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Staphylinid beetles (Coleoptera, Staphylinidae) recorded by pitfall and light trapping in Mrtvý Luh peat bog

Jaroslav Boháč[1,*] & Aleš Bezděk[2]

[1]Institute of Landscape Ecology, Academy of Sciences of the Czech Republic, Na Sádkách 7, CZ-37005 České Budějovice, Czech Republic
[2]Institute of Entomology, Academy of Sciences of the Czech Republic and Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, CZ-370 05 České Budějovice, Czech Republic
**jardabo@cas.cz*

Abstract
Communities of staphylinid beetles were studied using pitfall and light traps in Mrtvý Luh peat bog in the Bohemian Forest. The methods used for staphylinids trapping influence principally the results of the beetles community structure: three species of staphylinids were found both in pitfall traps and light traps only from total 38. The number of species found by pitfall traps was distinctly lower than by light traps (15 versus 26 species). The number of species differs significantly in the community studied by pitfall trapping in the centre and margin of the peat bog (4 and 13 species). Differently from its margin (1 tyrphophilous species), there were not found any tyrphobionts or tyrphophils in the centre of the peat bog. The myrmecophagous species *Drusilla canaliculata* prevails in the centre of the peat bog. There were no significant differences in the number of staphylinids found in the centre and margin of the peat bog by light traps (19 and 15 species). The dominant species (*Deleaster dichrous* and *Carpelimus* spp.) are good fliers with great migration possibilities. Many other staphylinids kept by light traps are accidental only. Other methods are needed for the study of staphylinid beetles (sifting and tramling).

Key words: Staphylinidae, flight activity, distribution, peat bog, Bohemian Forest

Introduction

The Mrtvý Luh State Nature Reserve (1st zone of the National Park), a montane oligotrophic valley peat bog, is a part of an extensive complex of wetlands, peat bogs and forests situated along the upper Vltava River in the Bohemian Forest. The peat bog is important by unique flora and fauna (Hudec et al. 1995). Only two groups of invertebrates (spiders and moths) were studied more intensively (Novák & Spitzer 1972, Kůrka 1990, Spitzer et al. 1999, 2003). These papers provided clear evidence, that the Mrtvý Luh State Nature Reserve represented a locality of a very high conservation value. Several species strictly associated with peat bog (tyrphobiontic and tyrphophilous species) were recorded, e.g. spiders *Haplodrassus moderatus* Kulcz. and *Savignya frontata* Kulcz., noctuid moths *Eugraphe subrosea* (Steph.) and *Xestia alpicola* (Zetterst.), gelechiid moth *Athrips pruinosella* (Lienig & Zeller). Data dealing with faunistics of braconids were recently added by Lozan (2002).

Beetles of the Mrtvý Luh peat bog have not been studied systematically yet. Only scarce records about the presence of tyrphobiontic carabid beetle *Carabus menetriesii pacholei* Sokolář and several staphylinid beetles (*Phloeonomus pusillus* Grav., *P. punctipennis* Thoms.,

Thinobius atomus Fauv.) in the Mrtvý Luh peat bog were given by Slaba (1972) and Smetana (1964b).

The main aim of this paper is to provide basic faunistic data about staphylinid beetles collected by pitfall and light traps during the years 2000–2002 and compare them with staphylinid assemblages of other central European peat bogs (Smetana 1964a, Frisch 1995).

Study Area

The study area was the Mrtvý Luh State Nature Reserve, a montane oligotrophic valley peat bog, situated in the Bohemian Forest, SW Bohemia (48°52' N, 13°52' E, 740 m a.s.l.). The peat bog is bordered by the streams of Studená and Teplá Vltava and by the railway track Volary – Černý Kříž. It covers an area of approximately 350 ha.

Staphylinid beetles were monitored in two different habitats within the peat bog:

(A) Marginal elfin pine forest. Pine forest forms the marginal belt of the peat bog. Tree layer is dominated *by Pinus rotundata*, ground layer by *Vaccinium vitis-idaea* and *V. myrtillus*. The herb coverage is about 40%. The moss layer is strongly dominated by *Sphagnum angustifolium*, with scattered *S. fallax* and *S. flexuosum*.

(B) Treeless centre. The treeless centre forms the central part of the peat bog. *Vaccinium uliginosum*, *Eriophorum vaginatum* and *Calluna vulgaris* are the most abundant plant species. Plant cover forms about 40% of the total area. The moss layer is dominated by *Sphagnum fuscum*, followed by *S. angustifolium* and *Polytrichum stictum*.

