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# Distribution and biology of mayflies (Ephemeroptera) of the Czech Republic: present status and perspectives

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The checklist of mayflies of the Czech Republic now comprises 107 species (30 genera, 16 families), 87 spp. found until 1970 (first research period) and 99 after 1970 (second research period). The distribution of these species in principal river basins (Elbe: 95 spp., Danube: 79 spp. and Oder: 55 spp.), their frequency, abundance and spatial distribution (highest richness in the colline zone: 93 spp.) are summarised. Main species traits (current preference, feeding and locomotion types and life cycle) are presented in tables. Saprobiological characteristics, substantially modified or newly suggested in at least 36 spp., are defined according to the Czech Standard. Four species are classified extinct, 7 critically endangered, 7 endangered, 16 vulnerable and 14 near threatened. Long-term changes caused mainly by morphological degradation of potamal watercourses (extinction and area diminishing, re-occurrence at some sites after decades of very scarce frequency or quantitative changes) are discussed.

**Keywords:** Ephemeroptera; Czech Republic; occurrence; species traits; saprobiology; protection

## Introduction

The end of the 1960s undoubtedly represents a certain milestone in the research of the mayfly fauna of the Czech Republic. The monograph by Landa (1969) treated all species so far known from the former Czechoslovakia from the taxonomical point of view and basic data on life cycles including a new classification of the former was published (Landa 1968). Simultaneously, the first phase of extensive faunistic research of aquatic insects (Ephemeroptera, Plecoptera and Trichoptera, started early in the 1950s) at several hundreds of localities evenly spread throughout the whole area had been finished at that time. This gave a chance to define some "zero state" as a base to evaluate long-term changes of both aquatic insect taxocoenes and water habitats in general in the future. Such attempts have been realised by Landa and Soldán (1989) and Soldán

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et al. (1998). The former monograph tried to summarise all historical as well as still not published data on the occurrence of individual species, the latter evaluated and described in detail long-term changes of the Ephemeroptera and Plecoptera taxocenes at 149 selected localities. Distributional maps of 99 species of mayflies accompanied by notes on their spatial distribution and principal species traits, saprobiology and protection status were published by Soldán and Zahrádková (2000).

Since then, new species to the Czech mayfly fauna have been discovered, a large number of additional data accumulated, and semi-quantitative samples taken again at selected localities. However we do not feel this research to be entirely finished, we consider reasonable to briefly summarise recent knowledge and thus to complete a certain phase that might be, with respect to initial data acquired early in the past century, stimulative for evaluating the impact of climate and human activities on aquatic habitats. The objective of this contribution is to (1) complete a checklist of species so far detected, (2) briefly summarise actual data on distribution and its changes in comparison with the "zero state", (3) determine principal species traits, (4) evaluate the individual species from the saprobiological and protection status point of view and (5) comment on the methodical approach of further research including mapping procedure.

## Geographic and hydrological background

The Czech Republic (total area 78,864 km$^2$, 131 inhabitants/km$^2$) is landlocked in Central Europe and supplied solely with atmospheric precipitations. From the geomorphological point of view, the Czech Republic belongs to the Hercynian system (western part) and the Alpine-Himalayan system (eastern part). The elevation ranges from 116 to 1602 m a.s.l., with an average altitude of 430 m. Lowlands (below 200 m a.s.l.) as well as mountains (above 800 m) cover only a small part of the country consisting of three main river basins: the Elbe (Labe, North Sea drainage area, 51,399 km$^2$), the Oder (Odra, Baltic Sea drainage area, 4721 km$^2$) and the Morava (the Danube tributary, Black Sea drainage area, 22,744 km$^2$) (Figure 1).

The Elbe River drains 65% of the area. The length of the river within the state is 370 km with mean annual discharge at the state border of 293 m$^3$/s. The most important tributaries are the Vltava, Sázava, Berounka, Jizera, and Ohře rivers. The Oder River (128 km long within the state with mean annual discharge of 48.1 m$^3$/s at the state border) drains 6% of the whole area. The most important tributaries are the Opava, Ostravice and Olše rivers. Small disjunctive areas along the northern border of the republic and the boundary of the Labe basin also belong to the Odra River basin. The Danube River basin consists of the Morava River basin, small disjunctive areas along the southwestern state border, and the boundary of the Labe River basin covering 29% of the state area. The Morava River (284 km long within the state, mean annual discharge at the state border near Břeclav of 106.7 m$^3$/s) possesses the two most important tributaries: the Bečva and Dyje rivers. Czech Republic is characterised by a vast majority of small and medium-sized permanent running waters with catchment areas of less than 1000 km$^2$ (94% of the territory). The highest Strahler stream order is 8. Typical standing waters are ponds and reservoirs, natural lakes are almost missing.

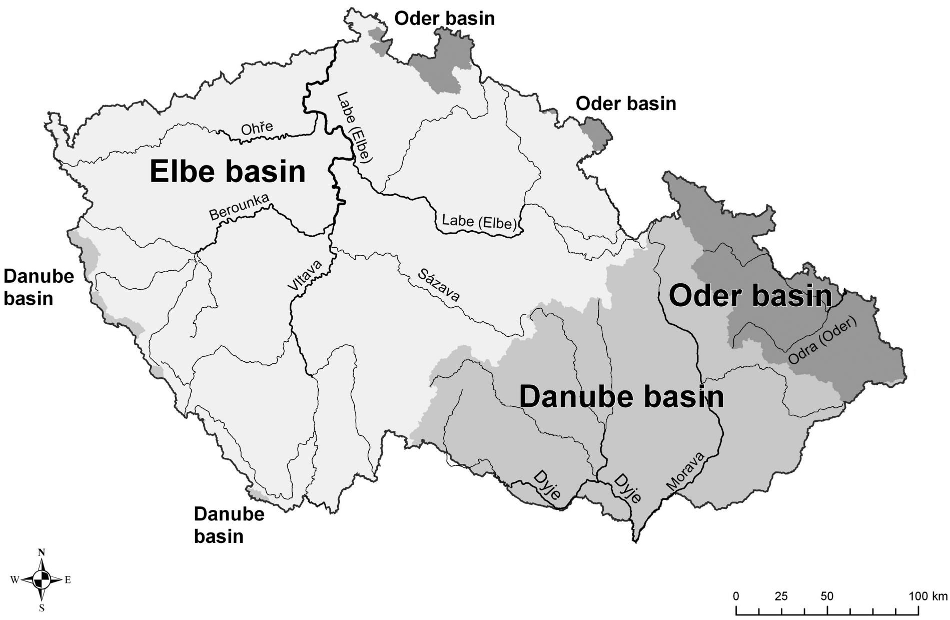
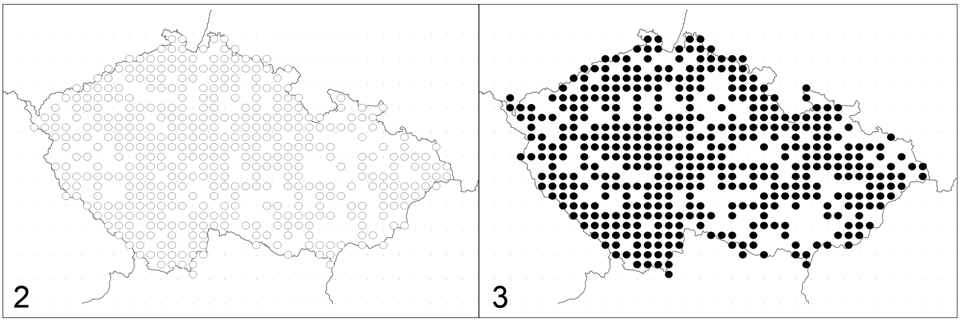



Figure 1. Map of the Czech Republic showing main river basins.

## Sources and periods of research, mapping procedure

The oldest material we possess (collection by V. Landa in the Institute of Entomology; České Budějovice) comes from the 1940s (earlier data are rather scarce) but mostly from the 1950–1960s. The results are summarised (Landa 1969) and supplemented by those of a subsequent phase of faunistic research (1970–1980) by Landa and Soldán (1989). In the 1990s our knowledge has been extended based on new material collected at 149 sites distributed all over the Czech Republic (Soldán et al. 1998) and partially on data from the monitoring of the Ministry of Environment open to the public (1996–2007) and later also enlarged by unpublished data available in museums and universities and recent material being processed now. According to main socioeconomic changes with their impacts on the environment and main phases of sampling, the whole data set was split into two main parts (data collected before and after 1970, so-called "zero state"). All biotic data are supplemented with abiotic data obtained from GIS and from the notes in field protocols as well as accessible results of physicochemical and chemical analyses. Distribution maps of individual species are being arranged using the uniform grid system (squares derived from the geographical coordinates WGS84), with the square dimension of 10 × 6 minutes, i.e. approximately 12 × 11 km (altogether 675 squares in the Czech Republic). Species data were summarised within the two periods of research (ca. 80% of squares covered during the first period (Figure 2), ca. 78% during the secong period (Figure 3)). At present, an extensive research of selected 150 localities (sampled during both periods in all seasons) is being processed. Respective sampling (all seasons in 2006–2008) has been finished.




