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Small carrion beetles (Coleoptera: Leiodidae: Cholevinae) in Central European lowland ecosystem: seasonality and habitat preference

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Abstract. In order to examine habitat selectivity and seasonality in Central European small carrion beetles (Leiodidae: Cholevinae), the occurrence of these beetles and the structure of their assemblages in four different lowland habitats were examined by pitfall trapping in the Litovelské Pomoraví Protected Landscape Area (Czech Republic) over a period of one year. A total of 15 136 adults (7675 male specimens) (Leiodidae: Cholevinae) representing 19 species of small carrion beetles were trapped during this study. Based on seasonal changes in adult activity, the small carrion beetles were sorted into four groups, and according to their habitat associations into three groups. The activity of the majority of the species culminated in spring or autumn independent of their different patterns of seasonality.

Seasonality, habitat preference, resource partitioning, assemblages, carrion, lowlands, Leiodidae, Cholevinae, Central Europe

INTRODUCTION

Small carrion beetles (Leiodidae: Cholevinae) are important members of carrion beetle assemblages (Payne & King 1970, Nabaglo 1973, Johnson 1975, Shubeck et al. 1981). In general the small carrion beetles appear to be non-specialist detritovores (Tizado et al. 1995). Besides carrion, they feed on decaying fungi, decaying forest litter and organic material in vertebrate nests (Chandler & Peck 1992).

Little information is available on the autecological characteristics of the epigeal species of small carrion beetles (Leiodidae: Cholevinae). Some elementary information about the seasonal activity and habitat preferences of European species was published by Sokolowski (1942), Likovský (1967), Nabaglo (1973), Majer (1980), Topp (1990), Bocáková (1995), etc. Růžička (1994) studied the seasonal dynamics in forest and field sites in central Bohemia; Tizado et al. (1995) and Tizado & Salgado (2000) give an account of their distribution and ecological correlates in northern Spain; thir seasonal activity and altitudinal distribution were studied in northern Italy by Zoia (1990). North American species were recently studied by Peck & Anderson (1985) and by Chandler & Peck (1992).

Each area, forest or non-forest, is occupied by a different and characteristic assemblage of a species of few small carrion beetles. The diversity of such assemblage can be relatively high because individual species utilise the patchiness of the habitat or because other non-spatial segregating mechanism such as seasonal or diel time-partitioning have evolved. Similar species may coexist because size differences permit resource-partitioning (Topp & Engler 1980).

Topp & Engler (1980) and Engler (1982) described species packing in catopid assemblages in a beech stand in Germany, which appear to be governed by body size and seasonal time-partitioning.

This paper presents a study of the seasonality and habitat preference of the small carrion beetle assemblages in Central European lowland ecosystem.

MATERIAL AND METHODS

The material was collected in baited pitfall traps: 7.5 cm diameter, 14 cm deep, filled with 3–4% formalin. Each trap was baited with approximately 25 g of raw beef placed in a pot (3 cm diameter, 14 cm deep), which was hung from the metal roof (18×18 cm) of the trap. Traps were serviced at 2–3 weeks intervals, when the old bait was removed and replaced with fresh bait. The insects in the solution were sieved through a tea strainer and placed in 70% ethyl alcohol. Ten traps were placed at each locality in lines 15 m apart. Sampling began on April 5, 1995 and terminated on November 1, 1995.

Only the males of the genus *Catops* Paykull, 1798 were identified to species. Both sexes of *Sciodrepoides* Hatch, 1933 and *Ptomaphagus* Illiger, 1798 were identified, but only the numbers of males were used for comparison. Species diversity was calculated using Brillouin index by computer programme Divers (Krebs 1989), faunistic similarity of the assemblages was calculated using Renconen index by computer programme Similar (Krebs 1989). The percentage similarity measure (= Renconen index) is one of the best quantitative similarity coefficient (Wolda 1981) relatively little affected by sample size and by species diversity (Krebs 1989). Widely used Morisita index is more dependent on sample size, especially in samples of very small size (Krebs 1989). The similarity of the assemblages of individual sites was evaluated by cluster analysis (computer programme Statistica, method UPGMA – unweighted pair group using arithmetical average with Euclidean distance).

The material was identified to species using the key of Szymczakowski (1961), classification follows the paper of Švec & Růžička (1995). All the faunistic data was fully published previously (Kočárek 1997); the material is deposited in the collection of author.