Material and Methods

The species composition and abundance of Staphylinidae have been simultaneously monitored by two types of traps: unbaited pitfall traps and BL-Pennsylvania light traps (8 W black light). Ten unbaited pitfall traps were used in each site for three years (2000–2002). Each trap consisted of a 1000 ml glass bottle (60 mm mouth diameter), partly filled with 4% formalin solution as a preservative liquid. In each site ten traps were placed in the ground in two straight lines at 5 m intervals. One light trap was operated in each site periodically during the whole vegetation season. Eleven samples were taken in 2000, 9 samples in 2001 and 6 samples in 2002. One light trap sample represents 4 night's catch. All pitfall traps were emptied at the same dates as light traps.

Staphylinid beetles were divided to the following groups according to their habitat preferences: forest species, species of open biotopes, species of both forest and open biotopes, hygrophilous species and species tolerant of wetness (Horion 1963, 1965, 1967, Frisch 1995, Koch 1989, Smetana 1961, 1964a, 1964b, 1966). The list of tyrphobiotic and tyrphophilous staphylinid taxa (species closely associated with peat bogs) recorded in Czech Republic was compiled from literature sources (Smetana 1964a, Boháč 1972a, 1972b, 1979, 1982, 1984, 1986, 1988, 1999, 2001, Boháč & Matějíček 2002, 2003).

Results and Discussion

Community of staphylinid beetles in the Mrtvý Luh peat bog

During three years of simultaneous monitoring by pitfall and light traps, 38 species of staphylinids were recorded in the Mrtvý Luh peat bog, 15 species were recorded by pitfall traps, 26 species by light traps. Lists of collected species and their affiliation to the particular ecological groups are given in Tables 1 and 2. The overlap between both collecting methods was very slight, only three species (*Aleochara sparsa*, *Atheta crassicornis* and *A. fungi*) were

collected by pitfall as well as light traps. These species are ubiquitous living both in forest and open areas without special requirements to substrate humidity.

The method used for trapping of staphylinids influence principally the distribution of the beetles in the peat bog. The number of staphylinid species was significantly higher in the margin of the peat bog (13 species) than in the centre (4 species) using pitfall trapping. There were no significant differences in the number of staphylinid species found in the centre and the margin of the peat bog by light traps (19 and 15 species). The good fliers with great migration possibilities prevail in the dominant species captured by light traps (e.g. *Deleaster dichrous* and *Carpelimus* species).

The total number of staphylinids recorded in the Mrtvý Luh peat bog is distinctly lower compared with other investigated peat bog localities. SMETANA (1964a) reported 241 species from peat bog Háječek (Soos) in Western Bohemia. Similarly, FRISCH (1995) quoted 248 species from Roten Moores (Germany). There are two reasons for the differences in the number of found staphylinids. The first one is that both authors (SMETANA 1964a, FRISCH 1995) studied more biotopes besides the centre and margin of the peat bog (e.g. shore of streams, heathlands, birch plots, plots with *Phragmites communis*, *Typha latifolia*, *Carex* spp., Juncaceae, etc.) which host specific staphylinid species.

The second reason of this fact is that pitfall and light trapping is not sufficient for studying the staphylinid fauna properly, because small and light-weight staphylinids are not captured by pitfall trapping. The cited authors used other more effective and usually used method for staphylinids collecting – sifting by sifter and tramling of *Sphagnum*. On the other hand these methods are more destructive to the biotope than ones. Therefore sifting and tramling should be used very carefully in the protected areas. They are suitable for short time faunistical studies but are not recommended for long-term ecological projects with repeated sampling during the whole season.

Staphylinid beetles in pitfall traps

The community of staphylinid beetles differs in the treeless centre of the peat bog and the marginal forested part by the number of species (Table 1). Four staphylinid species were found in the centre and thirteen species in the marginal forested part of the peat bog using pitfall traps. The eudominant species *Drusilla canaliculata* prevails in the centre of the peat bog. This is a eurytopic species living in xerophilous and mesophilous biotopes and penetrating often to light forests (see the characteristics of species below). It is often found in wetlands and also in *Sphagnum*. The species is myrmecophagous and its high abundance is probably connected with numerous nests of ants. The species absent practically in forest biotopes beside of peat bogs in Germany (FRISCH 1995). The other species occurring in the centre of the peat bog are represented by two hygrophilous species (*Paederus riparius* and *Bolitobius formosus*) and one ubiquitous species living both in seminatural and man-made biotopes (*Aleochara sparsa*).