Figures 2–3. Map of the Czech Republic showing squares of the uniform grid system sampled during (2) the first (until 1970) and (3) the second period of research (after 1970).

**Species diversity, frequency and abundance**

The checklist of mayflies of the Czech Republic (Table 1), now comprising 107 species (30 genera, 16 families), naturally developed gradually. For instance, three species were known in 1860, 10 species in 1900, 33 in 1930, 70 in 1960 and 94 species in 1990. The last checklist consisted of 102 species (Soldán and Zahrádková 2000). Since then two species new to the Czech fauna, namely *Baetis nexus* and *Baetopus tenellus*, have been found (Horsák 2001; Větříček and Geriš 2003) and one species, *Ecdyonurus silvaegabretae*, has been newly described (Soldán and Godunko 2006). Further species, *B. liebenaue* and *B. vardarensis*, have been identified in earlier material (cf. Soldán 2005). The checklist also contains *species inquirendae* (Table 1), namely *Cloeon cognatum, C. inscriptum* and *C. praetextum*, the delimitation of which remains unclear and which, together with *Rhithrogena picteti*, in the larval stage still cannot be reliably distinguished from *C. dipterum*, *C. simile* and *R. iridina*, respectively. Consequently, since our research is based predominantly on larvae we treated them as *Cloeon dipterum* s. lat. (= *C. dipterum* + *C. cognatum* + *C. inscriptum*), *Cloeon simile* s. lat. (= *C. simile* + *C. praetextum*) and *R. iridina* +*R. picteti* (cf. also Sowa 1975; Soldán and Zahrádková 2000). The status of *Electrogena samalorum* (Landa [in Landa and Soldán], 1982) [*Electrogena* sp. (? *samalorum* Landa, 1982) in Table 1] remains unclear. The species is currently considered conspecific with *E. ujhelyii* (Sowa, 1981) [cf. Zurwerra and Tomka (1986: 217)], however comparison of the type material has never been done. There are some apparent morphological differences (especially in larvae and egg chorionic structure) as well as separated populations showing rather different species traits. Larvae of *Electrogena* sp. (cf. *samalorum*) prefer larger streams of meta- and hyporhithral with stony bottoms and adults fly rather earlier while those of ''true'' *E. ujhelyii* colonise mostly epirhithral zones and even hypocrenal localities with gravel bottoms and CPOM (coarse particulate organic matter) and fly rather later).

We do not consider the checklist complete, however, at this moment, we still have not incorporated some additional species into the list since respective material needs to be treated in detail, verified in determination, and compared with still not identified samples to know their actual distribution. The provisionally identified species comprise *Baetis* (*Acentrella*) *inexpectatus* (Tshernova, 1928), *Cercobrachys minutus* (Tshernova, 1952), and *Rhithrogena podhalensis* Sowa & Soldán, 1986 (findings of these species formally published by Soldán 2005). The species of unclear

Table 1. Ephemeroptera of the Czech Republic – checklist, frequency, abundance and distribution of species within the main river basins and periods of research. See text for further details.

| Species | Czech Republic | | | Findings of species in river basin | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Frequency | | | Elbe | | Danube | | Oder | |
| | till 1970 | after 1970 | Abundance | till 1970 | after 1970 | till 1970 | after 1970 | till 1970 | after 1970 |
| *Ameletus inopinatus* Eaton, 1887 | 3 | 4 | 2 | + | + | + | + | + | + |
| *Metreletus balcanicus* (Ulmer, 1920) | – | 1 | 4–5 | – | + | – | + | – | – |
| *Siphlonurus aestivalis* Eaton, 1903 | 3 | 4 | 4–5 | + | + | + | + | – | + |
| *Siphlonurus armatus* Eaton, 1870 | 2 | 1 | 2 | + | + | + | + | – | – |
| *Siphlonurus lacustris* Eaton, 1870 | 4 | 3 | 3 | + | + | + | + | + | – |
| *Siphlonurus alternatus* (Say, 1824) | 3 | 2 | 2 | + | + | + | – | – | – |
| *Ametropus fragilis* Albarda, 1878 | 1 | – | ? | + | – | – | – | – | – |
| *Baetis sinaicus* Bogoescu, 1931 | 1 | 1 | 1 | + | + | – | – | – | – |
| *Baetis alpinus* (Pictet, 1843) | 5 | 5 | 5 | + | + | + | + | + | + |
| *Baetis melanonyx* (Pictet, 1843) | 1 | 2 | 3 | – | + | + | + | – | + |
| *Baetis buceratus* Eaton, 1870 | 1 | 4 | 4 | + | + | – | + | – | + |
| *Baetis nexus* Navás, 1918 | – | 1 | 2–3 | – | – | – | + | – | – |
| *Baetis fuscatus* (Linnaeus, 1761) | 5 | 5 | 5 | + | + | + | + | + | + |
| *Baetis scambus* Eaton, 1870 | 3 | 5 | 5 | + | + | + | + | + | + |
| *Baetis lutheri* Müller – Liebenau, 1960 | 1 | 4 | 4–5 | + | + | + | + | – | + |
| *Baetis vardarensis* Ikonomov, 1962 | 1 | 1 | 4–5 | + | + | – | + | – | – |
| *Baetis liebenauae* Keffermüller, 1974 | – | 1 | 2 | – | + | – | – | – | – |
| *Baetis tracheatus* Keffermüller & Machel, 1967 | 1 | 1 | 1 | + | + | – | – | – | – |
| *Baetis vernus* Curtis, 1834 | 5 | 5 | 5 | + | + | + | + | + | + |
| *Baetis calcaratus* Keffermüller, 1972 | 1 | 2 | 1 | + | + | – | – | – | – |
| *Baetis digitatus* Bengtsson, 1912 | – | 1 | ? | – | – | – | + | – | – |
| *Baetis muticus* (Linnaeus, 1758) | 5 | 5 | 4 | + | + | + | + | + | + |
| *Baetis niger* (Linnaeus, 1761) | 4 | 5 | 3 | + | + | + | + | + | + |
| *Baetis gadeai* Thomas, 1999 [species inquirenda] | 1 | 1 | 1 | + | + | – | + | – | – |
| *Baetis rhodani* (Pictet, 1843) | 5 | 5 | 5 | + | + | + | + | + | + |

(*continued*)

Table 1. (*Continued*).

| Species | Czech Republic: Frequency till 1970 | Czech Republic: Frequency after 1970 | Czech Republic: Abundance | Elbe till 1970 | Elbe after 1970 | Danube till 1970 | Danube after 1970 | Oder till 1970 | Oder after 1970 |
|---|---|---|---|---|---|---|---|---|---|
| *Baetopus tenellus* Albarda, 1978) | – | 1 | 1 | – | – | – | + | – | – |
| *Centroptilum luteolum* (Müller, 1776) | 5 | 5 | 4 | + | + | + | + | + | + |
| *Cloeon dipterum* (Linnaeus, 1761) s. lat. | 5 | 5 | 4 | + | + | + | + | + | + |
| *Cloeon simile* Eaton, 1870 s. lat. | 3 | 2 | 2 | + | + | + | – | + | – |
| *Procloeon bifidum* (Bengtsson, 1912) | 3 | 4 | 3 | + | + | + | + | + | + |
| *Procloeon ornatum* Tshernova, 1928 | – | 1 | 1 | – | – | – | + | – | – |
| *Procloeon nana* (Bogoescu, 1951) | – | 1 | 1 | – | + | – | – | – | – |
| *Procloeon pennulatum* (Eaton, 1970) | 2 | 1 | 1 | + | + | + | – | + | + |
| *Procloeon pulchrum* (Eaton, 1970) | – | 1 | 1 | – | + | – | – | – | – |
| *Isonychia ignota* (Walker, 1853) | 1 | – | ? | + | – | + | – | – | – |
| *Oligoneuriella rhenana* (Imhoff, 1852) | 3 | 3 | 3 | + | + | + | + | + | + |
| *Arthroplea congener* Bengtsson, 1908 | 1 | 1 | 1 | + | + | + | – | – | – |
| *Ecdyonurus aurantiacus* (Burmeister, 1839) | 2 | 5 | 3 | + | + | – | + | – | + |
| *Ecdyonurus dispar* (Curtis, 1834) | 3 | 5 | 4 | + | + | + | + | + | + |
| *Ecdyonurus insignis* (Eaton, 1870) | 3 | 2 | 2 | + | + | + | + | + | – |
| *Ecdyonurus macani* Thomas & Sowa, 1970 | 1 | 2 | 2 | – | + | – | + | + | + |
| *Ecdyonurus starmachi* Sowa, 1971 | 1 | 3 | 3 | + | + | – | + | – | + |
| *Ecdyonurus submontanus* Landa, 1969 | 3 | 5 | 3 | + | + | + | + | + | + |
| *Ecdyonurus torrentis* Kimmins, 1942 | 4 | 5 | 3 | + | + | + | + | + | + |
| *Ecdyonurus venosus* (Fabricius, 1775) | 5 | 5 | 3 | + | + | + | + | + | + |
| *Ecdyonurus* cf. *austriacus* Kimmins, 1958 | 1 | 2 | 3 | + | + | – | + | – | + |
| *Ecdyonurus silvaegabretae* Soldán & Godunko, 2006 | – | 1 | 3 | – | + | – | – | – | – |
| *Ecdyonurus subalpinus* Klapálek, 1907 | 3 | 4 | 3 | + | + | + | + | – | + |
| *Electrogena affinis* (Eaton, 1887) | 2 | 4 | 3 | + | + | + | + | + | + |
| *Electrogena lateralis* (Curtis, 1834) | 4 | 4 | 3 | + | + | + | + | + | + |
| *Electrogena quadrilineata* (Landa, 1969) | – | 4 | 3 | – | + | – | + | – | + |