Study areas

The beetles were sampled at four representative sites of the Litovelské Pomoraví Protected Landscape Area in central Moravia, the Czech Republic (soil types are named using the nomenclature of FAO 1990):

Site no. 1 – hornbeam oakwood forest of group type *Melanpyro nemorosi-Carpinetum typicum*. The site is about 1.2 km north-east of the village of Moravičany (49° 46’ N; 17° 57’ E) at 290 m a. s. l. on an eutric cambisol.

Site no. 2 – floodplain forest of group type *Ficario-Ulmetum*. The site is about 0,7 km west of the village of Střeň (49° 42’ N; 17° 08’ E) at 227 m a. s. l. on a stagno-gleic fluvisol.

Site no. 3 – shrubby ecotone at the edge of a lowland forest of group type *Ficario-Ulmetum* near (about 600 m to the north) Moravičany (49° 46’ N; 17° 56’ E) at 247 m a. s. l. Contiguous field habitat was planted partially with *Panicus miliaceum* and *Zea mays*. The soil type is fluvisol.

Site no. 4 – open field habitat situated about 1.5 km north of Střeň (49° 44’ N; 17° 09’ E) at 226 m a. s. l. Traps were placed along a road in a grassy meadow periodically inundated from a field planted with *Beta vulgaris*. The soil type is stagno-gleyic luvisol.

RESULTS

A total of 15 136 adults (7 675 male specimens) of small carrion beetles (Leiodidae: Cholevinae) beetles representing 19 species were trapped during the study. The numbers of individuals collected at each site are summarised in Tab. 1.

Habitat associations

According to this habitat associations the small carrion beetles were sorted into three groups (Tab. 2). The species that preferred the forest habitat were *Catops neglectus*, *C. nigrita*, *C. picipes*, *C. subfuscus subfuscus*, *C. tristis tristis*, *C. westi*, *Ptomaphagus variicornis*, *Sciodrepoides fumatus fumatus* and open non-forest habitat were *Catops grandicollis*, *C. morio*, *C. nigricans*, *Ptomaphagus sericatus*, *Sciodrepoides watsoni watsoni* and those with no clear habitat preference were *Catops fuliginosus fuliginosus* and *C. kirbyi kirbyi*.

The similarity of the assemblages was high between the two forest sites (Site no. 1, Site no. 2) and between ecotone (Site no. 3) and open field site (Site no. 4) (Tab. 3, Fig. 1). In total, individuals of the genus *Sciodrepoides* dominated at all sites (Fig. 2). The assemblages at both forest sites were similar in having few individuals of the genus *Ptomaphagus* and comparatively many individuals of the genus *Catops*. In contrast, the open field habitat and the ecotone had a similar and higher relative abundance of the genus *Ptomaphagus* than of *Catops*. Altogether, the highest species diversity

Tab. 1. Total numbers of male specimens of Leiodidae: Cholevinae caught at each site in the lowland ecosystem at the Litovelské Pomoraví Protected Landscape Area, Czech Republic. Legend: site no. 1 – hornbeam oakwood forest, 2 – floodplain forest, 3 – shrubby ecotone of a lowland forest, 4 – open field habitat

species \ site no.	1	2	3	4	total
Catops coracinus coracinus Kellner, 1846	0	1	0	0	1
C. fuliginosus fuliginosus Erichson, 1837	0	16	25	7	48
C. grandicollis Erichson, 1837	16	14	75	254	359
C. chrysomeloides (Panzer, 1794)	0	0	3	6	9
C. kirbyi kirbyi (Spence, 1815)	0	0	49	0	49
C. morio (Fabricius, 1792)	0	0	117	40	157
C. neglectus Kraatz, 1852	103	0	2	0	105
C. nigricans (Spence, 1815)	0	7	0	17	24
C. nigrita Erichson, 1837	81	235	15	0	331
C. picipes (Fabricius, 1792)	27	142	69	0	238
C. subfuscus subfuscus Kellner, 1846	83	62	0	0	145
C. tristis tristis (Panzer, 1794)	94	142	0	0	236
C. westi Krogerus, 1931	44	34	42	1	121
Ptomaphagus sericatus (Chaudoir, 1845)	97	59	395	513	1064
P. variicornis (Rosenhauer, 1847)	18	52	93	0	163
Sciodrepoides watsoni watsoni (Spence, 1815)	880	571	1423	1269	4143
S. fumatus fumatus (Spence, 1815)	196	270	6	0	472
S. alpestris Jeannel, 1934	0	8	0	0	8
Choleva spadicea (Sturm, 1839)	0	2	0	0	2
Number of specimens	1639	1615	2314	2107	7675
Number of species	11	15	13	8	19
Brillouin index of species diversity (bits/individ.)	2.37	2.80	1.95	1.51	2.49

