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

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Received June 20, 2001; accepted October 16, 2001
Published April 3, 2002

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.

INTRODUCTION


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; their 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). 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 Moravany (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 Stěně (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

<table>
<thead>
<tr>
<th>species \ site no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Catops coracinus</em> coracinus Kellner, 1846</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><em>C. fuliginosus</em> fuliginosus Erichson, 1837</td>
<td>0</td>
<td>16</td>
<td>25</td>
<td>7</td>
<td>48</td>
</tr>
<tr>
<td><em>C. grandicollis</em> Erichson, 1837</td>
<td>16</td>
<td>14</td>
<td>75</td>
<td>254</td>
<td>359</td>
</tr>
<tr>
<td><em>C. chrysomeloides</em> (Panzer, 1794)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td><em>C. kirbyi</em> kirbyi (Spence, 1815)</td>
<td>0</td>
<td>0</td>
<td>49</td>
<td>0</td>
<td>49</td>
</tr>
<tr>
<td><em>C. morio</em> (Fabricius, 1792)</td>
<td>0</td>
<td>0</td>
<td>117</td>
<td>40</td>
<td>157</td>
</tr>
<tr>
<td><em>C. neglectus</em> Kraatz, 1852</td>
<td>103</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>105</td>
</tr>
<tr>
<td><em>C. nigricans</em> (Spence, 1815)</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td><em>C. nigrita</em> Erichson, 1837</td>
<td>81</td>
<td>235</td>
<td>15</td>
<td>0</td>
<td>331</td>
</tr>
<tr>
<td><em>C. picipes</em> (Fabricius, 1792)</td>
<td>27</td>
<td>142</td>
<td>69</td>
<td>0</td>
<td>238</td>
</tr>
<tr>
<td><em>C. subfuscus subfuscus</em> Kellner, 1846</td>
<td>83</td>
<td>62</td>
<td>0</td>
<td>0</td>
<td>145</td>
</tr>
<tr>
<td><em>C. trisits trisits</em> (Panzer, 1794)</td>
<td>94</td>
<td>142</td>
<td>0</td>
<td>0</td>
<td>236</td>
</tr>
<tr>
<td><em>C. westi</em> Krogerus, 1931</td>
<td>44</td>
<td>34</td>
<td>42</td>
<td>1</td>
<td>121</td>
</tr>
<tr>
<td><em>Ptomaphagus sericatus</em> (Chaudoir, 1845)</td>
<td>97</td>
<td>59</td>
<td>395</td>
<td>513</td>
<td>1064</td>
</tr>
<tr>
<td><em>P. variicornis</em> (Rosenhauer, 1847)</td>
<td>18</td>
<td>52</td>
<td>93</td>
<td>0</td>
<td>163</td>
</tr>
<tr>
<td><em>Sciodrepoides watsoni watsoni</em> (Spence, 1815)</td>
<td>880</td>
<td>571</td>
<td>1423</td>
<td>1269</td>
<td>4143</td>
</tr>
<tr>
<td><em>S. fumatus fumatus</em> (Spence, 1815)</td>
<td>196</td>
<td>270</td>
<td>6</td>
<td>0</td>
<td>472</td>
</tr>
<tr>
<td><em>S. alpestris</em> Jeannel, 1934</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td><em>Choleva spadicea</em> (Sturm, 1839)</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Phenology group</th>
<th>Habitat preference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Catops fuliginosus fuliginosus</em></td>
<td>c</td>
<td>unclear</td>
</tr>
<tr>
<td><em>C. grandicollis</em></td>
<td>c</td>
<td>non-forest</td>
</tr>
<tr>
<td><em>C. kirbyi kirbyi</em></td>
<td>d</td>
<td>unclear</td>
</tr>
<tr>
<td><em>C. morio</em></td>
<td>d</td>
<td>non-forest</td>
</tr>
<tr>
<td><em>C. neglectus</em></td>
<td>c</td>
<td>forest</td>
</tr>
<tr>
<td><em>C. nigricans</em></td>
<td>c</td>
<td>non-forest</td>
</tr>
<tr>
<td><em>C. nigrita</em></td>
<td>a</td>
<td>forest</td>
</tr>
<tr>
<td><em>C. picipes</em></td>
<td>c</td>
<td>forest</td>
</tr>
<tr>
<td><em>C. subfuscus subfuscus</em></td>
<td>b</td>
<td>forest</td>
</tr>
<tr>
<td><em>C. tristis tristis</em></td>
<td>c</td>
<td>forest</td>
</tr>
<tr>
<td><em>C. westi</em></td>
<td>a</td>
<td>forest</td>
</tr>
<tr>
<td><em>Ptomaphagus sericus</em></td>
<td>a</td>
<td>non-forest</td>
</tr>
<tr>
<td><em>P. varicornis</em></td>
<td>a</td>
<td>forest</td>
</tr>
<tr>
<td><em>Sciodrepoides watsoni watsoni</em></td>
<td>a</td>
<td>non-forest</td>
</tr>
<tr>
<td><em>S. fumatus fumatus</em></td>
<td>b</td>
<td>forest</td>
</tr>
</tbody>
</table>

**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. varicornis, 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 nigriclavus* 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).

<table>
<thead>
<tr>
<th>site no. \ site no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>71.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>66.1</td>
<td>49.9</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>60.6</td>
<td>40.8</td>
<td>82.9</td>
</tr>
</tbody>
</table>

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.
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 (Halflter 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.

REFERENCES


BOOK REVIEW


The first edition occurred in print in 1982 (for review see J. Hyg. 28, 1984, 338), second edition followed in 1989 (for review see Folia Parasitol. 38, 1991, 62), subsequent third edition succeeded in 1995. This publication remained a favourite textbook nominally because of original illustrations demonstrating complex life cycles of parasites. In the foreword (Part I.) by L. H. Miller from National Institutes of Health, Bethesda, is given a global overview of parasitic diseases and the impact they make on human health. The first author is Professor of Public Health at the Columbia University in New York. As emphasized in the preface (Part II.), much of the text have been rewritten, particularly regarding the protozoans.

The volume is arranged in 11 parts embracing 41 chapters. The text comprises protozoans, helminths and arthropods of medical importance. Individual chapters are constructed by a general framework enclosing sections on historical information, basic description of life cycle, cellular and molecular pathogenesis, clinical disease, diagnosis, prevention and control. Each chapter is provided with references to pioneering and topical papers covering new findings, relevant reviews or monographs mostly exceeding 50 quotations. Recorded are over 1760 citations from the world scientific literature. Thus, there is presented a comprehensive thesaurus of parasitological bibliography.