(*continued*)

Table 1. (*Continued*).

| Species | Czech Republic: Frequency till 1970 | Czech Republic: Frequency after 1970 | Czech Republic: Abundance | Elbe till 1970 | Elbe after 1970 | Danube till 1970 | Danube after 1970 | Oder till 1970 | Oder after 1970 |
|---|---|---|---|---|---|---|---|---|---|
| *Electrogena* sp. (?*samalorum* Landa, 1982) | – | 1 | 2 | – | + | – | + | – | – |
| *Electrogena ujhelyii* (Sowa, 1981) | – | 1 | 4–5 | – | + | – | + | – | – |
| *Epeorus assimilis* Eaton, 1885 | 5 | 5 | 3 | + | + | + | + | + | + |
| *Heptagenia coerulans* Rostock, 1878 | 1 | 2 | 2 | + | + | + | + | – | – |
| *Heptagenia flava* Rostock, 1878 | 4 | 4 | 2 | + | + | + | + | + | + |
| *Heptagenia longicauda* (Stephens, 1836) | – | 1 | 1 | – | + | – | + | – | – |
| *Heptagenia sulphurea* (Müller, 1776) | 4 | 5 | 4 | + | + | + | + | + | + |
| *Heptagenia fuscogrisea* (Retzius, 1783) | 2 | 2 | 3 | + | + | + | + | + | – |
| *Rhithrogena landai* Sowa & Soldán, 1986 | 1 | 1 | 2 | + | + | – | + | – | + |
| *Rhithrogena beskidensis* Alba-Tercedor & Sowa, 1987 | 1 | 3 | 3 | – | + | + | + | + | – |
| *Rhithrogena savoiensis* Alba-Tercedor & Sowa, 1987 | 1 | 2 | 4 | + | + | – | + | – | – |
| *Rhithrogena germanica* Eaton, 1885 | 1 | 1 | 2 | + | + | – | – | – | + |
| *Rhithrogena circumtatrica* Sowa & Soldán, 1986 | 1 | 1 | 1 | + | + | + | – | + | + |
| *Rhithrogena corcontica* Sowa & Soldán, 1986 | – | 1 | 1 | – | + | – | – | – | + |
| *Rhithrogena hercynia* Landa, 1969 | 1 | 3 | 4 | + | + | – | + | – | + |
| *Rhithrogena loyolaea* Navás, 1922 | 1 | 1 | 2 | + | + | + | + | – | – |
| *Rhithrogena zelinkai* Sowa & Soldán, 1984 | 1 | 1 | 1 | – | + | + | – | – | – |
| *Rhithrogena carpatoalpina* Kłonowska et al., 1987 | 4 | 5 | 5 | + | + | + | + | + | + |
| *Rhithrogena iridina* (Kolenati, 1839) and *Rhithrogena picteti* Sowa, 1971 | 3 | 5 | 5 | + | + | + | + | + | + |
| *Rhithrogena puytoraci* Sowa & Degrange, 1987 | 1 | 1 | 5 | + | + | – | + | – | – |
| *Rhithrogena semicolorata* (Curtis, 1834) | 5 | 5 | 5 | + | + | + | + | + | + |
| *Choroterpes picteti* (Eaton, 1871) | 2 | 2 | 3 | + | + | + | – | + | – |
| *Habroleptoides confusa* Sartori & Jacob, 1986 | 5 | 5 | 4 | + | + | + | + | + | + |
| *Habrophlebia fusca* (Curtis, 1834) | 4 | 4 | 3 | + | + | + | + | + | + |
| *Habrophlebia lauta* Eaton, 1884 | 5 | 5 | 3 | + | + | + | + | + | + |

(*continued*)

Table 1. (*Continued*).

| Species | Czech Republic | | | Findings of species in river basin | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Frequency | | | Elbe | | Danube | | Oder | |
| | till 1970 | after 1970 | Abundance | till 1970 | after 1970 | till 1970 | after 1970 | till 1970 | after 1970 |
| *Leptophlebia marginata* (LINNÉ, 1767) | 5 | 4 | 5 | + | + | + | + | – | + |
| *Leptophlebia vespertina* (LINNAEUS, 1746) | 3 | 1 | 2–3 | + | + | + | – | – | – |
| *Paraleptophlebia cincta* (RETZIUS, 1783) | 2 | 2 | 2–3 | + | + | + | + | + | – |
| *Paraleptophlebia submarginata* (STEPHENS, 1836) | 5 | 5 | 5 | + | + | + | + | + | + |
| *Paraleptophlebia werneri* ULMER, 1919 | 2 | 1 | 1 | + | + | + | – | – | – |
| *Ephemera danica* MÜLLER, 1764 | 5 | 5 | 3 | + | + | + | + | + | + |
| *Ephemera glaucops* PICTET, 1843 | 1 | 1 | 1 | + | + | – | – | – | – |
| *Ephemera lineata* EATON, 1870 | 1 | 1 | 1 | + | + | – | – | – | – |
| *Ephemera vulgata* LINNAEUS, 1758 | 4 | 2 | 2 | + | + | + | + | + | + |
| *Palingenia longicauda* (OLIVIER, 1791) | 1 | – | 5 | – | – | + | – | – | – |
| *Ephoron virgo* (OLIVIER, 1791) | 1 | 2 | 3 | + | + | + | + | – | – |
| *Potamanthus luteus* (LINNÉ, 1767) | 4 | 4 | 4 | + | + | + | + | + | + |
| *Ephemerella ignita* (PODA, 1761) | 5 | 5 | 5 | + | + | + | + | + | + |
| *Ephemerella mesoleuca* (BRAUER, 1857) | 1 | 1 | 1 | – | + | + | + | – | – |
| *Ephemerella mucronata* (BENGTSSON, 1909) | 4 | 5 | 4 | + | + | + | + | + | + |
| *Ephemerella notata* EATON, 1887 | 3 | 2 | 2 | + | + | + | + | + | – |
| *Torleya major* (KLAPÁLEK, 1905) | 4 | 5 | 3 | + | + | + | + | + | + |
| *Brachycercus harrisellus* CURTIS, 1834 | 2 | 1 | 2 | + | + | + | + | + | – |
| *Caenis horaria* (LINNAEUS, 1758) | 4 | 4 | 3 | + | + | + | + | – | – |
| *Caenis lactea* (BURMEISTER, 1839) | 2 | 2 | 2 | + | + | + | + | + | – |
| *Caenis luctuosa* (BURMEISTER, 1839) | 3 | 3 | 3 | + | + | + | + | – | + |
| *Caenis macrura* STEPHENS, 1835 | 4 | 5 | 5 | + | + | + | + | + | + |
| *Caenis pseudorivulorum* KEFFERMÜLLER, 1960 | 3 | 4 | 3 | + | + | + | + | – | + |
| *Caenis pusilla* NAVÁS, 1913 | – | 1 | 2 | – | + | – | + | – | – |
| *Caenis rivulorum* EATON, 1884 | 1 | 1 | 2 | + | + | – | + | – | – |
| *Caenis robusta* EATON, 1884 | 4 | 4 | 3 | + | + | + | + | + | + |
| *Prosopistoma pennigerum* (MÜLLER, 1785) | 1 | – | 1 | + | – | – | – | – | – |
| TOTAL | 88 | 99 | | 82 | 95 | 68 | 79 | 49 | 55 |

distribution include *Oligoneuriella pallida* (Hagen, 1855), *Caenis beskidensis* Sowa, 1973 and *Ecdyonurus carpathicus* Sowa, 1973 from the Jeseníky Mts which had been most probably misidentified earlier (cf. Zahrádková et al. 1999; Soldán and Zahrádková 2000).

The frequency (i.e. number of localities with positive occurrence of the species in question) is determined by means of a slightly modified five-degree scale which is comparable to that applied by Sartori and Landolt (1999) in Switzerland. We prefer this scale since it is constructed especially for mayflies respecting the chorological specificity of the order, and applied in the area of continental Europe of comparable size and similar species composition. Moreover, the total number of evenly distributed localities investigated (up to about 2000) is comparable within the altitudinal zones and habitats. The scale is as follows (cf. Sartori and Landolt 1999): F1 – very scarce (up to 10 localities of occurrence), F2 – scarce (11–25 localities), F3 – medium frequent (26–50 localities), F4 – frequent (51– 100 localities), F5 – very frequent (over 100 localities).