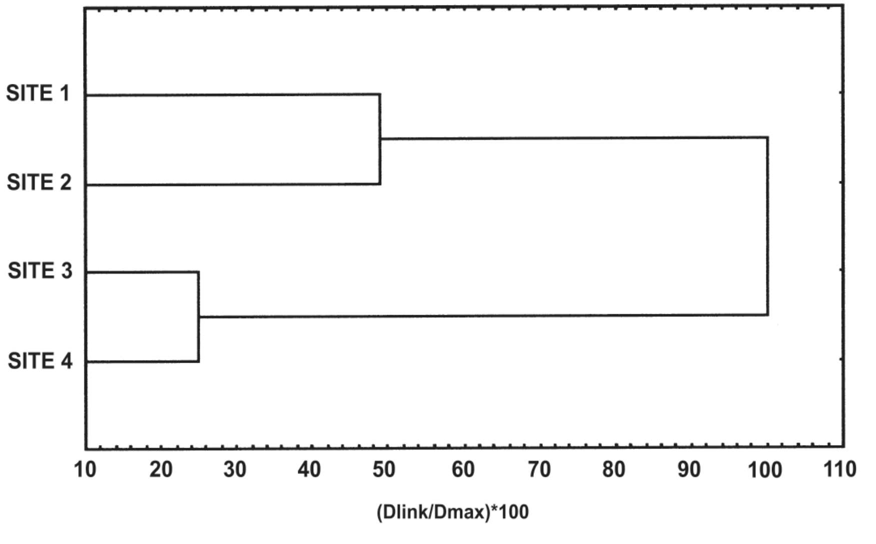

Fig. 1. Hierarchical cluster analysis (unweighted pair-group average with Euclidean distance) of similarity of Leiodidae: Cholevinae assemblages in individual sites. Site 1 – hornbeam oakwood forest, site 2 – floodplain forest, site 3 – shrubby ecotone of a lowland forest, site 4 – open field habitat.

Tab. 2. Ecological characteristics of dominant Leiodidae: Cholevinae species found in the Litovelské Pomoraví Protected Landscape Area, Czech Republic

Species	phenology group	habitat preference
Catops fuliginosus fuliginosus	c	unclear
C. grandicollis	c	non-forest
C. kirbyi kirbyi	d	unclear
C. morio	d	non-forest
C. neglectus	c	forest
C. nigricans	c	non-forest
C. nigrita	a	forest
C. picipes	c	forest
C. subfuscus subfuscus	b	forest
C. tristis tristis	c	forest
C. westi	a	forest
Ptomaphagus sericatus	a	non-forest
P. variicornis	a	forest
Sciodrepoides watsoni watsoni	a	non-forest
S. fumatus fumatus	b	forest