Part III. on Eukaryotic Parasites is intended to give an introduction to the biology of parasitic protozoans and helminths and their activities as parasites. Part IV. is concerned with the Protozoa and diseases caused by them. Discussed are giardia, leishmaniae, African and American trypanosomes, Trichomonas vaginalis, the malarial plasmodia, Cryptosporidium parvum, Toxoplasma gondii, Entamoeba histolytica, protozoa of minor medical importance and non-pathogenic protozoa. Part V. focuses on roundworms (Nematodes). Described are infections by pinworms, whipworms, ascarids, hookworms, trichinellae, filarial worms, nematodes of minor medical importance and aberrant nematode infections. Part VI. ensures coverage of tapeworms (Cestodes), namelly of the genera Taenia and Diphyllobothrium, tapeworms of minor medical importance and juvenile tapeworm infections (cysticercosis and echinococcosis). Part VII. constitutes a highlight of flukes (Trematodes), namely the schistosomes, liver and lung flukes, and some species of minor medical importance. Part VIII. examines the Arthropods: insects and arachnids, acting as vectors transmitting infectious agents or causing direct injury to human health. Subsequent parts IX. through XI. centre attention upon medical ecology, travel medicine and mode of action of antiparasitic drugs. Supplementary chapters (appendices) offer coverage of drugs for treatment regimes, handling of specimens for routine laboratory diagnostic techniques, and a diagnostic atlas of parasites.

This publication represents a medium sized textbook of medical parasitology and apparently has entered the path of well-established, continuously revised and updated editions. Its special advantage there are extensive full-page plates of parasite life cycles designed originally by J. Karapelou. Most of these have been updated, and all parasite stages in each illustration have been “stained” red. 414 illustrations, 327 in full colour, are composed of line drawings, photographs and microphotographs. This new edition presents a change of publisher, inclusion of an additional author, some new textual parts: sections on cellular and molecular pathogenesis, passages on biochemistry and immunology including topical information on cytokines and other factors, chapters on ecology of parasitic diseases and on travel medicine, a comprehensive list of antiparasitic drugs, and others. Innovation for this edition constitute also some all-page textual boxes entitled “gray matter” summarizing current research. However, a pedantic reader may find several incorrect issues and typographical errors. Some inaccurate terms of previous editions have been eliminated, but some of them can be detected: Loxoceles (nine times) instead of Loxosceles, Naegleria (seven times) instead of Naegleria, Opisthorchis viverini instead of viverini, Schistosoma matthei or matthei instead of mattheei, Spirometra ranorum instead of ranarum, Vaginulus plebeius instead of plebeius. Not insignificant additional misprints appeared in the index. According to International Code of Zoological Nomenclature, in species names a comma should be placed between the name of the author and the year. Schematic line drawings of some arthropods present sheer contours. The price of this volume is very reasonable. Nevertheless, reproductions of some colour photographs are not perspicuous. The authors offer the contents of this textbook to students of parasitic diseases as a supplement to witnessing them first hand at the bedside or in the field.

Jindřich Jira
A review of Chinese *Aphodius* species (Coleoptera: Scarabaeidae).  
Part 6: *A. (Phaeaphodius) plutenkoi* sp. n. from Shaanxi

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*Received September 15, 2001; accepted October 6, 2001
Published April 3, 2002*

**Abstract.** *Aphodius (Phaeaphodius) plutenkoi* sp. n. discovered in the Qinling Shan Mts (China: Shaanxi) is described and its diagnostic characters are illustrated. The new species is the only so far known species of the subgenus with striking dark spot pattern on yellowish brown elytron.

**Taxonomy, new species, Coleoptera, Scarabaeoidea, Aphodiinae, Aphodius, Phaeaphodius, Palaearctic region**

**INTRODUCTION**

According to the recent literature the subgenus *Phaephodius* Reitter, 1892 (genus *Aphodius* Illiger, 1798) is represented by approximately 12 species known to occur the Palaearctic, Oriental and Afrotropical zoogeographical regions (Ahrens & Stebnicka 1997, Balthasar 1964, Dellacasa 1988, 1993, Dellacasa et al. 2001).  
Recently collected material of dung beetles from the Chinese province of Shaanxi contains a new *Phaeaphodius* species described in the present paper.

**MATERIAL AND METHODS**

Specimen chosen for scanning electron micrographs was cleaned by ultrasound. Three specimens (holotype and two paratypes) were dissected for examination of male genitalia.  
The following codes (after Arnett et al. 1993) identify the collections housing the material examined:  
DKCP – Czech Republic, Charles University, Praha, David Král collection;  
KMCT – Japan, Tokyo, Kimio Masumoto collection;  
SJCP – Czech Republic, Praha, Stanley Jakl collection.  
Specimens of the presently described species are provided with one red printed label: “*Aphodius (Phaeaphodius) plutenkoi* sp. n. HOLOTYPUS, ALLOTYPUS or PARATYPUS [with No. and sex symbol for male or female] David Král det. 2002”. Exact label data are cited for all specimens. Remarks of the author are found in square brackets: [p] – data preceding this mark in quotation marks are printed; [h] – the same but handwritten.

*Aphodius (Phaeaphodius) plutenkoi* sp. n.  
(Figs 1–8)

**TYPE MATERIAL.** Holotype (male), allotype (female) and paratypes Nos 1–7 (males), Nos 8–12 (females), labelled: “China – Shaanxi 1900m Taibaishan range 1.–12. 8. [19]99 Houzhenzi vill. V. Siniaev + A. Plutenko lgt.” [p];  
paratype No. 13 (male), labelled: “Qinling Mts. (1400–1600 m) Chang’an, Shaanxi, China 33° 95’ N 108° 80’ E 27.IV.1993 M. Tabano coll.” [h];  
paratype No.14 (male), labelled: “CHINA, 1000–1300 m, Shaanxi, Qinling mts, XUNYANGBA (6 km E), 23.v.–14.vi.2000, V. Kubáň lgt.” [p].  
Holotype, allotype and paratypes Nos 1, 2, 8, 9, 14 in DKCP; paratypes Nos in 3–7, 10–12 in SJCP and paratype No. 13 in KMCT.
DESCRIPTION OF HOLOTYPE. Body length 8.1 mm. Oblong, strongly convex (Fig. 1); dorsal surface entirely bare, except for apical third of elytron microscopically setaceous, shining, except for finely chagrined and alutaceous elytron; colour black, pronotum with yellowish brown marginal band; elytron bicoloured, yellowish brown with darkened sutura and oblique transversal row of 5 small dark spots situated on interval 2–7 medially; extremities brownish to dark brown; setation pale.

Head (Figs 1, 2) trapezoidal, only slightly convex. Clypeal margin distinctly upturned, anteriorly broadly, shallowly emarginate; anterior angle rounded, side almost straight towards gena. Gena regularly rounded, distinctly exceeding eye, separated from clypeal side by slight sinuation. Medial frontal tubercle remarkably developed, with sharp apex; lateral tubercles vague. Clypeal surface covered with double punctation, fine almost regularly spaced punctures separated by approximately 1–2 their diameter intermixed with coarse more densely spaced punctures, punctuation becoming sparser posteriorly of frontal tubercles, coarse punctures here absent.

Pronotum (Figs 1, 3) strongly convex, anteriorly with shallow medial fovea; broadest just before middle of pronotal length, slightly narrowed anteriorly. Anterior angle rounded, only slightly projecting anteriad; sides in dorsal aspect broadly rounded and distinctly diverging towards approximately half of pronotal length, then rounded to slightly emarginate posterior angles; posterior margin broadly rounded, not bisinuate. Lateral and posterior margins remarkably rimmed, marginal line with several coarse densely, regularly spaced punctures. Punctuation of dorsal surface double, consisting of coarse, very irregularly and sparsely spaced punctures, mixed with fine irregularly spaced punctures separated approximately by 2–3 their diameter, punctuation missing in anterior fovea and discally.

