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Importance of woody and grassy areas as refugia for field Carabidae and Staphylinidae (Coleoptera)

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Abstract. The importance of refugia for field Carabidae and Staphylinidae was investigated. Unbaited pitfall traps were placed along a linear transect that spanned a section of forest, a field sown with spring barley and a grassy ridge. The traps were inspected at 2–3 day intervals from April to September, 1996. The traps were divided according to their position, the forest, margins (two) and central part of the field, and the grassy ridge. At each site carabid and staphylinid species were ranked according to their abundance. To test the hypothesis that dominant field species should also dominate in the forest and grassy ridge if they are refugia the dominance of particular species at different sites was compared. The total catch of 6214 adults consisted of 36 carabid and 69 staphylinid species. The grassy ridge community was dominated by 4 generalist carabid species present in all biotopes and 5 species typical of fields (which together represented 93.9% of individuals of the carabids caught in the field). For the staphylinids 1 generalist, 2 field species and 2 species migrating from the grassy ridge to field margins (made up 77.8% of the field population) were among the dominant species in the grassy ridge community. The grassy ridge thus provided a refugium for an important part of the field carabid and staphylinid populations. In contrast, the proportion of carabid and staphylinid species shared by field and forest communities was smaller (77.8% and 5.5%, respectively). The forest margin was a less suitable carabid and staphylinid refugium than the grassy ridge.

Carabidae, Staphylinidae, refugium, field, ridge, forest, community, abundance, dominance, Czech Republic, Palaearctic region

INTRODUCTION

There are many studies of the factors influencing the abundance of dominant species and composition of carabid communities on arable land (Thiele 1977, Luff 1987, Kromp 1999, Holland & Luff 2000). During the vegetative period the distribution of species in the crops is patchy (Thomas et al. 2001). The local abundance of a carabid species is determined by microclimate (Novák 1967, Petruška 1971, Skuhravý et al. 1971, Wallin 1985, Honěk 1988, 1997) and presence of animal prey or vegetable food (Kromp 1990, Andersen & Eltun 2000). However, overall carabid abundance depends on their abundance in habitats surrounding the arable fields (Gravesen & Toft 1987, French & Elliott 1999). Only a few species survive harvesting, ploughing and the other “hostile” agricultural practices arable fields are subjected to during a year (Pfiffner & Luka 2000). Most species require adjacent undisturbed habitats, “refugia”, for overwintering or breeding (Kromp & Steinberger 1992, Thomas et al. 1997, Thomas & Marshall 1999). From there they migrate into the crops (Petersen 1999). In central Bohemia (western Czech Republic) field margins are frequently bordered by grassy verges or forests. We used pitfall traps to compare the similarity of carabid communities in fields and both types of bordering plant stands. Although the importance of refugia for Carabidae is well studied, there is less information on the second most important group of generalist predators, the Staphylinidae. This is because are captured by pitfall traps and they

Tab. 1. Relative abundance (percentage of the total catch in the traps placed at a particular site) at 5 sites A–E of the groups of carabid species distinguished by their preference for forest, field and grassy ridge habitats

Species	forest A	field margin B	field centre C	field margin D	ridge E
forest	28.2	0.2	0.4	0.5	1.6
emigrants	61.4	7.7	2.2	1.5	8.7
field	0.0	12.9	23.4	23.5	5.2
generalist	9.1	78.3	72.7	70.9	78.2

are difficult to identify. Since we were able to identify all the staphylinids caught we could compare carabid and staphylinid communities with the same precision.

In this paper we report on a one year study, which compared carabid and staphylinid communities in a field surrounded by a grassy ridge and a deciduous forest. We used pitfall traps, which measure the "activity density" of carabids. i.e. the frequency with which the beetles cross the area of the trap. This depends on carabid abundance (numbers of individuals per area), species, microclimate and availability of food (Adis 1979, Honěk & Martinková 2001). To compensate for the pitfall trapping efficiency we compared species dominance in the crop and surrounding plant stands. We assumed that a similar rank of dominance of a species in two samples indicates that the places where the samples were taken are equally suitable for the species. The dominance rank may be similar even when the species activity densities at both places are different because of circumstances limiting beetle catchability. This may be influenced by the duration of species occurrence at a given place (local population dynamics) and factors directly affecting pitfall trap catches (microclimate, density of plant stand, quality of turf). In this way we determined the species typical for the crop and important in the surrounding plant stands. For those species that live on both "sides" of a field edge the surrounding stands may act as refugia.