The abundance is understood as the expression of the quantitative presentation of a particular species at a locality and its respective percentage expresses the dominance of a species within the mayfly taxocene. We used usual comparative abundance (dominance) five-degree scale as follows (cf. e.g. Vaňhara and Kubíček 1999, p. 32): A1 – subrecedent (very rare, up to 1.0%); A2 – recedent (rare, 1.1 – 2.0%); A3 – subdominant (fairly numerous, 2.1–5.0%); A4 – dominant (numerous, 5.1–10.0%); A5 – eudominant (common, over 10.0%).

## Long-term changes

The first period of investigation represents the time before the intensive development of industry and agriculture in the Czech Republic in the 1970s and 1980s. During the second period, after some mitigation of organic pollution and acidification in the 1990s, new impacts emerged. The influence of morphology degradation of streams and changed hydrology became more evident and is further intensified by climate changes at present. Changes of environment (local, regional and possibly global as well) are reflected in changes in the structure of taxocenes and species distribution. Altogether 88 species had been recorded in the first period. Of these, 16 were classified as very frequent (Table 1), e.g. *Baetis alpinus*, *Epeorus assimilis*, *Habroleptoides confusa*, *Ephemerella ignita* and nearly a third as very scarce (e.g. most *Rhithrogena* species). A total number of 99 species was recorded in the second period. The lists of both very frequent and very scarce species were similar to those of the first period. Besides these similarities, several more or less apparent differences between both research periods were detected.

In general there are five main types of pronounced distributional or quantitative changes: (1) species recorded in the first period only and/or earlier (e.g. *Prosopistoma pennigerum*, *Palingenia longicauda*, *Isonychia ignota*); (2) species recorded in the second period only (e.g. *Baetis nexus*, *Baetopus tenellus*); (3) species with pronounced area change within the Czech Republic (e.g. *Leptophlebia vespertina*; the whole Elbe basin in the past, only its southern and southeastern part at present (see Figure 4). Since the larvae have disappeared mostly from localities at lower altitudes, some climate changes [warming] might be taken into account); (4) species that re-occurred at a higher number of sites after decades of very scarce frequency of distribution (e.g. *Oligoneuriella rhenana*, *Ephoron virgo*); and (5) species showing

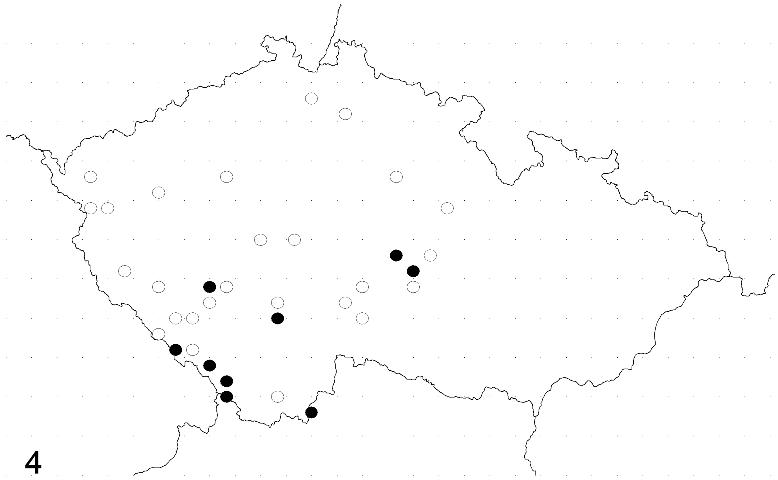



Figure 4. Distribution of *Leptophlebia vespertina*. Empty circle: no data after 1970, full circle: findings after 1970.

apparent changes in quantitative presentation without substantial area changes (e.g. *Leptophlebia marginata*: found at half of localities at present, but still in mass occurrence at respective habitats). Most of these changes have been described in detail by Landa and Soldán (1989), Soldán et al. (1998) and Soldán and Zahrádková (2000).

## Species traits

### *Locomotion types, current preferences and feeding types*

Different types of locomotion are recognised in Table 2:

(1) Fish-like active. Larvae usually live in lenitic habitats and actively swim (Cloeoninae). (2) Fish-like passive. Larvae usually live in lotic habitats, can easily swim, but this type of movement is not usual (Baetinae); or larvae living at streamline (*Isonychia*) that never actively swim. (3) Flattened active. Larvae mostly prefer places with moderate to low current and actively swimming as a way of movement (*Electrogena*). (4) Flattened passive. Larvae prefer streamline with fast to very fast current and never actively swim (*Rhithrogena*). (5) Hydrodynamic. Larvae live in places with very strong current and never occur in other places except for a short period before hatching (*Oligoneuriella*, *Prosopistoma*). Further categories, namely (6) Sprawling and (7) Walking larvae are sometimes difficult to be distinguished. According to Merrit and Cummins (1996), sprawlers inhabit the surface of floating leaves of hydrophytes or fine sediments, usually with modifications for staying on top of the substrate and maintaining the respiratory surfaces free of silt (some Caenidae). Walking larvae (sometimes called climbers) are usually adapted to living on hydrophytes or debris often showing vertical movements (Merrit and Cummins 1996). (8) Burrowing larvae usually make U-shaped tubes in solid, muddy or clayey substrate using gill movement for respiration and filter feeding (most Ephemeroidea). However, this classification seems to be difficult in some cases. For instance, young larvae of *Potamanthus luteus* are burrowers while

Table 2. Some ecological and saprobiological characteristics of the Ephemeroptera species of the Czech Republic. Feeding types and current preferences; according to Schmedtje and Colling (1996), locomotion types modified according to Merrit and Cummins (1996). Saprobic valences modified according to Sládečková et al. (1998). RB (rheobiont), RP (rheophile), RL (rheo- to limnophile), LR (limno- to rheophile), LP (limnophile). Species with substantial modification or saprobial valence newly suggested are marked with asterisk (*).

| | Feeding type | | | | | | | Locomotion type | | | | | | | | Saprobity | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Grazers - Scrapers | Shredders | Gatherers - Collectors | Active filter feeders | Passive filter feeders | Predators | Current preference | Fish-like active | Fish-like passive | Flattened active | Flattened passive | Hydrodynamic | Sprawling | Walking | Burrowing | Xenosaprobity | Oligosaprobity | Betamesosaprobity | Alphamesosaprobity | Polysaprobity | Weighting factor | Saprobic value |
| *A. inopinatus* | 7 | 0 | 3 | 0 | 0 | 0 | RL | 2 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 5 | 0.1* |
| *M. balcanicus* | 5 | 0 | 5 | 0 | 0 | 0 | RL | 3 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 0 | 3 | 0.9* |
| *S. aestivalis* | 1 | + | 9 | 0 | 0 | + | RL | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 2 | 0 | 3 | 2.0 |
| *S. armatus* | 1 | + | 9 | 0 | 0 | + | RL | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8* |
| *S. lacustris* | 1 | + | 9 | 0 | 0 | + | RL | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 2 | 0 | 0 | 3 | 1.0 |
| *S. alternatus* | 1 | + | 9 | 0 | 0 | + | LR | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 0 | 3 | 1.1* |
| *A. fragilis* | 0 | 0 | 10 | 0 | 0 | + | RP | 0 | 5 | 0 | 0 | 0 | 0 | 3 | 2 | | | + | | | | |
| *B. sinaicus* | 5 | 0 | 5 | 0 | 0 | 0 | RB | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | | | | | |
| *B. alpinus* | 5 | 0 | 5 | 0 | 0 | 0 | RB | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 4 | 0 | 0 | 2 | 1.2 |
| *B. melanonyx* | 5 | 0 | 5 | 0 | 0 | 0 | RB | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 4 | 0 | 0 | 0 | 3 | 0.4 |
| *B. buceratus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1* |
| *B. nexus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 3 | 0 | 4 | 2.3* |
| *B. fuscatus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1 |
| *B. scambus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |
| *B. lutheri* | 5 | 0 | 5 | 0 | 0 | 0 | RB | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 6 | 0 | 0 | 3 | 1.6 |
| *B. vardarensis* | 5 | 0 | 5 | 0 | 0 | 0 | RB | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 0 | 4 | 2.2* |
| *B. liebenauae* | 4 | 0 | 6 | 0 | 0 | 0 | RL | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 2.0* |
| *B. tracheatus* | 4 | 0 | 6 | 0 | 0 | 0 | RL | 0 | 10 | 0 | 0 | 0 | + | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1 |

(*continued*)

Table 2. (*Continued*).