Scutellum (Fig. 4) triangulate, sides weakly arcuate, surface with several coarse punctures.

Elytra (Fig. 4) strongly convex, nearly parallel, humerus not denticulate. Striae distinctly impressed, strial punctures moderately deeply impressed, regularly spaced, separated by approximately their diameter, crenating margins of intervals remarkably. Striae 1 and 10 completely developed, reaching nearly apex of elytron; stria 2 joining 3 and 9 just before apex, striae 4–6 a little shortened and confluent subapically, striae 7 and 8 distinctly shortened and confluent approximately in apical 1/6 of elytron length. Stria 8 shortened distinctly before humerus. Intervals distinctly convex, very finely, sparsely punctate. Sutural interval strongly angustate apically.

Macropterous.

Metasternal plate concave, with coarse, sparse, regular punctation, and complete longitudinal line. Abdominal sternites remarkably chagrined, with recumbent short setae.

Femora with fine, sparse and irregularly punctuation. Protibia (Fig. 5) with three sharp external teeth and row of 3 very feebly developed external denticles in basal half; ventromedial edge with several, remarkably irregularly spaced denticles, apical and medial of them remarkably more developed; terminal calcar inserting against emargination between medial and apical external teeth, stout and long, reaching approximately to apical third of protarsomere 2, obtusely angulate apically. Apical margin and two well developed transversal carinae of meso- and metatibia fimbriate densely with setae distinctly inequal in length. Basimesotarsomere longer than superior terminal calcar of mesotibia, inferior terminal spur simply pointed. Basimetasomere (Fig. 6) distinctly longer than superior terminal calcar of metatibia and equal approximately to next three tarsomeres combined.

Aedeagus as in Figs 7, 8.

Variability in males. Body length 7.7–8.3 mm.

Female (body length 7.8–8.2 mm; allotype – 8.0 mm) differs from male as follows: frontal tubercles vague to absent; pronotum without anterior fovea, punctuation of clypeus and pronotum more coarse and dense; terminal calcar of protibia slender, apically pointed; metasternal plate almost flat.

DIFFERENTIAL DIAGNOSIS. Aphodius (Phaeaphodius) plutenkoi sp. n. differs from all so far known Phaeaphodius representatives in combination of the following diagnostic characters: anterior
Figs 1–6. Aphodius (Phaeaphodius) plutenkoi sp. n. (paratype No. 1); 1 – forebody (magnification 30×); 2 – head (43×); 3 – pronotum (60×); 4 – basis of pronotum and right elytron (50×); 5 – right protibia with terminal calcar (95×); 6 – right apex of metatibia with basimetatarsomere and superior terminal calcar (110×). Left anterodorsolateral aspect (1), dorsal aspect (2, 4–6), left lateral aspect (3).
angles of clypeus rounded, frons trituberculate, lateral and basal margin of pronotum completely rimmed, elytron chagrined and alutaceous, elytral intervals remarkably convex. In addition, it is the only so far known species of this subgenus with striking dark pattern on yellowish brown elytron. **DISTRIBUTION.** China: Shaanxi prov.

**COLLECTION CIRCUMSTANCES.** Paratype No. 14 was taken from pitfall trap baited with fish, in a forested area.

**NAME DERIVATION.** Patronymic, dedicated to my friend Andrey Plutenko (Russia: Smolensk) a recognized specialist of Carabidae, and one of the collectors of the new species.

**Acknowledgements**

I am indebted to my friends Stanley Jakl (Praha), Vit Kubáň (Moravian Museum, Brno) and Kimio Masumoto (Tokyo) for making me possible to study interesting material collected in China. My thanks are extended to the staff of the Laboratory of Electron Microscopy (Institute of Parasitology, České Budějovice) for their kind assistance in providing scanning electron micrographs, and to Zuzana Čadová (scientific illustrator, Charles University, Praha) for executing drawings of male genitalia. The study was supported in part by grants from the Charles University Grant Agency (GAUK – 135/2002) and from the Ministry of Education (MŠMT ČR J13 – 9811310004).

**REFERENCES**


Revision of the genus Zodarion (Araneae: Zodariidae) in the Czech and Slovak Republics

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Received September 15, 2000; accepted October 16, 2001
Published April 3, 2002

Abstract. More than 1800 individuals of three species of the genus Zodarion Walckenaer, 1833 collected in the Czech and Slovak Republics were revised. Z. germanicum (C. L. Koch, 1837) was collected in 1870 in the Czech Republic and in 1897 in Slovakia for the first time. Hitherto, this species was recorded from about 50 (Czech Republic) and 80 sites (Slovakia), respectively. This species was most frequently collected from open grassy habitats. Z. rubidum Simon, 1914 was first collected in 1981 in the Czech Republic, and in 1983 in Slovakia. Hitherto, this spider was recorded from 7 (Czech Republic), and 8 sites (Slovakia), respectively. This species was collected from open sparsely covered habitats. Z. italicum Canestrini, 1868 was found very recently in an abandoned stone pit in the Czech Republic. Maps of the records for the Czech Republic and Slovakia and descriptions of the three species are presented.

Distribution, description, Araneae, Zodarion, Palaearctic region

INTRODUCTION

Zodariidae has long been a poorly known spider family. A generic revision of this family was made recently. Based on a cladistic analysis, Jocqué (1991) defined six subfamilies and 47 genera, which include about 500 species worldwide. Representatives of Zodariidae can be distinguished from other spiders by the absence of a gnathocoxal serrula, the presence of anterior spinnerets, which are longer than the other spinnerets, and the lateral implantation of the teeth on the tarsal claws (Jocqué 1991).

The most derived genus of the 47 genera is Zodarion Walckenaer, 1833. There are about 50 species of this genus in Europe; 47 species (belonging to six groups) are reported from Western and Central Europe (Bosmans 1993, 1997) and three other species were reported from the Balkans (Deltchev 1987). From the Central Europe only the following four species are so far known: Zodarion germanicum, Z. rubidum, Z. hamatum and Z. italicum. Before 1990 only Z. germanicum was known to occur in the Czech Republic and Slovakia. This species belongs to the “Z. germanicum” species group (Bosmans 1997). In 1991 another species, Z. rubidum, of the “Z. rubidum” species group, was discovered in south Moravia (Pekár 1994). This species has spread during the last three decades from South to Central Europe including Austria (Wunderlich 1973), Germany (Broen & Moritz 1987), Switzerland (Maurer & Hänggi 1990), Poland (Woźny & Siwek 1995) and Hungary (Samu & Szinetár 1999). Only very recently another species, Z. italicum from the “Z. italicum” species group, was found in the Czech Republic (Řezáč 2001).
MATERIAL

During more than a hundred years of arachnological survey in the Czech Republic and Slovakia there were up to 2200 individuals of zodariid spiders collected. Because the widely used identification-key for spiders (Miller 1971) includes only a verbal description of one species (Z. germanicum), misidentifications were likely. Therefore, the objective was to revise as many specimens as possible. However, about one-fourth of all the collected material, particularly that from Northern Moravia, was unavailable. Records of these specimens thus remain unverified. In total, I was able to revise 263 records (1844 specimens): 69 records (395 specimens) of Z. germanicum from the Czech Republic, 135 records (1134 specimens) of this species from Slovakia, 25 records (112 specimens) of Z. rubidum from the Czech Republic, 32 records (196 specimens) of this species from Slovakia, and two records (7 specimens) of Z. italicum from the Czech Republic.