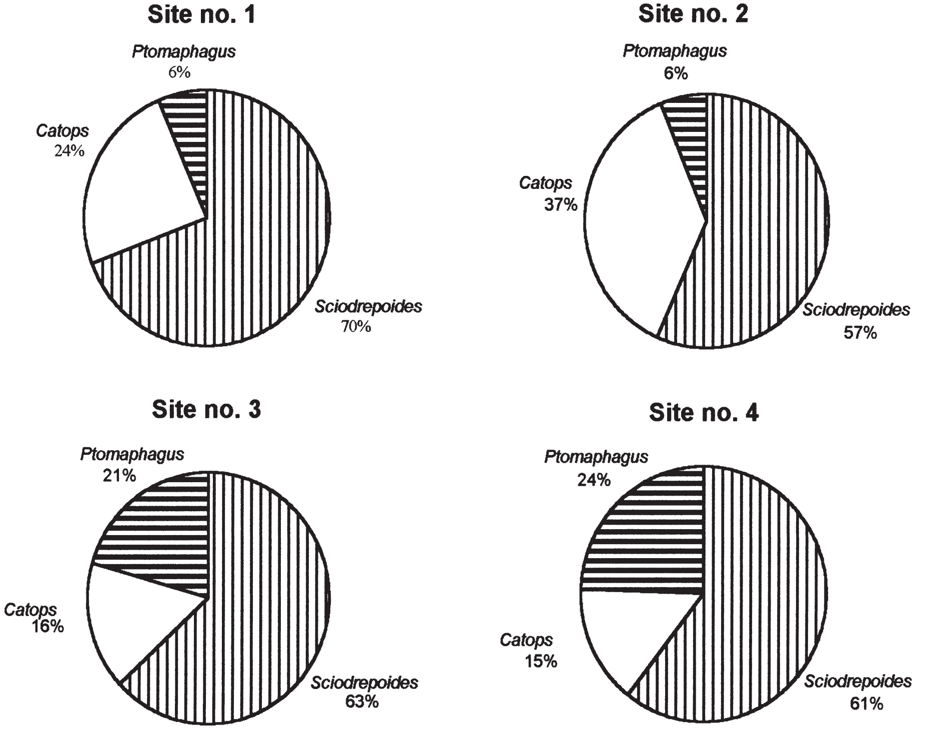

Fig. 2. Relative percentage of individuals in each genus of Leiodidae: Cholevinae caught at each of the sites. Site no. 1 – hornbeam oakwood forest, site no. 2 – floodplain forest, site no. 3 – shrubby ecotone of a lowland forest, site no. 4 – open field habitat.

was found in the floodplain forest, followed by the the ecotone, hornbeam oakwood forest and the open field habitat (Tab. 1).

Seasonality

Based on the seasonal changes in adult activity, the small carrion beetles were sorted into four groups (Fig. 3): a – species active throughout the sampling season from spring to the late autumn (*Ptomaphagus sericatus*, *P. variicornis*, *Sciodrepoides watsoni watsoni*, *Catops nigrita*, *C. westi*); b – species showing a unimodal peak in activity in spring (*Sciodrepoides fumatus fumatus*, *Catops subfuscus*); c – species showing bimodal peak in activity, with peaks in spring and autumn *(C. grandicollis*, *C. neglectus*, *C. tristis tristis*, *C. nigricans*, *C. picipes*, *C. fuliginosus fuliginosus*) and d – species showing a unimodal peak in activity in an autumn (*C. kirbyi kirbyi*, *C. morio*).

DISCUSSION

The habitat associations of individual species are similar to those cited by Růžička (1995). The clustering of species into groups generally preferring forest or non-forest habitat is over simplified (cf. Tizado et al. 1995, Tizado & Salgado 2000). It is better subdivide forest habitats into a wet forest type (represented by the floodplain forest in this study), and a dry forest type (represented by the hornbeam oakwood forest). A species that preferred exclusively dry forest sites was *Catops neglectus*, species that preferred wet forest sites were *C. nigrita* and *C. picipes*. In the other species no differences in preference for one of the two forest types were found.

The highest species diversity (expressed by Brillouin index of species diversity, see Tab. 1) was found in wet floodplain forest (2.80 bits per individual); species diversity was high also in hornbeam oakwood forest (2.37 bits per individual). The lowest species diversity was found in open field habitat (1.51 bits per individual). The differences in diversity were caused by the higher number of species of *Catops*, which were also relatively more abundant in forest sites than in open field habitat (Fig. 2). The ecotone habitat was characterised by the occurrence of species typical of both habitats and by the highest total number of specimens caught (see Tab. 1).

Habitat associations can also be observed at the microhabitats level (Sokolowski 1942). The majority of the species generally occupy decaying litter and carrion, but there are species that prefer mammal nests (*Talpa europea*, *Oryctolagus cuniculus*, *Microtus* spp. etc.). The typical genus associated with the tunnels and nests is *Choleva* Latreille, 1796 (Růžička & Vávra 1993), only two specimens of one species were found. Species of *Catops nigriclavis* Gerhardt, 1900 also prefer the nests of small mammals (especially *Talpa europea*) but was not caught in the traps in spite of it being common in the area (Kočárek 1997). Some species of the genus *Catops* (e. g. *C. grandicollis*, *C. westi*, *C. fuliginosus fuliginosus*, *C. nigricans*, *C. morio*) do not show as strong preference for mammal nests as the foregoing species but they are more numerous in nests than in the ground litter or carrion (cf. Topp 1990); some species are also associated with decaying fungi (Sokolowski 1942, Szymczakowski 1961).