MATERIAL AND METHODS

Experimental field

The experiment at field was at Praha-Ruzyně (50° 07' N 14° 16' E, altitude 380 m a. s. l.), of a medium size (ca. 6 ha) and situated on a slight slope with a northerly inclination (towards the forest). The northern, western and southern margins of the field were bordered by a mixed deciduous forest (mostly oak), the southern by a field from which it was separated by ca. 7 m wide grassy ridge (former field track). For many years the field was used to produce different crops (cereals, rape and maize) rotated in an irregular order. In 1996, the field was sown on April 12 with spring barley and harvested on August 23. The crop was grown using the usual agricultural practices for the Czech Republic (Špaldon 1982). No insecticide was applied during the period of investigation.

Trapping

Seventeen unbaited pitfall traps were placed ca. 10 m apart along a linear transect from the margin of the forest, across the field to the grassy ridge. The pitfall traps were plastic cups, 8 cm in diameter (50.3 cm^2 outlet area) and 11 cm deep. The cups were dug into the soil, with the rim flush with the soil surface. No bait was used. The few pieces of soil at the bottom of the cups provided shelter for the trapped arthropods. There were four traps in the forest, 11 in the field and 2 on the grassy ridge. The traps were inspected at 2–3 day intervals, from April 15 to September 11, 1996. Most beetles were identified to species and immediately released, the species difficult to determine were collected and identified in the laboratory.

Data analysis

Since the daily catches of each trap were low the numbers of individuals of particular species captured per trap were summed over the whole catching period. This compensated for temporal variation in species activity density. The 17 traps placed along the transect were divided into 5 groups: those placed in (A) the forest (traps no. 1–4), (B) in the field margin near to the forest (traps no. 5–6), (C) in the central part of the field (traps no. 7–13), (D) in the field margin near to the grassy ridge (traps no. 14–15) and (E) in the grassy ridge (traps no. 16–

17). The places where these groups of traps (A–E) were placed are called "sites". The division of field traps into 3 groups was adopted in order to compare species abundance in the centre and margins of the field. As the differences between the margins and the centre of the crop were small in some analyses we divided the traps into forest (group A), field (B–D) and grassy ridge (E), which were designated "habitats". Five characteristics of the carabid and staphylinid communities were compared:

(i) Community composition. The average catches (numbers of specimens$\times$trap$^{-1}\times$catching period^{-1}) of each species in each habitat were calculated and the species ranked according to their abundance. The log abundance was then plotted against species rank.

(ii) Species dominance. For each species the arithmetic mean of its abundance at each site was calculated and the order of dominance determined for 13 most abundant species of each family ranked from 1 (least abundant) to 13 (most abundant). For a particular species its rank was plotted against the habitat (the species rank was 0 if it was not among the 13 top most abundant). This plot showed the changes in species dominance along the transect. The species were then sorted according to the similarity in their patterns of variation in dominance along the transect.

(iii) Species abundance. The differences in abundance were compared for 10 dominant carabid species and 3 staphylinid species. Their average numbers in each of the 17 traps were transformed to square roots. The traps were divided into those in forest (n = 4), crop (n = 11) and the grassy ridge (n = 2) habitats. A one-way ANOVA was performed using the species catches in traps as a response variable and the habitats as factors.

(iv) Species diversity. The traps were divided according to habitat. Shannon-Wiener index H was calculated for carabid and staphylinid communities at each site: $H = \mathrm{sum}(p_i \times \log p_i)$, where p_i is the proportion of i-th species in the total catch of the traps at each site.

(v) Species similarity. The similarity between carabid and staphylinid communities at different sites was calculated using Renkonnen index of percentage similarity Re, which is: $Re = \mathrm{sum}(\mathrm{minimum}\ [p_{ia}, p_{ib}])$, where p_{ia} and p_{ib} are the proportion of i-th species in the total catch at sites a and b, i.e. the sum of the smaller one of p_{ia} and p_{ib} quantities of each species.

RESULTS

1. Community composition

In total 36 carabid species were captured (Appendix). Their abundance decreased proportionately with species rank (Fig. 1). The total number of species and the overal abundance was highest in the field. Numbers and abundance of species of the same rank were smaller in the forest and grassy ridge than in the field. The 69 staphylinid species captured in this study (Appendix) was nearly twice the number of carabid species. Species abundance exceeded that of Carabidae in particular habitats. Only a few top ranking species were abundant and a large proportion of the staphylinid community consisted of rare species (Fig. 1). As a consequence, the species abundance/rank plots were J-shaped. In contrast to carabids, the forest community of Staphylinidae was more abundant and richer than the field and grassy ridge communities.