Records for the Czech Republic are localised according to phytogeographical units (Anonymus 1987) while the records for Slovakia are localised according to geomorphological units (Anonymus 1980).

The structure of palps and epigynes were examined under a scanning electron microscope (JOEL JSM 6400).

The body parts were dried at room temperature, mounted and oriented on stubs and sputtered coated with gold.

Abbreviations used


Enyo germanica: Barta 1868: 141.


DESCRIPTION. Prosoma: Dark brown, anterior head margin rather square (Fig. 1). Opisthosoma: dark sepia-brown dorsally, white ventrally (Fig. 2). The white spot on the ventral side extends to the sides and reaches less than half way up the sides of the opisthosoma (Fig. 3). Legs: Cx and Tr pale, Fe dark brown, Pt and Ti brown, Mt and Ta yellow. Male. Total body length 3.2–3.7 mm. Palp: Tegulum strongly protruding, retinaculum L-shaped, embolus stiliform hidden behind tegulum and retinaculum (Fig. 7). The distal end of cymbium bears one claw-like spine on the prolateral side (Fig. 8). Tibial apophysis pointed ventrally (Fig. 13). Female. Total body length 3.9–5.1 mm. Epigyne: with large incision, dorsal and lateral rims excavated forming a pouch (Fig. 14).
HABITAT. Collected at various grassy habitats mostly of the steppe character (e. g. Svatoň & Majkus 1988, Gajdoš 1988), but often on rocks (e. g. Růžička et al. 1996, Gajdoš 1991), in meadows (e. g. Gajdoš 1985), pine and oak forest margins (e. g. Buchar 1970, Žitňanská 1981), heath (e. g. Gajdoš 1992), scrub and peat-bog margins (e. g. Bílek 1983).

DISTRIBUTION. This species is distributed throughout the Czech Republic and Slovakia. The first record of this species in the Czech Republic comes from Hanušovická vrchovina (Barta 1868). Hitherto, this species was recorded in the following 54 localities dispersed over 49 squares (including unverified records, Fig. 19): Krkonoše (Schenkel 1929, Bílek, unpubl.), Labské středohoří (Buchar 1979, Buchar & Hajer 1990), Rožďalovická tabule (Buchar 1970), Dolní Pojizeří (Šmelhausová 1995, Kubcová, unpubl., Kůrka, unpubl.), Pardubické Polabí (Dolanský, unpubl.), Bydžovská pánev (Bílek 1973, 1981, Bílek & Bilková 1984), Střední Porošičí (Absolon 1980, Kaučiková 2000), Pražská kotlina (Kůrka 1992, Řezáč 2000, unpubl., Buchar, unpubl., Pekár, unpubl.), Dolní Povltaví (Buchar, unpubl.), Střední Povltaví (Chalupská 1983, Bílek, unpubl., Řezáč, unpubl.), Český kras (Buchar 1961, unpubl., Žďárský, unpubl.), Křivoklátsko (Knobloch 1979, Hotská 1981, Šmaha 1983a, b, 1985, Hasch 1984, Růžička, unpubl.), Branžovský hvozd (Buchar, unpubl.), Českobudějovické Předūšumaví (Růžička, unpubl.), Třebonišská pánev (Buchar 1981, Mähringová 1993), Budějovická pánev (Pavlík 1986), Žďárské vrchy (Kasal, unpubl.), Českomoravská vrchovina (Kůrka 1994), Moravské podhůří Vysočiny (Šinková 1973, Kůrka 1994, Růžička et al. 1996, Buchar, unpubl., Jelínek 1999), Dyjsko-


Figs 7–12. 7–8: *Zodarion germanicum* (C. L. Koch, 1837). 7 – left male palp (ventral view), 8 – distal end of male palp (ventral view); 9–10: *Z. rubidum* Simon, 1914. 9 – left male palp (ventral view), 10 – distal end of male palp (ventral view); 11–12: *Z. italicum* Canestrini, 1868. 11 – left male palp (ventral view), 12 – distal end of male palp (ventral view) (SEM). Scale lines: 0.05 mm.
Fig. 19. Map of records of *Zodarion germanicum* (C. L. Koch, 1837) in the Czech Republic. Shaded – verified records, ? – unverified records.
Fig. 20. Map of records of *Zodarion germanicum* (C. L. Koch, 1837) in Slovakia. Shaded – verified records, ? – unverified records.
Fig. 21. Map of records of *Zodarion rubidum* Simon, 1914 in the Czech Republic. Shaded – verified records, ? – unverified records.

Zodarion rubidum Simon, 1914
(Figs 4–6, 9, 10, 15, 16, 21, 22)

DESCRIPTION. Prosoma: yellowish orange, anterior head margin round (Fig. 4). Opisthosoma: brown dorsally, white ventrally (Fig. 5). The white spot on the ventral side extends beyond half way up the side of the opisthosoma (Fig. 6). Legs: Fe yellowish orange, other segments yellow. The distal end of cymbium bear 3–5 comb-like spines on the prolateral side in each instar (Fig. 10). Male. Total body length 2.2–3.2 mm. Palp: Retinaculum hooked, embolus pointed (Fig. 9). Tibial apophysis bluntly pointed (Fig. 15). Female. Total body length 3.1–4.8 mm. Epigyne: with two median pits (Fig. 16).

HABITAT. This species was found in biotopes with sparse vegetation cover such as sand dunes (e. g. Pekár 1994, Růžička 1998), rocks (e. g. Kůrka 1981) and mining tips (e. g. Krajča 1996).

DISTRIBUTION. In the Czech Republic this species was recorded for the first time at Pražská kotlina (Kůrka 1981). Hitherto it was recorded in 3 more localities (Fig. 21): Dolnomoravský úval (Pekár 1994, unpubl., Růžička 1998), Moravské podhůří Vysočiny (Jelínek 1999), and Pražská kotlina (Řezáč 2001, Pekár, unpubl.). For Slovakia the first record comes from Hronská pahorkatina (Hejkal, unpubl.). Hitherto it was reported from 5 more localities (including one unverified record, Fig. 22): Hornonitrianska kotlina (Pekár 1993, 1994, unpubl.), Podunajská rovina (Krajča 1996, Krajča &
Fig. 23. Map of record of *Zodarion italicum* Canestrini, 1868 in the Czech Republic. Shaded – verified record.