The community of staphylinid beetles of the forested margin of the peat bog collected by pitfall traps is represented by 13 species. Four species (*Drusilla canaliculata, Platydracus fulvipes, Dinothenarus fossor* and *Zyras lugens*) are dominant. The activity of *Drusilla canaliculata* is not so high as in the centre of the peat bog, but nevertheless it is the most numerous species. It is myrmecophagous species together with *Zyras lugens*. Characteristic species of the margin of peat bog are staphylinids living both in forested and unforested areas (8 species). The number of hygrophilous species is low (4 species). Only one species of tyrphophilous staphylinid was found in this place: *Ochthephilum fracticorne*. This species is typical of the centre of the peat bog (SMETANA 1964a, FRISCH 1995).

Table 1. List of staphylinid beetles recorded from the centre and margin of the Mrtvý Luh peat bog by pitfall traps. 1 – forest species, 2 – species of open areas, 3 – species living in forest as well open areas, 4 – hygrophilous species.

			Ecological groups			
Species	**centre**	**margin**	**1**	**2**	**3**	**4**
Aleochara sparsa Heer, 1839	8	6	–	–	+	–
Atheta crassicornis (Fabricius, 1720)	–	5	–	–	+	–
Atheta fungi (Gravenhorst, 1806)	–	4	–	–	+	–
Bolitobius formosus (Gravenhorst, 1806)	2	–	+	–	–	–
Drusilla canaliculata (Fabricius, 1787)	566	43	–	+	–	–
Ochthephilum fracticorne (Paykull, 1800)	–	1	–	+	–	+
Oxytelus rugosus (Fabricius, 1775)	–	1	–	–	+	–
Paederus riparius (Linnaeus, 1758)	1	–	–	+	–	+
Philonthus decorus (Gravenhorst, 1802)	–	2	+	–	–	–
Platydracus fulvipes (Scopoli, 1763)	–	13	+	–	–	–
Quedius fuliginosus (Gravenhorst, 1802)	–	1	–	–	+	+
Quedius paradisianus (Heer, 1839)	–	2	–	–	+	+
Staphylinus fossor (Scopoli, 1772)	–	12	–	–	+	–
Zyras limbatus (Pakull, 1789)	–	5	–	–	+	–
Zyras lugens (Gravenhorst, 1802)	–	12	+	–	–	–

Staphylinids in light traps

The dominant species of staphylinids collected by light traps are represented by *Deleaster dichrous* and two species of the genus *Carpelimus* (*C. rivularis* and *C. impressus*). The first species was not found by other authors studying intensively staphylinid fauna of peat bogs (Roubal 1934, Smetana 1964a, Frisch 1995). This species is broadly distributed in the Palaearctic region living on shores of rivers, streams, lakes and ponds. The species is a good flier often flying during the evening and night on long distances (Horion 1963). The species of the genus *Carpelimus* are living on shores of stream, rivers and ponds in great communities. They are good fliers also (Horion 1963), often sampled by light traps. Other hygrophilous species living on shores of running and standing waters were found in smaller amount (*Bledius gallicus*, other *Carpelimus* species, *Ischnopoda umbratica*, *Neobisnius prolixus*, *Paederus fuscipes*, *Ocalea rivularis*, and *Philonthus quisquiliarius*). Ubiquitous staphylinid species (*Acrotona parens*, *Aleochara* species) were found in single specimens.

Only one relic species of staphylinid beetles in the sense of Boháč (1999) was found – *Ocalea rivularis.* This is a hygrophilous and ripicolous species living mainly in mountains on shaded biotopes (Frisch 1995, Boháč & Matějíček 2003). This staphylinid lives on shores of streams in wet moss, detritus and it is stenotherm species characteristic of biotopes with cold microclimate.

Other species of staphylinid beetles kept by light traps are mostly accidental. The next groups are possible to determine after their ecological characteristics: species living under the bark (*Gabrius expectatus*), ubiquitous species (*Acrotona parens*, *Aleochara* spp., *Atheta* spp.), species living in decaying organic matter, e.g. red deer faeces (*Tachinus lignorum*), mycetophagous species (*Ischnosoma splendidum*), pollen eaters (*Hapalaraea floralis*).

Table 2. List of staphylinid beetles recorded from the centre and margin of the Mrtvý Luh peat bog by light traps. 1 – forest species, 2 – species of open areas, 3 – species living in forest as well open areas 4 – hygrophilous species.