2. Species dominance

Dominant carabid species may be divided into 4 groups (Table 1). Two groups preferred forest: (1) "Forest" species (*Carabus nemoralis*, *Pterostichus oblongopunctatus*) were abundant mostly in

Tab. 2. Relative abundance (percentage of the total catch in the traps placed at a particular site) at 5 sites A–E of the groups of staphylinid species distinguished by their preference for forest, field and grassy ridge habitats

Species	forest A	field margin B	field centre C	field margin D	ridge E
forest	26.9	0.8	0.0	0.4	0.3
field	0.8	60.2	79.9	76.9	72.5
generalist	10.4	5.9	2.3	2.2	0.9
emigrants	34.2	0.8	1.1	4.0	15.4
forest and ridge	3.7	0.8	0.0	0.4	4.0

the forest and very rarely in the field, where they made up only 0.4% of the carabid catch (Fig. 2, top). (2) "Forest emigrants" (*Abax parallelepipedus*, *Carabus hortensis*, *Platynus assimilis*) were abundant in the forest but also spread into the field, where their abundance decreased with distance from the forest margin. They were again more abundant in the grassy ridge (Fig. 2, top). Two groups were associated with the field: (3) Typical "field" species (*Bembidion lampros*, *Harpalus affinis*, *H. distinguendus*, *Poecilus cupreus*, *Trechus quadristriatus*) were scarcer in the

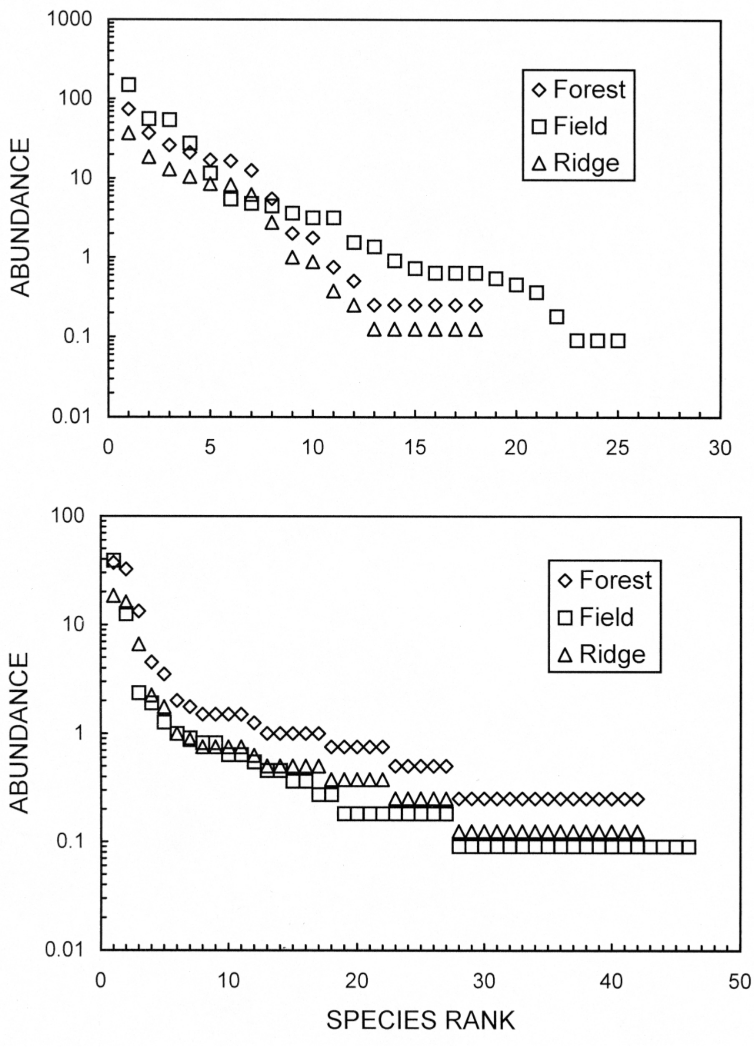

Fig. 1 The log total catch (abundance, average no. of individuals.trap^{-1}.catching period^{-1}) plotted against species rank in samples from forest, field, and grassy ridge habitats. Top: Carabidae. Bottom: Staphylinidae.

Tab. 3 Average numbers (individuals.trap^{-1}.catching period^{-1}) of abundant carabid and staphylinid species in field, grassy ridge and forest habitats. Below each figure is its SE, which is asymmetrical because it is calculated using square root transformed data

