1.3(1).4			+	+		40
Zabrus (Pelor) spinipes spinipes (Fabricius, 1798)	NMED	b	MX	2.3.2	+	+	+			60
Total: 76 species					49	48	48	44	41	