			Ecological groups			
Species	**centre**	**margin**	**1**	**2**	**3**	**4**
Acrotona parens (Mulsant et Rey, 1851)	1	–	–	–	+	–
Aleochara bilineata (Gyllenhal, 1810)	1	–	–	+	–	–
Aleochara lanuginosa Gravenhorst, 1802	6	–	–	–	+	–
Aleochara sanguinea (Linnaeus, 1758)	1	–	–	–	+	–
Aleochara sparsa Heer, 1839	3	2	–	–	+	–
Atheta crassicornis (Fabricius, 1720)	8	0	–	–	+	–
Atheta fungi (Gravenhorst, 1806)	2	0	–	–	+	–
Atheta longicornis (Gravenhorst, 1802)	1	–	–	–	+	–
Atheta nigra (Kraatz, 1856)	–	1	–	+	–	–
Atheta sordidula (Erichson, 1837)	–	1	–	–	+	–
Bledius gallicus (Gravenhorst, 1806)	4	2	–	–	+	+
Carpelimus impressus (Lacordaire in Boisduval et Lacordaire, 1835)	3	15	–	–	+	+
Carpelimus obesus (Keisenwetter, 1844)	–	2	–	–	+	+
Carpelimus rivularis (Motschulsky, 1860)	14	52	–	–	+	+
Carpelimus subtilis (Erichson, 1839)	–	1	–	–	+	+
Deleaster dichrous (Gravenhorst, 1802)	38	36	–	–	+	+
Gabrius expectatus Smetana, 1952	–	2	+	–	–	–
Hapalaraea floralis (Paykull, 1789)	1	1	–	–	+	–
Ischnopoda umbratica (Erichson, 1831)	1	–	–	–	+	+
Ischnosoma splendidum (Gravenhorst, 1806)	1	–	+	–	–	–
Neobisnius prolixus (Erichson, 1840)	–	1	–	–	+	+
Ocalea rivularis (Miller, 1851)	1	–	–	–	+	+
Oxypoda soror (C. G. Thomson, 1855)	–	1	–	–	+	–
Paederus fuscipes (Curtis, 1826)	1	–	–	–	+	+
Philonthus quisquiliarius (Gyllenhal, 1810)	7	–	–	–	+	+
Tachinus lignorum Linnaeus, 1758	1	–	–	–	+	–

The tyrphobionts and tyrphophilous staphylinid beetles occurring in the mountain peat bogs of Czech Republic

A great number of species are hygrophilous and many species are characteristic of various types of wetlands. Staphylinid beetles are very sensitive to the changes of the humidity of ecosystems and landscape (Boháč 1999). The number of staphylinid species found in the Mrtvý Luh peat bog is very low in comparison with other authors (Smetana 1964a, Frisch 1995). We try to create the list of staphylinid beetles with possible occurrence in the Mrtvý Luh peat bog according to literature sources (Smetana 1964a, Boháč 1972, 1984). These species, probably present in the peat bog, were not found by used methods (pitfall and light traps) (Table 3). The reason is that the used methods are not suitable for collecting the tyrphophilous and tyrphobiont species of staphylinids. These species live deep in the mosses and substrate and some of them are able to survive for a long time under the water level (e.g.

Table 3. List of tyrphobionts and tyrphophilous species of staphylinid beetles occurring in the peat bogs of Czech Republic.

Tyrphobionts	**Source**
Mylaena elongata (Matthews, 1838)	Roubal 1934, Horion 1967
Stenus pumilio Erichson, 1839	Roubal 1934, Smetana 1964a
Stenus lustrator Erichson, 1839	Roubal 1934, Smetana 1964a, 1966
Tyrphophilous species	
Acidota crenata (Fabricius, 1792)	Roubal 1934, Smetana 1964a, Boháč 2001
Atheta arctica (Thomson, 1856)	Smetana 1964a, Boháč 1988, 2001
Atheta fallaciosa (Sharp, 1869)	Smetana 1964a
Boreophilia smolkai (Rybinski, 1902)	Benick 1974
Euaesthetus laeviusculus (Mannerheim, 1844)	Roubal 1934, Smetana 1964a
Gymnusa brevicollis (Paykull, 1800)	Smetana 1964, Boháč 1972
Lathrobium rufipenne Gyllenhal,1813	Boháč 1986
Lathrobium sphagnetorum Muona, 1977	Boháč 1986
Mylaena gracilis (Matthews, 1838)	Smetana 1964a
Mylaena intermedia Erichson, 1837	Smetana 1964a
Ochthephilum fracticorne (Paykull, 1800)	Boháč 1986
Philonthus corvinus Erichson, 1839	Smetana 1958, 1964, Boháč 1982
Philonthus nigrita (Gravenhorst, 1806)	Smetana 1958, Boháč 1972
Quedius boopoides Munster, 1922	Smetana 1958
Schistoglossa curtipennis (Sharp, 1869)	Smetana 1964a
Stenus bifoveolatus Gyllenhal, 1827	Smetana 1964, Horion 1967
Stenus brevipennis Thomson, 1851	Smetana 1964a, Boháč & Matějíček 2002
Stenus formicetorum Mannerheim, 1843	Roubal 1934, Smetana 1964a
Stenus kiesenwetteri Rosenhauer, 1856	Smetana 1964a, Boháč unpubl.
Stenus latifrons Erichson, 1839	Roubal 1934, Smetana 1964a

Stenus spp., *Gymnusa* spp., *Myllaena* spp.). This is the reason that these small species are not captured by pitfall traps. Their light activity is low in suitable biotopes and substrate humidity and there are not forced to migrate to other biotopes. In our opinion this is the reason why these species are absent in the light traps.