Krumpálová (1998), Malé Karpaty (Gajdoš, unpubl., Prídavka, unpubl.), Považské podolie (Gajdoš, unpubl.), and Borská nížina (Prídavka, unpubl.).

**Material Examined.**

Zodarion italicum Canestrini, 1868  
(Figs 11, 12, 17, 18, 23)

DESCRIPTION. Prosoma: yellowish-brown with dark markings, anterior head margin round. Opisthosoma: brown dorsally, white ventrally. The white band on the ventral side extends beyond half way up the sides of the opisthosoma. Legs: Fe yellowish to brown, other segments yellow. Male. Total body length 2.4 mm. Palp: Retinaculum beak-like, embolus distally bent (Fig. 11). Distal end of cymbium with one strong and 3 comb-like spines on the lateral side (Fig. 12). Tibial apophysis pointed with a submedial tooth (Fig. 17). Female. Total body length 3.1 mm. Epigyne with broad triangular median plate (Fig. 18).

HABITAT. This species was found in an abandoned stone pit in an area with sparse cover of vegetation (Rézáč 2001, Pekár, unpubl.).

DISTRIBUTION. In the Czech Republic it is known only from Pražská kotlina (Fig. 23). It is still not recorded from Slovakia.


KEY TO JUVENILE SPIDERS

1. Prosoma dark brown, anterior head margin rather square (Fig. 1). The white spot on the ventral side of opisthosoma extends to sides and reaches less than half way up the sides of the opisthosoma (Fig. 3). The distal end of cymbium without a spine on the prolateral side. ...................................... Z. germanicum (C. L. Koch, 1837)
   – Prosoma pale to yellow, anterior head margin round (Fig. 4). The white spot on the ventral side of opisthosoma extends beyond half way up the sides of the opisthosoma (Fig. 6). The distal end of cymbium with a few modified spines on the prolateral side. .............................................................. Z. rubidum Simon, 1914

NOTE. Due to lack of immature material of Z. italicum, specimens of this species has not been distinguished from the above two species.

KEY TO ADULT SPIDERS

1. Male: The distal end of cymbium bears one claw-like spine on the prolateral side (Fig. 8). Tibial apophysis pointed ventrally (Fig. 13), tegulum strongly protruding, retinaculum L-shaped, embolus stiliform covered by tegulum and retinaculum (Fig. 7). Female: The distal end of palpal Ta without a spine. Epigyne with large incision, dorsal and lateral rims excavated forming a pouch (Fig. 14). .... Z. germanicum (C. L. Koch, 1837)
   – Male: The distal end of cymbium bears 3–5 comb-like spines on the prolateral side (Fig. 10). Female: Epigyne other than in Z. germanicum. .................................................................................................................... 2

2. Male: Tibial apophysis bluntly pointed (Fig. 15). Retinaculum hooked, embolus pointed (Fig. 11). Female: Epigyne with two median pits (Fig. 16). ......................................................... Z. rubidum Simon, 1914
   – Male: Tibial apophysis pointed with a submedial tooth (Fig. 17), retinaculum beak-like, embolus distally bent (Fig. 11). Female: Epigyne with broad triangular median plate (Fig. 18). ............ Z. italicum Canestrini, 1868

Acknowledgements

I am grateful to A. Kůrka (NMP) and B. Mocek (MHK) for their generous help with the loan of the museum material, and J. Nebesáfová (Institute of Parasitology, České Budějovice) for a help with the scanning electron microscopy. Further, I would like to thank K. Absolon, J. Buchar, J. Dolanský, P. Gajdoš, A. Jelinek, P. Kasal, A. Krajča, L. Kubcová, R. Pridavka, V. Růžička, M. Řezáč, J. Svoatoň, V. Thomka and J. Žďárek for allowing me to examine material from their personal collections. The study was funded by the grant of GA ČR (no. 206/01/P067) and the grant of MU (no. 143100010).


Distribution, skull morphometrics and systematic status of an isolated population of *Apodemus microps* (Mammalia: Rodentia) in NW Bohemia, Czech Republic

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Received October 14, 2001; accepted February 16, 2001
Published April 3, 2002

Abstract. An extensive series of owl pellets collected in Bohemia between 1974–1981 revealed an isolated population of the pygmy field mouse, *Apodemus microps* Kratochvíl et Rosický, 1952 near the town of Žatec, NW Bohemia. The population’s distribution was confined to 25 localities, all within an area of ca. 25×20 km. The region is nearly without woods and strongly agricultural. Altitude ranges mostly between 220–300 m (375 m exceptionally) and the climate is relatively dry and moderately warm. This represents the westernmost population of *A. microps* known, being 190 km from the nearest known Polish population and 230 km from a neighbouring southern Moravian population. One skull and three molar measurements from this population were compared with those from a sample composed of specimens of the nominotypic subspecies from S. Moravia and S. and E. Slovakia. Univariate as well as PC and DF analyses revealed highly significant differences; these suggest a distinct systematic position for the Bohemian population, described here as *Apodemus microps cimrmani* ssp. n.

Taxonomy, skull morphometry, distribution, new subspecies, Rodentia, Muridae, *Apodemus*, Palearctic region

INTRODUCTION

Barn owl (*Tyto alba*) pellets were collected in NW Bohemia, Czech Republic, between 1974–1981. By inspecting church lofts and towers, castles and other buildings suitable for the presence of the Barn owl, we obtained more than 130 pellet samples from 123 localities spread over an area of ca. 2,200 km². Five geographical units (as defined by Balatka et al. 1973) were covered entirely (i.e. Žatecká pánv, Házmberská tabule, Rakovnická pahorkatina, Žihelská pahorkatina and Džbán) also included were adjacent parts of some neighbouring geographical units (Kralovická tabule, Doupovské hory, Kladenská tabule, Chomutovsko-teplická pánv, Milešovské středohoří and Řipská tabule).

Owl pellet analysis revealed the presence of the skull remains of a very small *Apodemus* species which was, according to its molar size and the specific shape of the infraorbital foramen (cf. Cais 1978) identified as the pygmy field mouse, *Apodemus microps* Kratochvíl et Rosický, 1952. In 1979, identification was confirmed by the trapping of specimens.

During the last ten years various Latin names have been suggested for the pygmy field mouse, e.g. *A. uralensis* (Pallas, 1811), *A. mosquensis* (Ognev, 1913), *A. ciscaucasicus* (Ognev, 1924) and *A. volhynensis* (Migulin, 1938). Because there is still no agreement over the validity of these (cf. Voroncov et al. 1992, Orlov et al. 1996, Mežžerin 1997) I prefer to use the traditional name *A. microps* for central European populations, before the thorough taxonomic revision will be available.