	field	ridge	forest	average
Carabidae				
Poecilus cupreus	55.2	5.4a	0.0a	25.8
	49.3–61.4	4.0–7.0	0.0–0.0	17.9–35.2
Pseudoophonus rufipes	108.5	34.1	11.0a	67.4
	71.5–153.2	27.0–42.0	7.1–15.7	45.3–93.7
Pterostichus melanarius	50.4	29.7	4.0a	32.5
	42.3–59.2	21.0–40.0	1.8–7.0	25.3–40.6
Anchomenus dorsalis	10.5	69.5a	5.5	13.1
	9.2–11.9	68.0–71.0	0.2–17.9	9.1–17.9
Carabus granulatus	24.2	28.8	0.8a	16.3
	19.6–29.4	15.0–47.0	0.1–2.4	12.0–21.2
Pterostichus oblongopunctatus	0.2	0.3	25.5a	2.3
	0.1–0.4	0.0–1.0	24.2–26.7	1.1–4.1
Abax parallelepipedus	2.4	11.2	69.9a	11.3
	1.8–3.2	6.0–18.0	52.3–90.1	6.8–17.1
Platynus assimilis	2.1	21.3a	23.8a	6.9
	1.5–2.9	6.0–46.0	7.8–48.4	4.0–10.7
Carabus hortensis	1.4	2.6	16.5a	3.6
	0.6–2.4	1.0–5.0	14.0–19.1	2.3–5.3
Carabus nemoralis	0.2	2.5	19.8a	2.3
	0.1–0.4	2.0–3.0	15.1–25.1	1.2–3.9
Staphylinidae				
Philonthus cognatus	34.1	2.5a	0.2a	16.5
	30.5–37.9	2.0–3.0	0.0–0.8	11.7–22.2
Philonthus decorus	0.0	0.3	30.9a	2.2
	0.0–0.1	0.0–1.0	23.9–38.8	0.8–4.3
Drusilla canaliculata	6.0	138.4a	0.6a	9.9
	2.7–10.4	71.0–228.0	0.1–1.6	4.6–17.2

a – significantly different ($p<0.05$) from abundance in the field

grassy ridge and absent in the forest (Fig. 2, middle). (4) "Generalists" (*Carabus granulatus*, *Anchomenus dorsalis*, *Pseudoophonus rufipes*, *Pterostichus melanarius*), were abundant in the field and grassy ridge, but also occurred in the forest (Fig. 2, bottom). The field community (Table 1) consisted largely of generalist (74.0±3.1% of total field carabid population) and field specialist species (19.9±5.0%), forest emigrants were less abundant (3.8±2.8%). The grassy ridge may be a refugium for field and generalist species, which make up 93. 9% of the total carabid population in the field. The forest margin may be used as a refugium by forest emigrant and generalist species, which made up together 77.8% of the field carabid population.

The 8 dominant species of Staphylinidae were divided into five groups. Three groups were associated with surrounding habitats: (1) The "forest" species *Philonthus decorus* (Fig. 3, top). (2) "Forest and grassy ridge" species nearly absent in the field (*Oxypoda longipes*, *Platarea dubiosa*) (Fig. 3, middle). (3) "Emigrants" (*Ocypus nero*, *Omalium caesum*), species preferring forest and grassy ridge but migrating into the field (Fig. 3, middle). Two groups were typical of the field habitat: (4) "Generalist" *Atheta fungi* present in the forest and field but less abundant in the grassy ridge (Fig. 3, top). (5) "Field" species (*Drusilla canaliculata*, *Philonthus decorus*) also present in the grassy ridge but not in the forest (Fig. 3, bottom). The field fauna was thus largely