| Species | Feeding type | | | | | | Current preference | Locomotion type | | | | | | | | Saprobity | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grazers - Scrapers | Shredders | Gatherers - Collectors | Active filter feeders | Passive filter feeders | Predators | | Fish-like active | Fish-like passive | Flattened active | Flattened passive | Hydrodynamic | Sprawling | Walking | Burrowing | Xenosaprobity | Oligosaprobity | Betamesosaprobity | Alphamesosaprobity | Polysaprobity | Weighting factor | Saprobic value |
| *B. vernus* | 4 | 0 | 6 | 0 | 0 | 0 | RL | 0 | 10 | 0 | 0 | 0 | + | 0 | 0 | 0 | 2 | 6 | 2 | 0 | 3 | 2.0 |
| *B. calcaratus* | 4 | 0 | 6 | 0 | 0 | 0 | RL | 0 | 10 | 0 | 0 | 0 | + | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1* |
| *B. digitatus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | | + | + | | | | |
| *B. muticus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 4 | 0 | 0 | 2 | 1.3 |
| *B. niger* | 4 | 0 | 6 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 1 | 0 | 2 | 1.7 |
| *B. gadeai* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | | + | + | | | | |
| *B. rhodani* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 4 | 1 | 0 | 1 | 1.4 |
| *B. tenellus* | 0 | 0 | 0 | 0 | 0 | 10 | RP | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | | | + | | | | |
| *C. luteolum* | 6 | 0 | 4 | 0 | 0 | 0 | RL | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |
| *C. dipterum* s.l.at | 2 | 0 | 8 | 0 | 0 | 0 | LR | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 3 | 0 | 2 | 2.1 |
| *C. simile* s. lat. | 2 | 0 | 8 | 0 | 0 | 0 | LR | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8 |
| *P. bifidum* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |
| *P. ornatum* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | | + | | | | |
| *P. nana* | 6 | 0 | 4 | 0 | 0 | 0 | RL | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | + | + | | | | |
| *P. pennulatum* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 4 | 0 | 0 | 3 | 1.4 |
| *P. pulchrum* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | + | + | | | | |
| *I. ignota* | 0 | 0 | 0 | 0 | 10 | 0 | RB | 0 | 10 | 0 | 0 | + | 0 | 0 | 0 | 1 | 8 | 1 | 0 | 0 | 4 | 1.0* |
| *O. rhenana* | 0 | 0 | 0 | 0 | 10 | 0 | RB | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |
| *A. congener* | 0 | 0 | 0 | 10 | 0 | 0 | LR | 0 | 0 | 10 | 0 | 0 | + | 0 | 0 | 0 | 4 | 5 | 1 | 0 | 2 | 1.7* |
| *E. aurantiacus* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 3 | 0 | 3 | 2.2 |
| *E. dispar* | 5 | 0 | 5 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |

(*continued*)

Table 2. (*Continued*).

| Species | Feeding type | | | | | | | Locomotion type | | | | | | | | Saprobity | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grazers - Scrapers | Shredders | Gatherers - Collectors | Active filter feeders | Passive filter feeders | Predators | Current preference | Fish-like active | Fish-like passive | Flattened active | Flattened passive | Hydrodynamic | Sprawling | Walking | Burrowing | Xenosaprobity | Oligosaprobity | Betamesosaprobity | Alphamesosaprobity | Polysaprobity | Weighting factor | Saprobic value |
| *E. insignis* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8 |
| *E. macani* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 3 | 0 | 0 | 2 | 1.1 |
| *E. starmachi* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 1 | 0 | 0 | 2 | 0.7* |
| *E. submontanus* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 1 | 0 | 0 | 2 | 0.7 |
| *E. torrentis* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 3 | 0 | 0 | 2 | 1.1 |
| *E. venosus* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 3 | 1 | 0 | 1 | 1.3 |
| *E.* cf. *austriacus* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 2 | 0 | 0 | 2 | 0.9* |
| *E. silvaegabretae* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 6 | 0 | 0 | 0 | 0 | 0.6* |
| *E. subalpinus* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 2 | 0 | 0 | 3 | 1.0* |
| *E. affinis* | 5 | 0 | 5 | 0 | 0 | 0 | RL | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 0 | 3 | 0.8 |
| *E. lateralis* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 4 | 0 | 0 | 2 | 1.3 |
| *E. quadrilineata* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 4 | 0 | 0 | 3 | 1.4* |
| *E.* sp. (?*samalorum*) | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 4 | 0 | 0 | 3 | 1.4* |
| *E. ujhelyii* | 7 | 0 | 3 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 4 | 0 | 0 | 3 | 1.4* |
| *E. assimilis* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 0 | 3 | 0.8 |
| *H. coerulans* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 0 | 4 | 2.2 |
| *H. flava* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1 |
| *H. longicauda* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1 |
| *H. sulphurea* | 6 | 0 | 4 | 0 | 0 | 0 | RP | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |
| *H. fuscogrisea* | 4 | 0 | 6 | 0 | 0 | 0 | RL | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8 |
| *R. landai* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 3 | 4 | 3 | 0 | 0 | 2 | 1.0 |

(*continued*)

Table 2. (*Continued*).

| Species | Feeding type | | | | | | | Locomotion type | | | | | | | | Saprobity | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grazers - Scrapers | Shredders | Gatherers - Collectors | Active filter feeders | Passive filter feeders | Predators | Current preference | Fish-like active | Fish-like passive | Flattened active | Flattened passive | Hydrodynamic | Sprawling | Walking | Burrowing | Xenosaprobity | Oligosaprobity | Betamesosaprobity | Alphamesosaprobity | Polysaprobity | Weighting factor | Saprobic value |
| *R. beskidensis* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 6 | 0 | 0 | 3 | 1.6 |
| *R. savoiensis* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 6 | 0 | 0 | 3 | 1.6 |
| *R. germanica* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 1 | 6 | 3 | 0 | 0 | 3 | 1.2* |
| *R. circumtatrica* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 5 | 0.1* |
| *R. corcontica* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 5 | 0.1* |
| *R. hercynia* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 5 | 0.1* |
| *R. loyolaea* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 5 | 0.0* |
| *R. zelinkai* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 5 | 0.1 |
| *R. carpatoalpina* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 3 | 0.5 |
| *R. iridina* and *R. picteti* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 7 | 3 | 0 | 0 | 0 | 4 | 0.3* |
| *R. puytoraci* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 1 | 6 | 3 | 0 | 0 | 3 | 1.2* |
| *R. semicolorata* | 10 | 0 | + | 0 | 0 | 0 | RB | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 3 | 1.5* |
| *Ch. picteti* | 4 | 0 | 6 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1* |
| *H. confusa* | + | 0 | 10 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 3 | 4 | 2 | 1 | 0 | 1 | 1.1* |
| *H. fusca* | + | 0 | 10 | 0 | 0 | 0 | RL | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 1 | 4 | 4 | 1 | 0 | 1 | 1.5 |
| *H. lauta* | + | 0 | 10 | 0 | 0 | 0 | RL | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 1 | 5 | 3 | 1 | 0 | 1 | 1.4 |
| *L. marginata* | + | 0 | 10 | 0 | 0 | 0 | LR | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 2 | 7 | 1 | 0 | 3 | 1.9 |
| *L. vespertina* | + | 0 | 10 | 0 | 0 | 0 | LR | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8 |
| *P. cincta* | + | 0 | 10 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 4 | 5 | 1 | 0 | 2 | 1.7* |
| *P. submarginata* | + | 0 | 10 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 5 | 4 | 1 | 0 | 2 | 1.6 |

(*continued*)

Table 2. (*Continued*).

| Species | Feeding type | | | | | | | Locomotion type | | | | | | | | Saprobity | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grazers - Scrapers | Shredders | Gatherers - Collectors | Active filter feeders | Passive filter feeders | Predators | Current preference | Fish-like active | Fish-like passive | Flattened active | Flattened passive | Hydrodynamic | Sprawling | Walking | Burrowing | Xenosaprobity | Oligosaprobity | Betamesosaprobity | Alphamesosaprobity | Polysaprobity | Weighting factor | Saprobic value |
| *P. werneri* | + | 0 | 10 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 1 | 6 | 3 | 0 | 0 | 3 | 1.2* |
| *E. danica* | + | 0 | + | 8 | 2 | + | RP | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 1 | 4 | 4 | 1 | 0 | 1 | 1.5 |
| *E. glaucops* | + | 0 | + | 10 | 0 | + | RL | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | | | * | | | | |
| *E. lineata* | + | 0 | + | 8 | 2 | + | RP | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1 |
| *E. vulgata* | + | 0 | + | 10 | 0 | + | RL | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 1 | 6 | 3 | 0 | 3 | 2.2* |
| *P. longicauda* | 0 | 0 | + | 8 | 2 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 1 | 8 | 1 | 0 | 4 | 2.0* |
| *E. virgo* | 0 | 0 | + | 8 | 2 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 0 | 7 | 3 | 0 | 4 | 2.3 |
| *P. luteus* | 0 | 0 | 9 | 1 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 3 | 0 | 1 | 6 | 3 | 0 | 3 | 2.2 |
| *E. ignita* | 5 | + | 5 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 2 | 5 | 3 | 0 | 2 | 2.1 |
| *E. mesoleuca* | 4 | + | 6 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1* |
| *E. mucronata* | 6 | + | 4 | 0 | 0 | 0 | RB | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 5 | 4 | 1 | 0 | 0 | 2 | 0.6* |
| *E. notata* | 6 | + | 4 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 1 | 6 | 3 | 0 | 3 | 2.2 |
| *T. major* | 5 | + | 5 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 1 | 5 | 3 | 1 | 0 | 1 | 1.4 |