Noteworthy species

Ecological characteristics and the distribution in Czech Republic are provided for dominant and remarkable species.

Dominant species

Aleochara sparsa Heer, 1839 – eurytopic species living in the nests of mammals, birds and social insects. It is often found in the detritus by old trees, in moss, fungi etc. The species is a predator of flies (Koch 1989). It was found in forests close to peat bogs often in high abundance. Its abundance in the open peat bog is lower (Frisch 1995).

Carpelimus impressus (Lacordaire in Boisduval et Lacordaire, 1835) – eurytopic and hygrophilous species living on sandy and muddy shores of streams and ponds (Koch 1989, Boháč & Matějíček 2003). It has not been mentioned from peat bogs by previous authors (Smetana 1964a, Frisch 1995).

Carpelimus rivularis (Motschulsky, 1860) – eurytopic and hygrophilous species living on a wide spectrum of wet biotopes (shores of streams and rivers, ponds, wet meadows, etc.) (Koch 1989, Boháč & Matějíček 2003). It does not have narrow relationship to peat bogs (Smetana 1964a).

Deleaster dichrous (Gravenhorst, 1802) – hygrophilous species living on shores of streams. It is found in gravel, detritus, moss and under stones (Koch 1989, Boháč & Matějíček 2003). The species is flying during the night often on long distances (Horion 1963). This characteristic helps it to colonize quickly man-made habitats even in industrial areas.

Drusilla canaliculata (Fabricius, 1787) – eurytopic species living in xerophilous and mesophilous biotopes and often penetrating to light forests, meadows, pastures, fields, settlements, ruderals etc. (Koch 1989, Boháč & Matějíček 2003). It is found in wetlands and also in *Sphagnum* species (Frisch 1995). It is myrmecophagous and its high abundance is probably connected with the presence of nests of ants.

Platydracus fulvipes (Scopoli, 1763) – eurytopic hygrophilous species living in forests and on theirs margins, and often penetrating to dispersed belts and on shores of ponds and streams (Koch 1989, Boháč & Matějíček 2003).

Dinothenarus fossor Scopoli, 1772 – eurytopic xerophilous species living in dry forests and theirs margins. It is often observed by nests of ants (Koch 1989, Boháč & Matějíček 2003).

Zyras lugens (Gravenhorst, 1802) – eurytopic myrmecophilous species living by nests of ants (*Lasius fuliginosus*) beside of streams, on margins of forests, in parks and gardens, etc. (Koch 1989, Boháč & Matějíček 2003).

Remarkable species

Gabrius expectatus Smetana, 1952 – eurytopic forest species living under the bark of trees mainly in submountaneous and montaneous areas (Smetana 1958, Koch 1989).

Ocalea rivularis (Miller, 1851) – stenotopic hygrophilous species living on shores of streams and running waters from submontane to alpine areas (Koch 1989, Boháč & Matějíček 2003). It is found in moss and detritus. It prefers soils with calcium (Horion 1967). The species was found in the margin of the peat bog in low abundance (Frisch 1995).

Ochthephilum fracticorne (Paykull, 1800) – hygrophilous species living along the margins of watercourses, in bogs, swamps and wet meadows. It prefers colder submontane biotopes with colder microclimate (Boháč 1986).

Conclusions

1. Methods of beetle collecting influence principally the results of staphylinid communities structure. Three species of staphylinids were found both in pitfall and light traps out of the total of 38 species.
2. There are great differences in the community structure of staphylinids in the centre of the peat bog and in its margin, which was reflected by the pitfall trapping but not found using light traps.
3. Staphylinids collected by light traps are good migrators, and the presence of most of them is accidental in the peat bog.
4. Only one tyrphophilous species (*Ochthephilum fracticorne*) was found during accomplishing the study. The reason is, after our view, that the used methods are not very suitable for the collecting the staphylinids in peat bogs, but very efficient for other groups of insects (e.g. Novák & Spitzer 1972, Spitzer et al. 1999).
5. Other more effective methods are recommended for additional studies (sifting and tramling).

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