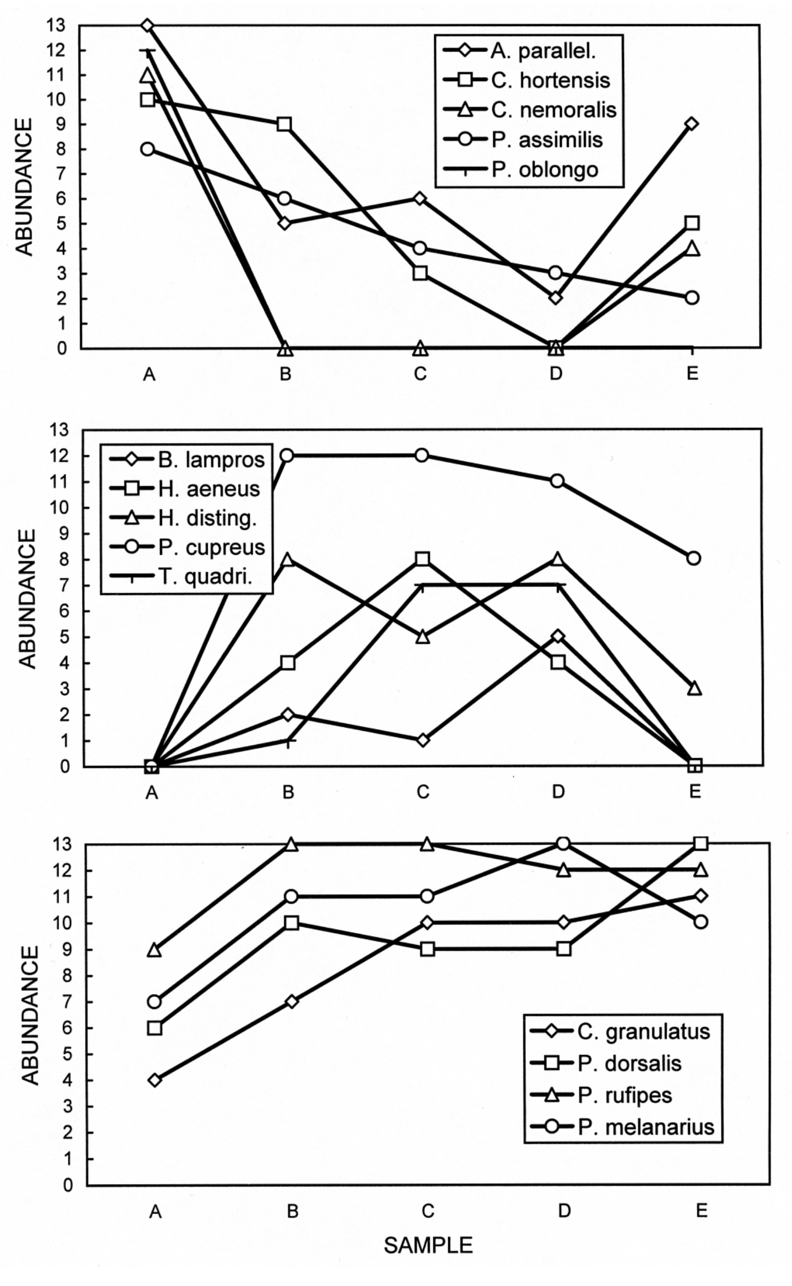

Fig. 2. The relative abundance of carabid species in samples from the forest (A), field (B–D) and grassy ridge (E) habitats. The ordinate indicates the species rank among the 13 species most abundant at a given site. Top: "Forest" and "forest emigrant" species. Middle: "Field" species. Bottom: "Generalist" species. For explanation of the species categories see Results.

Tab. 4. The Shannon-Wiener index of diversity H of the carabid and staphylinid communities in the forest, field, and grassy ridge habitats. Identification of the sites A–E as in Table 1

Site	Carabidae	Staphylinidae
A	0.725	0.961
B	0.608	0.795
C	0.736	0.557
D	0.834	0.756
E	0.899	0.541
Average±SE	0.760±0.045	0.722±0.070

composed of 2 field species (72.3±8.7% of total field staphylinid population), with 1 generalist (3.5±1.7%) and 2 emigrants (2.0±1.4%) of less importance. The grassy ridge may serve as refugium for all these species, i.e. 77.8% of total staphylinid population captured in the field. By contrast, the forest margin appeared to be unsuitable for field species. It may be used by generalist and emigrant species, i.e. only 5.5% of the field staphylinid population.

3. Abundance of dominant species

Abundance of dominant species differed between the field and adjacent habitats (Table 3). The differences between the field and forest were greater than the differences between the field and grassy ridge. Four species were significantly less abundant and 5 species significantly more abundant in the forest than in the field. Only 3 species had a significantly different abundance in the grassy ridge and in the field. Two species, *A. dorsalis* and *P. assimilis*, were more abundant in the grassy ridge, while the reverse was true for *P. cupreus*.

4. Species diversity

The diversity (Table 4) of carabids (H=0.726±0.054) and staphylinids (H=0.703±0.060) in the pooled samples (A+B+C) from the field was similar. The diversity in forest samples was greater for staphylinids than carabids, due to the greater abundance of rare species (Fig. 1). The diversity in the grassy ridge community was lower for staphylinids than carabids, due to the dominance of *D. canaliculata* in the staphylinid sample.

5. Species similarity

The similarity between samples from the central and marginal parts of the field (Table 5) was significantly greater for Carabidae (average Re=74.8±2.8%) than for Staphylinidae (Re=52.6±6.0%). This was caused by the dominance of abundant field and generalist carabid species evenly present throughout the field. The similarity between the field margin and grassy edge communities was slightly lower (Carabidae) or similar (Staphylinidae) to the within field samples. The similarity between field margin and forest samples was low for both families.