(*continued*)

Table 2. (*Continued*).

| | Feeding type | | | | | | | Locomotion type | | | | | | | | Saprobity | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Grazers - Scrapers | Shredders | Gatherers - Collectors | Active filter feeders | Passive filter feeders | Predators | Current preference | Fish-like active | Fish-like passive | Flattened active | Flattened passive | Hydrodynamic | Sprawling | Walking | Burrowing | Xenosaprobity | Oligosaprobity | Betamesosaprobity | Alphamesosaprobity | Polysaprobity | Weighting factor | Saprobic value |
| *B. harrisellus* | + | 0 | 10 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8* |
| *C. horaria* | + | 0 | 10 | 0 | 0 | 0 | LP | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 | 1 | 6 | 3 | 0 | 3 | 2.2 |
| *C. lactea* | + | 0 | 10 | 0 | 0 | 0 | LP | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1* |
| *C. luctuosa* | 2 | 0 | 8 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 0 | 0 | 5 | 5 | 0 | 0 | 3 | 1.5 |
| *C. macrura* | 2 | 0 | 8 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 0 | 1 | 3 | 5 | 1 | 0 | 1 | 1.6 |
| *C. pseudorivulorum* | 3 | 0 | 7 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 3 | 1.5 |
| *C. pusilla* | 2 | 0 | 8 | 0 | 0 | 0 | RL | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 3 | 6 | 1 | 0 | 3 | 1.8 |
| *C. rivulorum* | 3 | 0 | 7 | 0 | 0 | 0 | RP | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 1 | 7 | 2 | 0 | 3 | 2.1 |
| *C. robusta* | + | 0 | 10 | 0 | 0 | 0 | LR | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 | 1 | 6 | 3 | 0 | 3 | 2.2 |
| *P. pennigerum* | 2 | 0 | 6 | 0 | 0 | 2 | RB | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | | | * | | | | |

older ones can be classified as sprawlers. Psammophilous species are often "semiburrowers" (*Ametropus*).

As to current velocity preferences (Table 2), we follow the categories by Schmedtje and Colling (1996): RB (rheobiont, occurring in streams; bound to zones with high current); RP (rheophil, occurring in streams; prefers zones with moderate to high current); RL (rheo- to limnophil, usually found in streams; prefers slowly flowing streams and lenitic zones; also found in standing waters, e.g. *Ameletus, Siphlonurus*; LR (limno- to rheophil, preferably occurring in standing waters but regularly occurring in slowly flowing streams, e.g. *Arthroplea*); LP (limnophil, preferably occurring in standing waters; rarely found in slowly flowing streams, e.g. *Cloeon*, *Caenis horaria*). Rheophilic species (53) and rheobiontic species (23) dominate in the Czech mayfly taxocene.

To classify feeding types (Table 2) we follow the categories defined by Schmedtje and Colling (1996) relevant for mayflies: grazers–scrapers (feeding on attached algae and associated material, typically *Rhithrogena*), shredders (feeding on coarse particulate organic matter, e.g. some Siphlonuridae and Ephemerellidae), gatherers–collectors (feeding on decomposing fine particulate organic matter, e.g. Caenidae, Leptophlebiidae), active (*Arthroplea*, Ephemeroidea) and passive (*Isonychia*, *Oligoneuriella*) filter feeders (of fine particulate organic matter), predators (*Baetopus tenellus*). The grazers–scrapers and gatherer–collectors are frequent feeding types in the Czech mayfly taxocoene.

### *Habitat and zonation preferences*

More than 2000 sampling sites evenly distributed all over the Czech Republic were classified into 11 habitat types (Figure 5): C – crenal (5% of the data set), R – rhithral (53%), P – potamal (19%), CA – canal (5%), A – artificial biotope (1%), LA – lake (<1%), PL – pool (<1%), AS – astatic biotop (2%), W – wetland (<1%), PO – pond (13%), FP – fish pond (<1%).

Habitat (biotope) preferences of individual species (Table 3) were expressed as a percentage of its occurrence at respective biotope types that are defined as follows:

(1) running waters: C (crenal: spring and spring brook); R (rhithral: lotic-erosive biotopes, trout and greyling zones); and P (potamal: lotic-depositional biotopes, barbel and brass zones). The classification of vertical zonation of aquatic habitats follows Illies and Botosaneanu (1963) based mainly on water temperature conditions. However, some biotope types do not fully fit with this classification (e.g. artificial biotopes with relatively warm water – "roach zone", irrigation canals, flumes, mill-races or fishpond out- and inflows), here summarised under the category CA (canal); (2) stagnant waters: A (an artificial impoundment: miscellaneous reservoirs, e.g. reservoirs for water supply or irrigation, flooded quarries and sand pits); LA (a lake or glacial lakes); PL (a pool: permanent stagnant water and backwaters); AS (astatic: temporary or seasonal stagnant waters); W (wetland: mires, mainly bogs); PO (a pond without intensive fish breeding, oligotrophic); FP (fish pond: with intensive fish breeding, eutrophied). The number of species found at habitats was, as follow: C: 27, R: 90, P: 91, CA: 52, A: 20, LA: 4, PL: 21, AS: 3, W: 7, PO: 33, FP: 4.

The elevation (altitudinal) categories of occurrence (Table 3) are defined with respect to average elevation of the area: lowlands (planar) up to 200 m a.s.l.; colline (201–500 m); submontane (501–800 m) and montane (above 800 m). The number of

| Total number of samples | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | R | P | CA | A | LA | PL | AS | W | PO | FP | Total |
| till 1970 | 41 | 2070 | 905 | 256 | 33 | 14 | 45 | 6 | 11 | 484 | 13 | 3878 |
| after 1970 | 13 | 1804 | 695 | 137 | 28 | 3 | 52 | 1 | 2 | 368 | 2 | 3105 |
| Total number of sites | | | | | | | | | | | | |
| | C | R | P | CA | A | LA | PL | AS | W | PO | FP | |
| till 1970 | 15 | 614 | 211 | 66 | 14 | 5 | 26 | 4 | 5 | 139 | 2 | 1101 |
| after 1970 | 7 | 749 | 239 | 62 | 20 | 3 | 26 | 1 | 2 | 177 | 2 | 1288 |

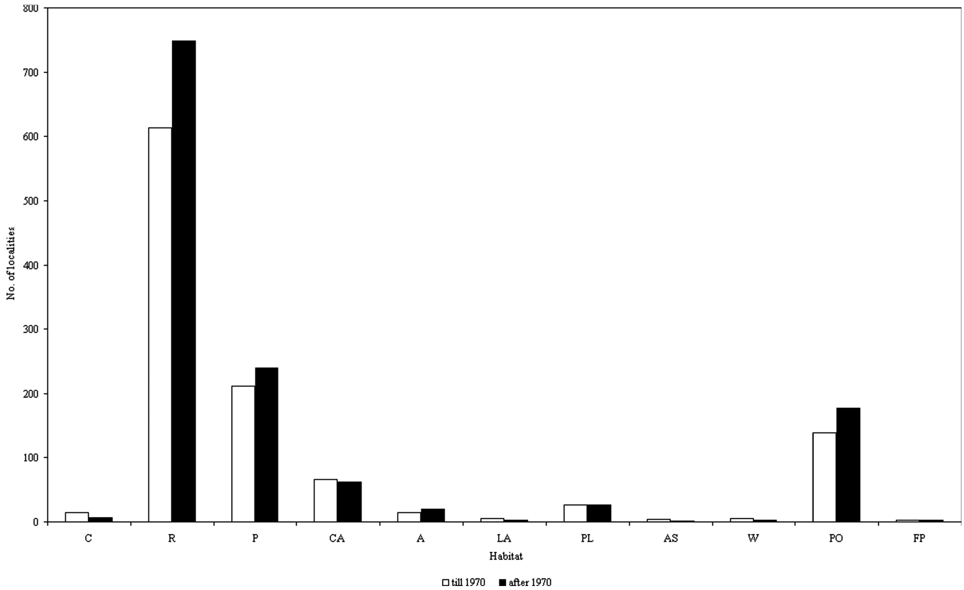



Figure 5. Distribution of sampling sites within the habitat types during the first and second period of research. Habitat types: C, crenal; R, rhithral; P, potamal; CA, canal; A, artificial; LA, lake; PL, pool; AS, astatic; W, wetland; PO, pond; FP, fish pond.

species in altitudinal categories was 71, 93, 85, and 49, respectively, with the highest species richness in the colline zone.