Tab. 3. Values of Renconen index showing faunistic similarity of Leiodidae: Cholevinae assemblages between each site. Legend: site no. 1 – hornbeam oakwood forest, 2 – floodplain forest, 3 – shrubby ecotone of a lowland forest, 4 – open field habitat

site no. \ site no.	1	2	3
1			
2	71.3		
3	66.1	49.9	
4	60.6	40.8	82.9

From the Fig. 3 is evident that the activity of the majority of species culminate (or continue) in the autumn period (with exclusion of three species in the material of this study). The same was found by Růžička (1995). In contrast, the activity of the most important carrion decomposers, burying beetles (Silphidae: Nicrophorinae) and carrion blowflies (Diptera: Calliphoridae), is most marked in spring and summer (Novák 1965, Růžička 1995, Kočárek & Benko 1997, Kočárek 2001). Burying beetles conceal the carcasses of small vertebrate underground and prepare them for consumption by their young (Scott 1998); consequently the small carrion beetles cannot utilise this food resource. Adult burying beetles are predators and feed on the larvae of carrion blowflies. The individuals that occur in autumn do not bury carcasses, but only feed prior to hibernation (Halffter et al. 1983, Kočárek 2001). In addition, the activity of carrion blowflies is most marked in spring and summer (Kočárek in press). Larvae of these flies produce excrement that contains ammonium rendering major parts of the carcass toxic for other consumers (Bornemissza 1957). The most numerous group of small carrion beetles shows a bimodal activity pattern (species of the group c), due to their diapausing in

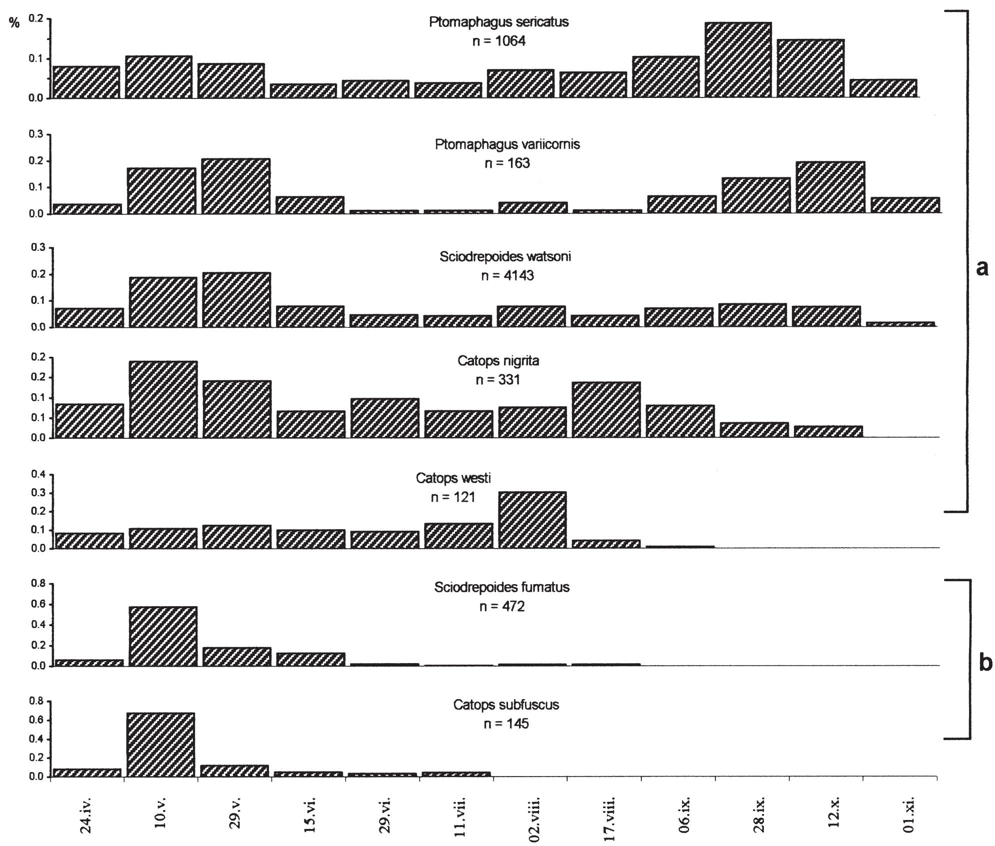

Fig. 3. Phenology of individual small carrion beetles found at the Litovelské Pomoraví Protected Landscape Area, Czech Republic. The groups are indicated by lower case letters (for details see the text).

summer (aestivating species) (Engler 1982). The diapause and consequent shift in occurrence and reproduction to a more favourable season (autumn) seems to be adaptive.