The aims of the present paper are: (1) to describe in detail the area of distribution of the westernmost isolate of the pygmy field mouse, (2) to make morphometric comparisons of this
Tab. 1. Number of all mammals, all *Apodemus* (A. sp.), all identified *Apodemus microps*, all identified *A. sylvaticus + A. flavicollis*, and percentage of *A. microps* among identified *Apodemus* spp. in individual samples

<table>
<thead>
<tr>
<th>locality</th>
<th>number of mammals</th>
<th>A. sp.</th>
<th>A. m.</th>
<th>A. s. + A. f.</th>
<th>A. m.</th>
<th>%</th>
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</thead>
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<td>1 Kadaň</td>
<td>62</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>33</td>
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<tr>
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<td>85</td>
<td>1</td>
<td>56</td>
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<td></td>
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<tr>
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<td>393</td>
<td>24</td>
<td>2</td>
<td>9</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>4 Libědice</td>
<td>152</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>5 Žaboklíky</td>
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<td>7</td>
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<td>23</td>
<td></td>
</tr>
<tr>
<td>6 Zatec</td>
<td>718</td>
<td>51</td>
<td>11</td>
<td>24</td>
<td>31</td>
<td></td>
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<tr>
<td>7 Radonice</td>
<td>1030</td>
<td>39</td>
<td>11</td>
<td>15</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>8 Zahořany</td>
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<td>3</td>
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<td>1</td>
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<td></td>
</tr>
<tr>
<td>9 Víškov</td>
<td>26</td>
<td>2</td>
<td>2</td>
<td>–</td>
<td>(100)</td>
<td></td>
</tr>
<tr>
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<td>2</td>
<td>10</td>
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<td>3</td>
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<td>13</td>
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<td>Mašťov (c)</td>
<td>598</td>
<td>69</td>
<td>13</td>
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<td>28</td>
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<td>5</td>
<td>1</td>
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<td>3</td>
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<tr>
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<tr>
<td>22 Soběchleby</td>
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<td>85</td>
<td>1</td>
<td>56</td>
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<tr>
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<td>324</td>
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<td>2</td>
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<td></td>
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<tr>
<td>25 Bílence</td>
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<td>46</td>
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<tr>
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</table>

population with conspecifics from south Moravia and south and east Slovakia, and (3) to check its systematic position.

**MATERIAL AND METHODS**

Barn owl pellets were analysed by hand. All mammal skulls and lower jaws were identified and counted; the number of individuals of a species being taken as the highest value from the number of skulls and left and right lower jaws in a sample. In *Apodemus* skulls, discrimination between *A. microps* and the two other species present in the area (*A. sylvaticus* (Linnaeus, 1758) and *A. flavicollis* (Melchior, 1834)) is easy according to the shape of the infraorbital foramen as described by Cais (1978). This character is usually well preserved – even in heavy damaged skulls. Identification of lower jaws that have been separated from skulls is difficult and often impossible when the molars are missing. Unfortunately, in barn owl pellets, and especially in older and partly decomposed ones, the number of *Apodemus* lower jaws practically always predominates over the number of skulls. Therefore, representation of *A. microps* in the sample was given as the relation between the number of identified skulls of *A. microps* and other two *Apodemus* spp. The number of all *Apodemus* specimens counted according to the number of lower jaws present is denoted as *Apodemus* sp. (cf. Tab. 1).

For morphometric evaluation I used skulls (mostly heavy damaged) obtained from barn owl pellets from NW Bohemia and also the skulls of specimens trapped in east and south Slovakia and south Moravia.

The Bohemian sample consisted of 173 skulls from 20 localities, i.e. from all those given in Tab. 1 with exceptions of localities 8, 12, 15, 21 and 25. From eastern Slovakia I measured skulls from Šaca near Košice (4 spec.), Haniska (7), Královský Chříč (1), Viničky (near Slov. Nové Mesto) (1), Verôške (Slovak Karst) (1),
Domica (3), Turňa n. Bodvou (2), Rimavská Sobota (2), Lúčky (near Michalovce) (1) (n = 22). From south Slovakia, I had skulls from Čálovo (3), Nové Zámky (1) and Dunajská Streda (1) (n = 5). From south Moravia, measured skulls from Lužice and Josefov (near Hodonín) (17), Čejkovice (12), Lednice (26) and Vlasatice (7) (n = 62). Mice from Slovakia were collected between 1953 and 1962, those from south Moravia in 1961 and 1977. Material from Bohemia is deposited in the pellet collection of the Department of Zoology, Charles University, Praha, under sample Nos 130–308. Skulls from Slovakia and Moravia are housed in the Institute of Vertebrate Biology, CAS, Brno, under Nos 373–772.

As the skulls obtained from owl pellets were heavy damaged, only four measurements were used for morphometric evaluation:

1. Length of the maxillary molar row (M1–M3)
2. First upper molar length (M1L)
3. First upper molar width (M1W)
4. Foramina incisiva length (FI)

Measurements were taken under a stereomicroscope with use of the calliper to a precision of 0.1 mm in FI and 0.05 mm in all other measurements. Molar measurements were taken on the crowns of the molars as the maximum distance on the longitudinal (M1–M3, M1L) or perpendicular (M1W) tooth axes. Only molars from the left side of the skull were used, in FI only the left foramen was measured. Age groups were assessed according to molar abrasion as suggested by Steiner (1968).

In the description of the type series (Tab. 3) further measurements and body weights were noted: body weight (W); head and body length (L) – taken from the snout to the anal orifice; tail length (T) – taken from the anal orifice to the tail tip; hind foot length (HF) – taken without the claws; ear length (E), condylobasal length (CBL); zygomatic width (ZG); rostral length (I1–M3) – taken as the distance between the prosthion and the most aboral point on the crown of the left upper M3, as suggested by Tvrtnković (1976).

Morphometric data were subjected to Discriminant Function Analysis (DFA) and to Principal Components Analysis (PCA) using Statgraphics (release 5.0) and Statistica Analysis System (release 6.0).

RESULTS AND DISCUSSION

1. Distribution of Apodemus microps in NW Bohemia

In central Europe the pygmy field mouse inhabits two major areas, i.e. the lowland part of southern Poland and the Pannonian Basin (Mitchell-Jones et al. 1999). These regions are separated by the Carpathians and the north Moravian mountains (Fig. 1). From the north individual populations penetrated southwards into the northern Moravian lowlands (Zejda et al. 1962) and, from the south, northwards into the river valleys of Slovakia (Kratochvíl 1962, Dudich & Štollmann 1979) and to the south- and central Moravian lowlands (Holišová et al. 1962). Isolated populations of unclear origin were also found along the upper forest border in the Tatra Mts (Mošanský 1962, Zima et al. 1984, Haitlinger 1990).

The occurrence of A. microps near the town Žatec in NW Bohemia was mentioned already by Kratochvíl (1962). Analysis of barn owl pellets collected in the period 1977–1980 in this region revealed the presence of this rodent in samples from 25 localities (Fig. 2). However, other samples collected between 1974 and 1981 at 98 localities spread over an extensive area of NW Bohemia did not contain A. microps. Similarly, A. microps was not found in numerous barn owl pellet samples collected between 1978 and 1980 in the valley of the Ohře river, further to the west (Vohralík & Lazarová 1998).