## *Life cycles*

Though Landa's (1968) classification deserves priority, we have followed that by Clifford (1982) since it is widely used in contemporary literature. Most species of the Czech Republic (see Table 3) show seasonal univoltine life cycle either with larval development during winter (Uw, all abbreviations after Clifford 1982) or quick larval development in spring or summer (Us), rarely most of the new generation overwinters in the egg stage but a small part overwinters as larvae (Uw-Us). Numerous species possess a seasonal bivoltine life cycle (MB) either of the "winter" (MBws) or "summer" (MBss) type, the later overwintering in the egg stage. Polyvoltinism (MP) is very rare (*Cloeon dipterum*) as well as a seasonal multivoltine cycle (MB-MP): the species might be bi- or polyvoltine depending on the year, local conditions. In relatively more frequent total uni-multivoltine life cycles (U-MB) they vary between major types of voltinism; in "winter" (Uw-MBws: a seasonal variable life cycle, typically these species have a univoltine winter cycle but there are two summer generations) or "summer" species (Us-MBss: a seasonal variable cycle with

Table 3. Some characteristics of the Ephemeroptera species of the Czech Republic. Vertical zonation: L (lowland), C (colline), S (submontane), M (montane). Habitat preference: C (crenal), R (rhithral), P (potamal), CA (canal), A (artificial), LA (lake), PL (pool), AS (astatic), W (wetland), PO (pond), FP (fish pond). Life cycle type according to Clifford (1982). Protection status according to Soldán (2005), see the text for abbreviations and further details.

| Species | Vertical distribution (%) | | | | Habitat (%) | | | | | | | | | | | Life cycle | | Protection status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | C | S | M | C | R | P | CA | A | LA | PL | AS | W | PO | FP | type | flight period | |
| *A. inopinatus* | 0 | 75 | 19 | 6 | 6 | 80 | 4 | 1.5 | 3 | 1 | 3 | 0 | 0 | 1.5 | 0 | Uw | V–VIII | |
| *M. balcanicus* | 0 | 100 | 0 | 0 | 0 | 75 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | V–VI | VU |
| *S. aestivalis* | 8 | 73 | 18 | 1 | 0 | 31.5 | 31.5 | 12 | 1 | 0 | 11 | 0 | 1 | 11 | 1 | Us–MBss | V–VI | |
| *S. armatus* | 0 | 75 | 19 | 6 | 0 | 25 | 12.5 | 25 | 0 | 0 | 0 | 0 | 0 | 37.5 | 0 | Us | V–VI | |
| *S. lacustris* | 0 | 33 | 37 | 30 | 3 | 67 | 15 | 0 | 1 | 6 | 5 | 0 | 0 | 3 | 0 | Us–Uw (MBws) | VI–VII | |
| *S. alternatus* | 6 | 64 | 19 | 11 | 0 | 8 | 28 | 17 | 0 | 11 | 8 | 0 | 0 | 28 | 0 | Us | V–VI | |
| *A. fragilis* | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ?Uw | V–VI | RE |
| *B. sinaicus* | 0 | 33 | 67 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VI–VII | VU |
| *B. alpinus* | 1 | 40 | 44 | 15 | 2 | 86 | 10 | 2 | <1 | 0 | 0 | 0 | 0 | <1 | 0 | MBws | V–VI, VIII–IX | |
| *B. melanonyx* | 0 | 29 | 57 | 14 | 0 | 93 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | V–VIII | NT |
| *B. buceratus* | 20 | 75 | 5 | 0 | 0 | 15 | 83 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBws | V–VI, VII–VIII | |
| *B. nexus* | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBws | V–VIII | VU |
| *B. fuscatus* | 8 | 81 | 11 | <1 | <1 | 48 | 46 | 6 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | MBws | V–X | |
| *B. scambus* | 5 | 75 | 19 | 1 | 0 | 60 | 40 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBws | V–IX | |
| *B. lutheri* | 10 | 77 | 13 | 0 | 0 | 30 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBws | V–IX | |
| *B. vardarensis* | 10 | 80 | 10 | 0 | 0 | 25 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBws | V–VII | NT |
| *B. liebenauae* | 15 | 75 | 10 | 0 | 0 | 25 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBss | V–VIII | VU |
| *B. tracheatus* | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 67 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | ?MBws | VIII–IX | VU |
| *B. vernus* | 7 | 70 | 18 | 5 | <1 | 62 | 26 | 8 | <1 | 0 | <1 | 0 | <1 | 2 | 0 | MBws (MP) | V–X | |
| *B. calcaratus* | 0 | 92 | 8 | 0 | 0 | 0 | 61 | 31 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | ?MBws | VI–VIII | VU |
| *B. digitatus* | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VIII | VU |
| *B. muticus* | 2.5 | 72 | 24 | 1.5 | 1 | 82 | 15 | 1 | <1 | 0 | <1 | 0 | 0 | <1 | 0 | MBws | V–IX | |
| *B. niger* | 0 | 70 | 26 | 4 | 0 | 72 | 25 | 3 | 0 | 0 | <1 | 0 | 0 | 0 | 0 | MBws | V–VI | |
| *B. gadeai* | 0 | 40 | 60 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ?MBws (MP) | VII–IX | VU |
| *B. rhodani* | 5 | 71 | 22 | 2 | <1 | 77 | 19 | 3 | <1 | 0 | <1 | 0 | 0 | <1 | 0 | MBws (MP) | III–IX | |
| *B. tenellus* | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ?MBss (?Us) | V–VI, VIII–IX | CR |
| *C. luteolum* | 5 | 84 | 10 | 1 | 0 | 63 | 27 | 8 | <1 | 0 | <1 | 0 | <1 | 1 | 0 | MBws (MP) | VI–VII, IX–X | |
| *C. dipterum* s.l.at | 12 | 78 | 10 | <1 | <1 | 17 | 16 | 8 | 4 | 0 | 7 | <1 | <1 | 45 | <1 | MBws | VI–IX | |
| *C. simile* s. lat. | 6 | 78 | 14 | 2 | 0 | 16 | 8 | 4 | 0 | 0 | 6 | 0 | 0 | 66 | 0 | MBws | VI–X | |
| *P. bifidum* | 8 | 85 | 6 | 1 | 0 | 38 | 53 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MBss | VI–VIII | |
| *P. ornatum* | 50 | 50 | 0 | 0 | 0 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ?MBss | V–VII | NT |
| *P. nana* | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ?MBss | V–VI | VU |
| *P. pennulatum* | 12 | 80 | 8 | 0 | 0 | 44 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | Us | VI–VIII | NT |

(*continued*)

Table 3. (*Continued*).

| Species | Vertical distribution (%) | | | | Habitat (%) | | | | | | | | | | | Life cycle | | Protection status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | C | S | M | C | R | P | CA | A | LA | PL | AS | W | PO | FP | type | flight period | |
| *P. pulchrum* | 100 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | MBss | V–VIII | NT |
| *I. ignota* | 67 | 33 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–VIII | RE |
| *O. rhenana* | 9 | 85 | 6 | 0 | 0 | 23 | 77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–VIII | EN |
| *A. congener* | 0 | 67 | 33 | 0 | 0 | 0 | 33.3 | 0 | 0 | 0 | 33.3 | 0 | 0 | 33.3 | 0 | Us | V | VU |
| *E. aurantiacus* | 13 | 80 | 7 | 0 | 0 | 39 | 61 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VIII–IX | |
| *E. dispar* | 3 | 83 | 13 | 1 | <1 | 66 | 31 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–IX | |
| *E. insignis* | 10 | 80 | 10 | 0 | 0 | 29 | 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–X | CR |
| *E. macani* | 12.5 | 75 | 12.5 | 0 | 0 | 69 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | IV–V | NT |
| *E. starmachi* | 2 | 78 | 20 | 0 | 0 | 70 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–VIII | |
| *E. submontanus* | 2 | 61 | 35 | 2 | 0 | 79 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VI–VIII | |
| *E. torrentis* | 1.5 | 82 | 15 | 1.5 | 0 | 80 | 19 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | |
| *E. venosus* | 1 | 57 | 30 | 12 | 2 | 79 | 17 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–X | |
| *E.* cf. *austriacus* | 0 | 0 | 50 | 50 | 5 | 95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–IX | VU |
| *E. silvaegabretae* | 0 | 0 | 0 | 100 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | |
| *E. subalpinus* | 2 | 76 | 20 | 2 | 2 | 93 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw (MBws) | V–VI | |
| *E. affinis* | 1 | 83 | 16 | 0 | 0 | 74 | 24 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VI–VIII | |
| *E. lateralis* | 4 | 83 | 12 | 1 | 3 | 82 | 8 | 4 | <1 | 0 | 0 | 0 | 0 | 2 | 0 | Uw | V–VII | |
| *E. quadrilineata* | 0 | 79 | 21 | 0 | 2 | 91 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–VII | NT |
| *E.* sp. (?*samalorum*) | 0 | 62.5 | 37.5 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VII | NT |
| *E. ujhelyii* | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–VIII | |
| *E. assimilis* | <1 | 60 | 33 | 7 | <1 | 86 | 13 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw (Uw–2Y) | V–VII | |
| *H. coerulans* | 33 | 63 | 4 | 0 | 0 | 4 | 92 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VIII | EN |
| *H. flava* | 18.5 | 76.5 | 5 | 0 | 0 | 25 | 71 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VIII | |
| *H. longicauda* | 0 | 67 | 33 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VIII | EN |
| *H. sulphurea* | 13 | 78 | 9 | 0 | 0 | 33 | 66 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | Uw (MBws) | V–VIII | |
| *H. fuscogrisea* | 0 | 81 | 19 | 0 | 0 | 31 | 46 | 15 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | Uw | V–VI | |
| *R. landai* | 0 | 0 | 50 | 50 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–IX | EN |
| *R. beskidensis* | 4 | 57 | 39 | 0 | 0 | 64 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–IX | NT |
| *R. savoiensis* | 0 | 71 | 29 | 0 | 0 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–IX | NT |
| *R. germanica* | 12.5 | 87.5 | 0 | 0 | 0 | 25 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | II–IV | CR |
| *R. circumtatrica* | 0 | 14 | 43 | 43 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VII–IX | VU |
| *R. corcontica* | 0 | 0 | 75 | 25 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | VU |
| *R. hercynia* | 0 | 37 | 47 | 16 | 0 | 79 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | IV–V | VU |
| *R. loyolaea* | 0 | 14 | 43 | 43 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VIII–IX | VU |
| *R. zelinkai* | 0 | 0 | 50 | 50 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | ?V–VIII | VU |
| *R. carpatoalpina* | <1 | 62 | 32 | 6 | <1 | 89 | 9 | <1 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–IX | |