I have shown that species of Leiodidae: Cholevinae seem to be separated from each other in one or both of two dimensions, i.e. seasonal activity and habitat preference. Thus, species appear to be differentially adapted to the resources. Factors not considered in this study were differences in food preference within the guild, preference for a certain stage in the decomposition of a carcass (see Kentner & Streit 1990) and diurnal activity. The study did not include egg and larval stages, as well as preferences for oviposition sites and substrates, that can be less or more different than the food resource of the imagoes.

These results have implications for the analysis of the community structure of these assemblages in relation to resource use and spatial and temporal coexistence. Each kind of food resource used by small carrion beetles is limited and ephemeral, and therefore an object of intense interspecific competition. We observed realised niches, which describe the more limited spectrums of conditions and

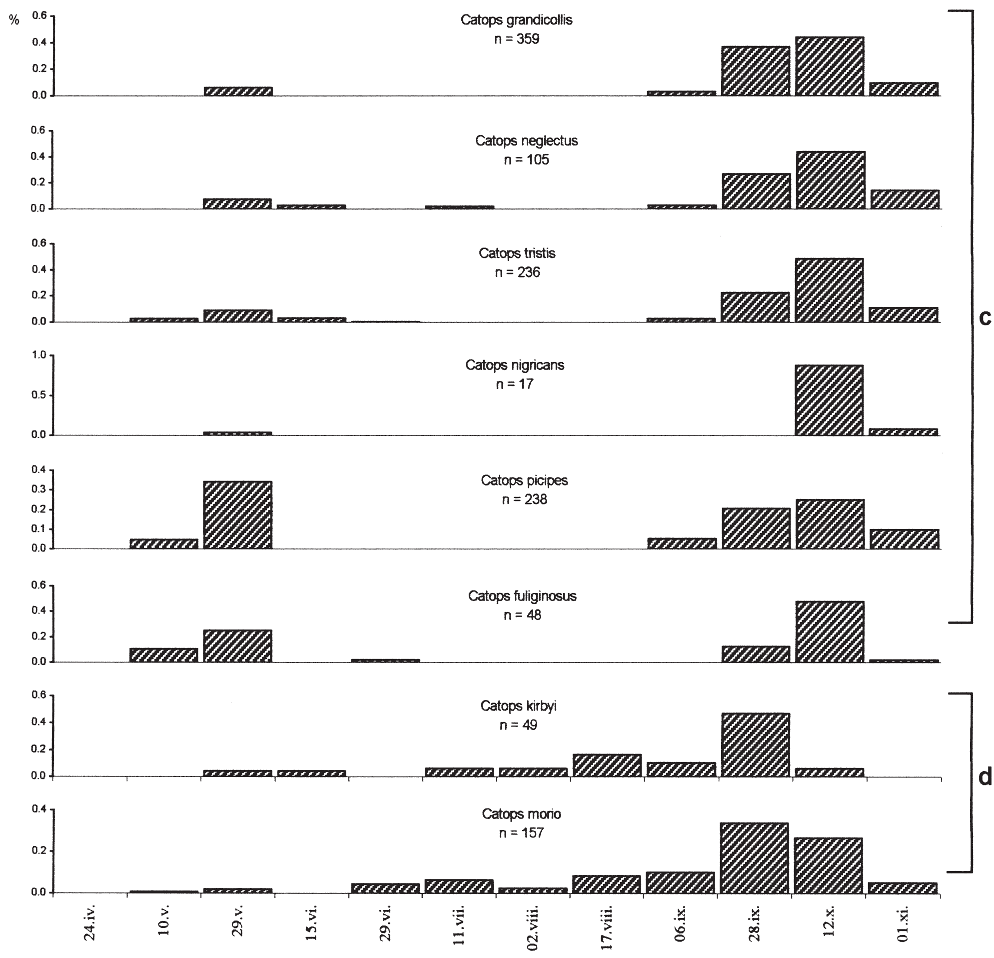

Fig. 3. Continuation.

resources that enable each species to persist, even in the presence of competitors and predators (Whittaker et al. 1973). The majority of species were able to occupy wide spectrum of habitats (fundamental niche) including e. g., high mountains. The realised niche in such habitats will be different.

Temporal coexistence patterns of small carrion beetle assemblages would also seem to require careful interpretation in terms of resource partitioning. I believe that the above points illustrate the importance of obtaining a detailed knowledge of individual species biologies for the analysis of the structure of small carrion beetle assemblages.

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