DISCUSSION

Many studies demonstrate the importance of surrounding uncultivated land in promoting the abundance and diversity of carabid and staphylinid species in field crops (Lee et al. 2001). Not only forest margins, ridges, hedges or abandoned fields may become refugia for field populations. Strips of wild vegetation or strips sown with alternative crops also positively affecte predator abundance in fields (e.g. Lys & Nentwig 1992, 1994, Kienegger & Kromp 2000). It is more difficult to demonstrate that a particular habitat at bordering a crop is a refugium because of differences in the catchability of species in crop and wild habitats and the heterochrony in their occurence in

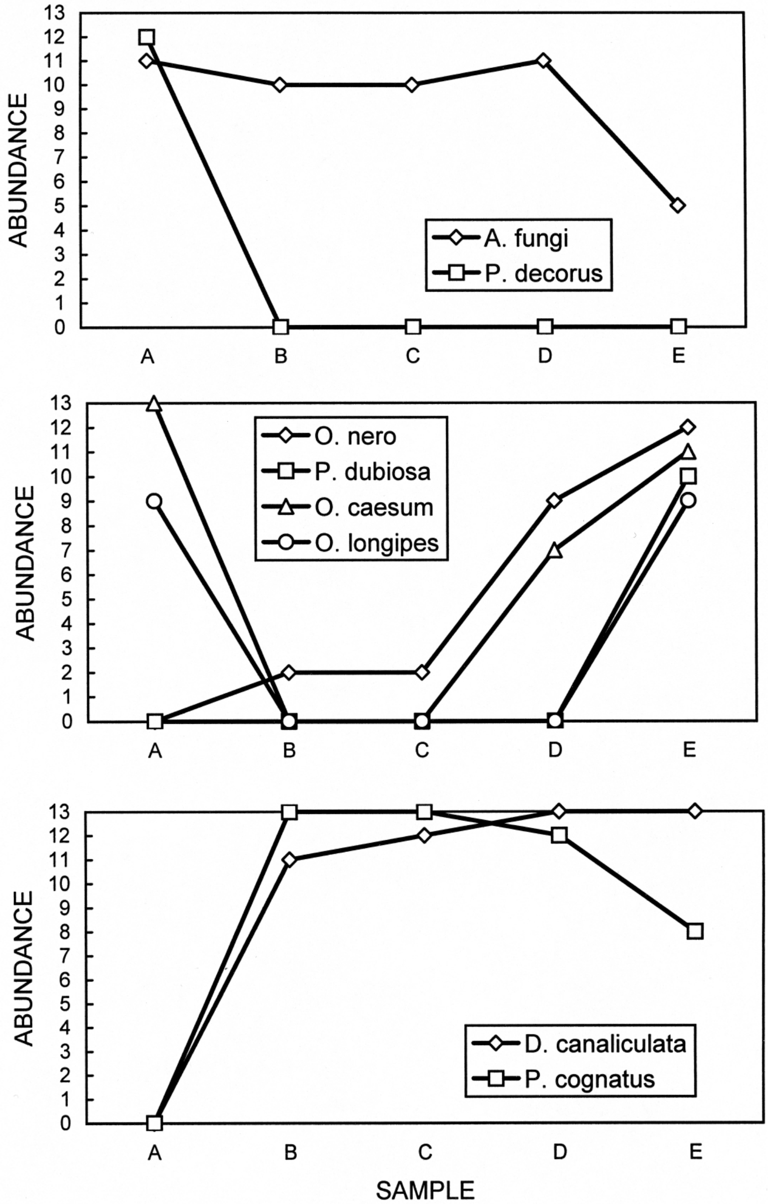

Fig. 3. The relative abundance of staphylinid species in the samples from the forest (A), field (B–D) and grassy ridge (E) habitats. The ordinate indicates the species rank among the 13 species most abundant at a given site. Top: "Forest" and "generalist" species. Middle: "Forest and grassy ridge" species, and forest "emigrant" species. Bottom: "Field" species. For explanation of the species categories see Results.

Table 5. The Renkonnen index Re of percentage similarity between the catches of Carabidae and Staphylinidae in traps placed at neighbouring sites. Identification of the sites A–E as in Table 1

Site	Carabidae	Staphylinidae
A vs B	17.1	12.9
B vs C	70.8	61.1
C vs D	78.7	44.1
D vs E	54.8	56.8

both habitats. By comparing the dominance of a species in annual samples collected at both sites we overcame these difficulties. This method is appropriate for species overwintering as adults. Its application to species overwintering as larvae, e. g. *P. rufipes* (Matalin 1997), should be studied.