A list of localities and sampling sites where owl pellets containing A. microps skulls were found (Fig. 2) includes: (1) Kadaň, monastery, square 5645 of the faunistic grid mapping system (see Buchar 1982, for details), altitude 300 m, date of collection 14. 2. 1980. (2) Soběsuky, church and rectory building, 5646, 265 m, 9. 3. 1978. (3) Břežany, church, 5646, 225 m, 13. 7. 1978. (4) Libědice, church, 5646, 255 m, 13. 7. 1978. (5) Žabokliky, church, 5647, 247 m, 13. 7. 1978. (6) Žatec, evangelical church, 5647, 260 m, 8. 3. 1978. (7) Radonice, church, 5745, 320 m, 16. 8. 1979. (8) Zahořany, church, 5645, 290 m, 16. 8. 1979. (9) Vilémov, church, 5645, 295 m, 13. 7. 1978. (10) Mašťov, 5745, (a) small church, (b) large church near the rectory, (c) castle, 350–375 m, 2. 3. 1978. (11) Podlesice, church,

The survey of localities where pellet samples did not contain *A. microps* skulls (Fig. 2): 5546 Údlice, Přečaply; 5645 Kadaň (church near rectory building); 5646 Nové Sedlo; 5647 Bitov ales, Hořetice, Libočany, Minice, Nehasice, Vysočany, Žiželice; 5745 Nepomyšl; 5746 Mory; 5747 Deštice, Holodeček, Sírem; 5845 Libyně, Lubeneck, Skytaly; 5847 Běsno, Děkov, Hořovičky, Kněžev, Kolešovice, Vrbice.

![Fig. 1. Distribution of *Apodemus microps* in central Europe, compiled from data of Kratochvil (1962), Holišová et al. (1962), Mošanský (1962), Zejda et al. (1962), Hamar et al. (1966), Steiner (1978), Dudich & Štolmann (1979), Ruprecht (1983), Zima et al. (1984), Haitlinger (1990), Petrov (1992), Kiseljuk (1993), Reiter et al. (1997), and Heroldová et al. (1998). Location of isolated Bohemian population is based on own data. Distributions in Ukraine and Romania should be considered as tentative. The type locality of the species is indicated by an asterisk.](image-url)
Fig. 2. Distribution area of isolated population of *Apodemus microps* in NW Bohemia. Black and white sectors in a ring depict the ratio between identified skulls of *A. microps* and *A. sylvaticus* + *A. flaviollis* in a pellet sample. For locality names and other information see Results and Tab. 1. Asterisks indicate sites where specimens were trapped.
Tab. 2. Standard descriptive statistics for samples of *Apodemus microps* studied (B = Bohemia, M+S = Moravia and Slovakia) – for measurement abbreviations see text

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<tr>
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<th>M1W</th>
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<td></td>
<td>B</td>
<td>M+S</td>
<td>B</td>
<td>M+S</td>
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<tr>
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<tr>
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<td>0.008</td>
<td>0.012</td>
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Fig. 3. Distribution of the length of the maxillary molar row (above) and the foramina incisiva length (below) in *Apodemus microps* samples studied.
The distribution of *A. microps* was confined to the low lying and poorly wooded region demarcated in the west by the Doupovské hory Mts. and in the south and south-east by the woody landscapes of the Rakovnická pahorkatina Highland. The area’s northern limit is most probably formed by the Ohře river. From the ratio between *A. microps* and the other two *Apodemus* spp. (Tab. 1, Fig. 2) it is clear that the core distribution area lay in the triangle closed by the Ohře and Blšanka rivers and the Doupovské hory Mts. Records from outside of this area (i. e. No. 1 – Kadaň, No. 22 – Soběchleby, No. 23 – Želeč and No. 25 – Bílenec) were based only on one or two specimens, so post-mortem transport by barn owls cannot be excluded. On the whole, the area inhabited by this population did not exceed 25 km in length and 20 km wide.

In 1979, specimens of *A. microps* were trapped several times near Žatec and Milčeves (Fig. 2) in field banks covered by grass and various herbaceous vegetation. In 1999, the population was still present in its core area (P. Nová, pers. comm.).

![Fig. 4. Distribution of the first upper molar length (above) and first upper molar width (below) in *Apodemus microps* samples studied.](image-url)
Tab. 3. Body and skull measurements in specimens of the type series (the holotype is indicated by an asterisk). Measurements are given in mm, weights in grams, age group allocation follows Steiner (1968). For further explanation of abbreviations see text.

<table>
<thead>
<tr>
<th>No.</th>
<th>date</th>
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<th>W</th>
<th>L</th>
<th>T</th>
<th>HF</th>
<th>E</th>
<th>CBL</th>
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<td>–</td>
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<td>74</td>
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<td>12.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>11.1</td>
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<td>1.00</td>
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<td>3.40</td>
<td>1.70</td>
<td>1.10</td>
<td>2</td>
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</tbody>
</table>

The climate of this region is dry, with annual precipitation in the *A. microps* core area of less than 450 mm, and between 450 and 500 mm in marginal localities. Summers are moderately warm, winters are mild (Syrový 1958). In Podbořany (locality No 16) average monthly temperatures in January, July and October are –2.5, 17.8 and 7.7 °C, respectively (annual average = 7.8 °C) (Novotný 1971). Soils are black or brown, deep and fertile. During our investigations nearly all the area was covered by large fields; agricultural production was intensive, the main crops being cereals and sugar beet. Altitude varies mostly between 220 and 300 m and, with exception of single locality (No. 10 – Mašťov at 375 m a. s. l.) does not exceed the 350 m contour line (Fig. 2).

![Fig. 5. The scatter diagram for M1L and M1W in *Apodemus microps* samples studied. Means are indicated by asterisk.](image-url)
Fig. 6. a – Results of Principal Components Analysis. b – Box plots of factor scores of the First Principal Component computed for all specimens irrespective of their abrasion category.
The distance of the NW Bohemian isolate from the nearest localities of *A. microps* in SW Poland (Haitlinger 1990) is ca. 190 km, whilst the nearest south Moravian localities (near Znojmo, Dukovaný, and Brno; Reiter et al. 1997, Heroldová et al. 1998, Holišová et al. 1962) are at distances of 230, 230, and 250 km, respectively.

The origin of the Bohemian population is unclear. Recent, long distance migrations (either natural or man made) cannot be excluded. However, also relictual occurrence and an isolation since time of Boreal (cf. Horáček & Ložek 1988) is possible. These hypotheses should be studied further by palaeontological and genetic methods.

2. Morphometric comparison between Bohemian, south Moravian and Slovak populations of *Apodemus microps*

As populations of *A. microps* from south Moravia, south Slovakia and east Slovakia belong to a continuous distributional area within the Pannonian region, we pooled all Moravian and Slovak skulls into single sample. Distributions of the values of the four measurements are given in Figs 3 & 4. Standard descriptive statistics for the study samples are shown in Tab. 2, the scatter diagram for both M1 measurements is in Fig. 5. It is clear that the molars are much smaller in the Bohemian population and, in contrast, the foramen incisivum is shorter in the Slovak and Moravian sample. According to Mann-Whitney U tests, differences in all measurements were highly significant (P < 0.0001). Age composition was not the same in the study samples. While the Bohemian sample contained practically equal numbers of age groups 2, 3, 4 and 5 (only group 6 was less numerous), in the Slovak & Moravian sample younger specimens (group 2) predominated considerably over other age groups. It may be that in the case of the length of the foramen incisivum (which correlates positively with age) unequal age composition may have slightly biased the differences observed, however, the absence of specimens possessing values lower than 4.3 mm in the Bohemian samples (Fig. 3, Tab. 3) suggests that this measurement really is longer in the Bohemian population.