(*continued*)

Table 3. (*Continued*).

| Species | Vertical distribution (%) | | | | Habitat (%) | | | | | | | | | | | Life cycle | | Protection status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | C | S | M | C | R | P | CA | A | LA | PL | AS | W | PO | FP | type | flight period | |
| *R. iridina* and *R. picteti* | <1 | 56 | 37 | 7 | <1 | 92 | 7 | 0 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VII–IX and V–VI | |
| *R. puytoraci* | 0 | 37.5 | 62.5 | 0 | 0 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | |
| *R. semicolorata* | 2 | 67 | 28 | 3 | <1 | 82 | 16 | <1 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | Uw | V–VII | |
| *Ch. picteti* | 27 | 70 | 3 | 0 | 0 | 7 | 93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–VIII | CR |
| *H. confusa* | 2 | 74 | 22 | 2 | <1 | 85 | 13 | 1 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | Uw | III–VII | |
| *H. fusca* | 6 | 85 | 9 | 0 | <1 | 81 | 11 | 5 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | Uw | VI–VII | |
| *H. lauta* | <1 | 73 | 25 | 2 | <1 | 83 | 14 | 2 | <1 | 0 | 0 | 0 | 0 | <1 | 0 | Uw | VI–VIII | |
| *L. marginata* | 5 | 69 | 25 | 1 | 0 | 41 | 23 | 14 | 1 | 0 | 6 | 0 | <1 | 14 | 0 | Uw | V–VII | |
| *L. vespertina* | 3 | 46 | 34 | 17 | 0 | 27 | 24 | 12 | 0 | 10 | 5 | 2 | 0 | 20 | 0 | Uw | V–VI | |
| *P. cincta* | 3 | 80 | 17 | 0 | 0 | 71 | 20 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VII–IX | |
| *P. submarginata* | 3 | 83 | 14 | 0 | <1 | 66 | 28 | 4 | <1 | 0 | <1 | 0 | 0 | <1 | 0 | Uw | IV–VI | |
| *P. werneri* | 7 | 93 | 0 | 0 | 0 | 50 | 7 | 14 | 0 | 0 | 0 | 7 | 0 | 22 | 0 | Us | V–VI | EN |
| *E. danica* | 4 | 83.5 | 12.5 | <1 | <1 | 73 | 22 | 4 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | 2Y (3Y) | V–VII | |
| *E. glaucops* | 33 | 67 | 0 | 0 | 0 | 33 | 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2Y | VI–VII | CR |
| *E. lineata* | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2Y | VI–VIII | EN |
| *E. vulgata* | 4.5 | 75 | 19 | 1.5 | 0 | 48 | 25 | 14 | 2 | 0 | 0 | 0 | 0 | 11 | 0 | 2Y | V–VII | |
| *P. longicauda* | 100 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3Y | VII | RE |
| *E. virgo* | 38 | 52 | 10 | 0 | 0 | 14 | 86 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us(?) | VII–VIII | CR |
| *P. luteus* | 28 | 68 | 4 | 0 | 0 | 12 | 87 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–VIII | |
| *E. ignita* | 6 | 74 | 19 | <1 | <1 | 64 | 32 | 3 | <1 | 0 | 0 | 0 | 0 | <1 | 0 | Us (MBss) | VI–VIII | |
| *E. mesoleuca* | 40 | 60 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VI | CR |
| *E. mucronata* | 1.5 | 55.5 | 39 | 4 | 0 | 83 | 16 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw (Us) | V–VI | |
| *E. notata* | 5 | 76.5 | 18.5 | 0 | 0 | 47 | 53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | EN |
| *T. major* | 1 | 77 | 21 | 1 | 0 | 70 | 30 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | |
| *B. harrisellus* | 10 | 71 | 19 | 0 | 0 | 29 | 52 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us | VI–IX | NT |
| *C. horaria* | 15 | 67 | 18 | 0 | 0 | 11 | 13 | 8 | 6 | 0 | 5 | 0 | <1 | 57 | <1 | MBws | VI–VIII | |
| *C. lactea* | 6 | 84 | 10 | 0 | 0 | 3 | 6.5 | 0 | 3 | 0 | 0 | 0 | 0 | 87 | 0 | Us (Uw) | VIII–X | NT |
| *C. luctuosa* | 12 | 85 | 3 | 0 | 0 | 43 | 54 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–VII | |
| *C. macrura* | 14 | 77 | 9 | 0 | 0 | 43 | 53 | 2.5 | 0 | 0 | 0 | 0 | 0 | 1.5 | 0 | Uw (MBws) | V–VIII | |
| *C. pseudorivulorum* | 8 | 79 | 12 | 1 | 0 | 41 | 58 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Us, MBss | VI–IX | |
| *C. pusilla* | 0 | 75 | 25 | 0 | 0 | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | VI–VII | NT |
| *C. rivulorum* | 0 | 80 | 20 | 0 | 0 | 60 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Uw | V–VI | NT |
| *C. robusta* | 13 | 76 | 10 | <1 | 0 | 8 | 8 | 7 | 3 | 0 | 4 | <1 | <1 | 68 | <1 | MBws | VI–VIII | |
| *P. pennigerum* | 0 | 50 | 50 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ?Uw, ?Us | VI–VII | RE |

one or two summer generations depending on temperature and habitat condition). A seasonal semivoltine life cycle (Y) was observed in species with a developmental cycle lasting two (2Y) or three (3Y) years. Naturally, in any period of the year larval populations are heterogeneous showing at least three size cohorts. Total uni-semivoltine life cycles (U-Y) includes species varying between major types of voltinism; a seasonal variable life cycle (Uw-2Y) is characterised either by a univoltine winter cycle or a two-year semivoltine cycle, depending on the year and local conditions.

In general, mayfly life cycles show a high plasticity and two or more type can be distinguished in numerous species. In these cases we tried to distinguish ''main'' (i.e. usual or most frequent) and ''accessory'' (i.e. unusual, not frequent and alternative) life cycle (cf. Table 3, life cycle(s) in brackets).

### *Saprobiology*

Saprobial valences are essential information to calculate the saprobic index (the Czech Standard 757716 is currently used). Five different saprobic classes for surface waters have been defined: (1) × – (xenosaprobity); (2) o – (oligosaprobity); (3) b – (betamesosaprobity); (4) a – (alphamesosaprobity); (5) – p (polysaprobity). Ten points were distributed among the classes on the basis of expert knowledge (see Zahradková and Soldán 2008 for details). The saprobic score and the weighting factor were derived for individual species on the respective valence specification according to Czech Standard 830532 (Sládečková et al. 1998). The mayfly list with saprobic valences incorporated into the Czech Standard 757716 (valid at present) was used as basic source. The list of Austrian mayflies (Bauernfeind et al. 1995) and an additional list of saprobial valences (Soldán et al. 1998) were compared and major differences were taken into account. Based on these sources, the list of mayflies and their saprobic valences, weighting factors and saprobic scores was completed and corrected for 36 species (Table 2), since earlier rather different Czech (Czechoslovak) standards were used (cf. Landa and Soldán 1989).

### *Protection status*

As the classification of protection status may differ at the national scale, we generally adopted the largely accepted classification suggested by Baillie and Groombridge (1996) as follows: extinct, EX (species not recorded for the past 30 years); critically endangered, CR (species showing well documented trend to become extinct or solitary, often living at a single locality and showing extremely low population density); endangered, EN (species showing a long-term decline in its occurrences, or living in the ''area pejus'' within the Czech Republic although still abundant in the ''area optimum''); vulnerable, VU (species generally meeting the requirements of the EN category but to an evidently lesser extent) and near threatened, NT (sparsely distributed species of a narrow ecological range, usually subdominant or recessive). This classification is mostly based on the one by Soldán (2005) but is rather simplified in comparison with earlier treatments (Soldán and Zahrádková 2000). We do not distinguish low risk (LR) and data deficient (DD) categories and the species previously classified like that are mostly comprised in the NT (near threatened) category. Naturally, species not marked in Table 3 belong formally to the NE (Not Evaluated species) category.

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