This study confirmed that a large proportion of field carabids, generalist species and field specialists, use grassy ridges as refugia. On the other hand, species typical of the grassy ridge invaded the field margin (*P. assimilis*) or spread over the whole area (*A. dorsalis*). In contrast, the adjacent forest was avoided by most field species and of forest species rarely emigrated into the field. Several carabid species, which are generaly distributed (*P. rufipes*, *Harpalus* spp.) are also seed predators (Jörgensen & Toft 1997). Their mixed polyphagy may contribute to their wide distribution. The proportionally fewer of the dominant field staphylinid species used surrounding habitats as refugia than of the Carabidae. Moreover some of the species of staphylinid caught in our study were mycophagous. Thus the positive effect of field edges as refugia for staphylinid predators was apparently less important than for carabids.

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APPENDIX
A list of the species captured in this study

Carabidae

Abax parallelepipedus (Piller et Mitterpacher) *, *Acupalpus meridianus* (L.), *Amara aulica* (Panzer), *A. familiaris* (Duftschmid), *A. similata* (Gyllenhal), *Anchomenus dorsalis* (Pontoppidan), *Anisodactylus signatus* (Panzer), *Bembidion lampros* (Herbst), *B. obtusum* Audient-Serville, *B. quadrimaculatum* (L.), *Brachinus explodens* Duftschmid, *Calathus erratus* (Sahlberg), *Carabus granulatus* L., *C. hortensis* L., *C. intricatus* L., *C. nemoralis* Müller, *Harpalus affinis* (Schrank), *H. distinguendus* (Duftschmid), *H. atratus* Latreille, *H. signaticornis* (Duftschmid), *Loricera pilicornis* (F.), *Notiophilus biguttatus* (F.), *N. palustris* (Duftschmid), *Panagaeus bipustulatus* (F.), *Platynus assimilis* (Paykull), *Poecilus cupreus* (L.), *Pseudoophonus rufipes* (DeGeer) **, *Pterostichus melanarius* (Illiger) ***, *P. oblongopunctatus* (F.), *P. vernalis* (Panzer), *Stomis pumicatus* (Panzer), *Synuchus vivalis* (Illiger), *Trechus quadristriatus* (Schrank)

Staphylinidae

Aleochara bipustulata (L.), *A. curtula* (Goeze), A. laevigata Gyllenhal, *A. ripicola* Mulsant et Rey, *A. sparsa* Heer, *Aloconota gregaria* (Erichson), *Amischa analis* (Gravenhorst), *A. cavifrons* Sharp, *A. soror* (Kraatz), *Atheta amplicollis* (Mulsant), *A. crassicornis* (F.), A. fungi (Gravenhorst), *A. gagatina* Baudi, *A. laticollis* (Stephens), *A.*

livida Mulsant et Rey, *A. pittionii* Sheerpeltz, *A. sodalis* (Erichson), *A. subtilis* (Scriba), *A. triangulum* (Kraatz), *Bolitobius formosus* (Gravenhorst), *Dinarea angustula* (Gyllenhal), *D. linearis* (Gravenhorst), *Drusilla canaliculata* (F.), *Enalodroma hepatica* (Erichson), *Ilyobates subopacus* Palm, *Lathrimaeum atrocephallum* (Gyllenhal), *Lathrobium fulvipenne* (Gravenhorst), *Leptacinus sulcifrons* (Stephens), *Lordithon lunulatus* (L.), *Mniobates forticornis* (Boisduval), *Ocypus nero semilatus* J. Müller, *O. fuscatus* (Gravenhorst), *O. melanari*us (Heer), *Oligota inflata* Mannerheim, *Omalium caesum* Gravenhorst, *O. rivulare* (Paykull), *Othius punctulatus* (Goeze), *Oxypoda abdominalis* Mannerheim, *O. haemorrhoa* Mannerheim, *O. lividipennis* Mannerheim, *O. longipes* Mulsant et Rey, *O. spectabilis* Märkel, *O. vicina* Kraatz, *Oxytelus insecatus* Gravenhorst, *O. mutator* Lohse, *O. rugosus* (Gravenhorst), *Parabemus fossor* (Scopoli), *Philonthus carbonarius* (Gravenhorst), *P. cognatus* Stephens, *P. coruscus* (Gravenhorst), P. decorus (Gravenhorst), P. chalceus Stephens, P. laminatus (Creutzer), *Platarea dubiosa* (Benick), *Quedius limbatus* (Heer), *Rugilus orbiculatus* (Paykull), *R. subtilis* (Erichson), *Sepedophilus marshami* (Stephens), *S. testaceus* (F.), *Staphylinus stercorarius* Olivier, *Sunius melanocephalus* (F.), *Tachinus rufipes* (DeGeer), *Tachyphorus hypnorum* (L.), *T. obtusus* (L.), *T. pusillus* Gravenhorst, *T. solutus* Erichson, *Xantholinus linearis* (Olivier), *Zyras humeralis* (Gravenhorst), *Z. limbatus* (Paykull)

* Rarely confounded with *Abax carinatus* (Duftschmid);
** Rarely confounded with *Pseudoophonus griseus* (Panzer);
*** Rarely confounded with *Pterostichus melas* (Creutzer).