PCA also revealed considerable differences between the two samples and resulted in separation of 84.4% specimens (Fig. 6a). The First Principal Component explained 65.7% and the second one 23.5% of the variation observed. Factor scores of the First Principal Component were further compared between Bohemian and Moravian + Slovak samples. Comparisons computed for all specimens, irrespective of their age (Fig. 6b), revealed similar results to those computed separately either for the lowest abrasion category or for the higher ones (Fig. 7). It is therefore suggested that the differences found between the geographical samples studied were not age biased.

DFA separated the two samples with a high classification success. All but one Bohemian specimen (99.1%, n = 116) and all but five Slovak and Moravian specimens (94.4%, n = 89) were assigned to their appropriate samples (Wilk’s lambda =0.207; F (4,199) = 187.9; P < 0.0001). The classification formula was as follows:

\[ S = -42.70 - 14.61 \times M1 - 10.36 \times FI + 44.66 \times M1L + 62.19 \times M1W \]

S > 0 assigns the specimen to Slovak and Moravian sample, S < 0 to the Bohemian one.

Differences found between Bohemian and Slovak + Moravian samples are surprisingly high – comparable with those often observed between different rodent species. Among possible explanations are long-term isolation, character replacement due to strong competition with the larger *A. sylvaticus*, founder effects or genetic drift in the (originally) very small Bohemian population.

3. Taxonomic status of the Bohemian population of *Apodemus microps*

The name *A. microps* was used for the first time by Kratochvíl & Rosický (1952/53) in the first part of their paper (published in 1952) dealing with the ecology and taxonomy of *Apodemus* spp. in the former Czechoslovakia. The description was based on specimens collected in several localities in
Fig. 7. Box plots of factor scores for the First Principal Component computed for the youngest specimens of abrasion category 2 (upper) and for older specimens of abrasion categories 3, 4, 5 and 6 (below).
the lowlands of SE Slovakia, but neither a type nor type series were designated. The only locality mentioned in first part of the paper, in which the name *A. microps* was introduced, was Šaca, which can therefore be considered as the type locality (Fig. 1). However, from a survey of the materials given in the second part of the same paper it is evident that the authors had at their disposal specimens from the vicinity of three small towns: Šaca and Moldava n. Bodvou (both in the Košice Basin) and Slovenské Nové Mesto (situated about 40–50 km southeast in the east Slovak lowlands). No other name for very small *Apodemus* mice (i.e. those different from *A. flavicollis*, *A. sylvaticus* and *A. alpicola* Henrich, 1952) is available in central Europe. The name *A. parvulus* used by Mošanský (1994) for mountain populations from the Liptovské Tatry Mts., Slovakia, was proposed only conditionally and not accompanied by a proper description; it must therefore be considered as *nomen nudum* (ICZN 1999, Articles 13 and 15).

As the *Apodemus* mice from the NW Bohemian study population differ considerably in skull characters from the nominotypic populations of *A. microps* in the northern part of the Pannonian basin, I am convinced that this merits subspecific ranking.

### Apodemus microps cimrmani ssp. n.

**Type material.** *Holotype:* An adult female (placental scars after at least two litters), No. 01097, skull and skin, collected 17 Oct. 1980 by V. Vohralík ca. 1 km SE of Žatec, Bohemia, 50°19'N, 13°31'E, altitude 270 m (cf. Figs 1, 2). *Paratypes:* Five males and two females (Nos 0928, 0970–0973, 01017, 01098) collected between 19 April 1979 and 17 Oct. 1980 by V. Vohralík and F. Pojer at the same locality as the holotype; 2 males and 1 female (Nos. 0959–0961) collected 13 Nov. 1979 by V. Vohralík in Milčevs, Bohemia, 50°17'N, 13°30'E, altitude 270 m (cf. Fig. 2). With the exception of No. 01017 (skull only) all other paratypes are skulls with accompanying skins.

**Deposition.** The holotype and eight paratypes are housed in the collections of the Department of Zoology, Charles University, Prague. Paratype Nos. 0960 and 0971 are in the collections of the Department of Zoology, National Museum (Natural History), Prague.

**Derivatio nominis.** Patronymic, named after Mr. Jára Cimrman, a famous inventor, traveller and the principal of the touring theatre who, in the beginning of 20th century has operated in Bohemia (cf. Svěrák et al. 1999, Smoljak & Svěrák 2000).

**Differential diagnosis.** A small mouse, distinguished from the nominotypic subspecies by the combination of considerably smaller molars (*M*1–*M*3 = 2.90–3.50 mm, *M*1*L* = 1.35–1.70 mm, *M*1*W* = 0.90–1.10 mm) and longer foramina incisiva (*FI* = 4.3–5.4 mm). For the means and the distribution of values of above measurements and a comparison with a sample of *A. m. microps* from Slovakia and Moravia see Tab. 2 and Figs 3, 4. The classification formula (DFA):

\[
S = -42.70 - 14.61 \times M1–M3 - 10.36 \times FI + 44.66 \times M1L + 62.19 \times M1W
\]

enables separation *A. m. cimrmani* ssp. n. (*S < 0*) and *A. m. microps* (*S > 0*) with the high classification success (the correct identification of 99.1% specimens of *A. m. cimrmani* and 94.4% of specimens of *A. m. microps* in our samples).

**Description** (based on the type series, Tab. 3). Upper side and the flanks are brownish with a visibly dark tinge in the medial part of the head and the body; the belly is lightly grey. Demarcation line between flanks and belly fairly distinct. Yellowish pectoral spot either very small or absent – in our 10 skins it is distinct in only one specimen, rather indistinct in four (including the type) and missing in five. Ears and hind foot very small (length = 11.5–13 mm and 17.3–18.6 mm, respectively). The karyotype of paratype No. 01017 was 2n = 48 (Zima & Macholán 1995).
DISTRIBUTION. Known to be confined to the area of ca. 25 per 20 km, situated near the town Žatec in NW Bohemia, Czech Republic (Fig. 2). This area is isolated from the species’ nearest known localities in Poland and Moravia by ca. 190 km and 230 km, respectively (Fig. 1).

Acknowledgements

For the loans of skulls from Moravia and Slovakia I am indebted to the responsible authorities at the Institute of Vertebrate Biology CAS, Brno and to Miloš Macholán (Brno). I also thank Daniel Frynta and Lukáš Kratochvíl (Praha) who considerably helped with the statistical evaluation, David Král (Praha) for taxonomic discussions, Ivan Horáček (Praha) for valuable comments and Huw I. Griffiths (Kingston upon Hull) who improved the English. The final part of the study was sponsored by the Grant Agency of Charles University (grant No. 230/1999/B BIO) and the MSMT grant No. J13/9811310004.

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