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BOOK REVIEW

PÜHLER A., REGITZ M., SCHMID R. D. (eds): **Römpp kompakt Lexikon Biochemie und Molekularbiologie**. Stuttgart-New York: Georg Thieme Verlag, 2000. IX+725 pages. Format 170×242 mm. Hard cover. Listprice EUR 40.39. ISBN 3-13-116681-9

This comprehensive volume presents a common product of 9 respected experts in various fields of biochemistry, molecular biology, microbiology, immunology and genetics. As declared in the preface by the editors, this lexicon is intended to explain the meaning of most important professional terms and their lexical elaboration. Introductory pages give the reader directions to the usage of this publication such as writing art, the principles of abbreviations, the mode of citations of literature. There is a list of most often quoted textbooks and encyclopaedic works. End-papers and fly-leaves comprise a list of chemical symbols and abbreviations repeated throughout the text. Subsequent pages constitute basic lexical part encompassing particular entries in two-column set-up, arranged in alphabetical order. Defined are key terms in a wide range of practically all aspects of biochemistry and molecular biology including relevant biological sciences. Particular entries embrace the extent from rather space-limited paragraphs up to >10 textual pages.

Entries devoted to biochemistry are concerned with miscellaneous substances and macromolecules: aminoacids, peptides, biogenic amines, simple and complex lipids, steroids, nucleic acids and nucleosides, carbohydrates, enzymes, vitamins, etc. Moreover, covered are biochemical pathways, metabolic routes, energy metabolism, and other processes. Entries encompassing molecular biology include key terms such as cloning vectors, molecular motors, polymerase chain reaction, amplification, hybridization *in situ*, hybridoma technique, sequence analysis, further on characterized are chemicals used in molecular biological laboratory techniques. Entries analyzing the cell biology centre attention upon miscellaneous cellular substances and components, upon cell structures such as biomembranes, cell organelles, the cell cycle, cell division, and other cellular activities and processes. Entries dealing with genetics and molecular genetics provide access to phenomenological and physiological aspects of hereditary factors: genes, genomes, chromosomes and chromosome techniques, DNA, RNA, codon, the transformation, mutation, recombination, suppression, sequencing, inheritable diseases, and many more. Entries concerned with biotechnology (technical biochemistry) include terms dealing with genetic procedures and methods: antibody engineering, recombinant gene expression, etc. Entries related to the immunity phenomena examine basic terms such as molecules of the immune system, antibodies and antibody reactions, allergy, immunoglobulins, diverse immunocompetent cells, a variety of immunoassays, cytokines, mediators and other factors. Entries based on microbiology and virology delineate prokaryotic and eukaryotic organisms and their classification, morphology, multiplication, physiological aktivities, biochemical composition, pathogenicity, etc. Moreover, outlined are entries focusing on natural products, alkaloids, antibiotics, fungicides, narcotics, microbial, fungal and plant toxins, animal venoms, plant stains, selected pathological conditions with clinical correlations and diverse related substances, miscellaneous procedural techniques, and others.

The text is attractively illustrated by numerous vivid figures composed of schematic line drawings depicting cells and cellular components, structural formulae, modelled structures and two- and three-dimensional arrangements of biomolecules, pathways for energy metabolism, biosynthetic processes, biochemical cycles and reactions, components and structures of prokaryotic and eukaryotic cells, internal structures of tissues, genetic maps, models and processings, genetic engineering, diagrams, diverse laboratory procedures, etc. In addition, there are 24 full-page plates presented in colour: featured are enzyme kinetics, secondary structures of proteins, a review of intermediate metabolism, basic mechanisms of metabolic regulation, glycogenogenesis, lipid and protein metabolism, photosynthesis and light related reactions, membrane proteins, oxygen and carbon dioxide transport, mechanism of muscular contraction, proteins of intermediate filaments and tubulins – components of the cytoskeleton, signal transduction effected by hormones in target cells, aspects of hormonal activity, signal transduction by G-proteins, necrosis and apoptosis, schematic presentation of the immune response, classes of immunoglobulins, activation of cytotoxic T cells, the cell cycle and its control, hereditary information, DNA cloning, and cell cycles of phages and viruses including the HIV. Finally, there are innumerable tables giving overviews of presented data. In conclusion, there is a formulary of anorganic and organic compounds introduced in the text.

This serviceable lexicon provides readers with comprehensive encyclopaedic body of information. It presents an outstanding aid for undergraduate and postraduate students and researchers in biological, medical and pharmaceutical sciences.

Jindřich Jíra