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# Ecology of *Leuctra geniculata* (Plecoptera: Leuctridae), an Atlantomediterranean species on the north-eastern border of its area

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**Abstract:** The first records of *Leuctra geniculata* Stephens, 1836 in the north-eastern border of its area (the Czech Republic) are presented and an overview of references, synonyms and distribution of the species is given. The ecological preferences of the species, supported by chemical and hydromorphological parameters, are defined. Probable dissemination paths into the Czech Republic and the supposed life cycle of the species are discussed. Photographs of morphological characters, SEM photos of eggs, associated macroinvertebrate assemblages (EPT taxa) and maps of distribution are included.

**Key words:** Plecoptera; *Leuctra geniculata*; ecology; first records; Czech Republic

## Introduction

Some rare stonefly species have been found during detailed monitoring of the ecological quality of streams in the Czech Republic. *Capnopsis schilleri* (Rostock, 1892) (Špaček et al. 1999; Helešic et al. 2001) in S Bohemia and *Agnetina elegantula* (Klapálek, 1905) in E Bohemia (Špaček 1998; Špaček et al. 2003) have been recorded. *Leuctra geniculata* Stephens, 1836, a new species for the fauna of the Czech Republic, has been found within various monitoring programmes (PERLA system monitoring, saprobiological monitoring, water authorities' monitoring).

*Leuctra geniculata* was originally described in Great Britain (terra typica) by Stephens (1836) as *Nemoura geniculata*. By the designation of the International Commission on Zoological Nomenclature, the genus name was changed to *Leuctra* (Stephens, 1835) in 1968. Illies (1966) established a new monotypic genus *Euleuctra* for the species but Consiglio (1975) synonymized this genus back to *Leuctra*.

The species was later recorded in the basins of major rivers (the Rhine and its tributaries) in W Europe (Müller-Liebenau 1961; Zwick 1973; Sartori & Ruffieux 1996) and is presently listed in Fauna Europaea (Fochetti & Figueroa 2004) from Spain, Portugal, Switzerland, Austria, Great Britain, Belgium, Luxembourg, Germany, France, Hungary and Romania (records from the last two listed countries are doubtful – see comments given below), although in some countries it was considered extinct, e.g., the Netherlands (Mol 1984). It was also found in Sardinia, Corsica (Consiglio 1975) and N Africa (Aubert 1959). The border of its area lies in the eastern part of the Rhine basin, as well as in the western pre-Alp region (Illies 1955). It was originally classified into the eastern–western group of plecopterans (Illies 1953) and later as an Atlantomediterranean species (Illies 1978). However, there are his-


Fig. 1. The occurrence of *Leuctra geniculata* in Europe with marks for findings outside the conjunctive area: + the first record in the Czech Republic in the river Střela, year: 2003; historical findings in ■ Hungary, year: 1914 and ● Transylvania (Romania), year: 1912.

torical records from Transylvania in Romania (Szilády 1912; Kis 1974) and from the Hungarian plains (Pongrácz 1914). The disjunctive occurrence outside the conjunctive area (Fig. 1) was considered to result from climatic changes after the Pleistocene (Raušer 1962). On the other hand, *L. geniculata* is not mentioned in the checklist of Slovakia (Krno 2003) and the historical records eastwards from Vienna, in Hungary (Pongrácz 1914) and Romania (Kis 1974), were not confirmed by recent records and seem to be doubtful (Raušer 1957; Kis 1974; Illies 1978). In the last few years, Graf (1999) recorded this species in Lower and Upper Austria, and Reusch & Weinzierl (1999) listed it from Germany (Baden-Württemberg, Bavaria, the Rhine basin, the North Rhine-Westfalia region). The Isar River in Munich (Bavaria, Germany) is one of its well-documented sites close to the Czech Republic (Dorn & Weinzierl 1999). Although Raušer (1980) did not specify any site, he anticipated the occurrence of the species on the territory of the Czech Republic. However, a later detailed stonefly monitoring programme between 1994 and 1996 at 149 sites evenly distributed throughout the whole country did not confirm its occurrence (Soldán et al. 1998).

Larvae of *L. geniculata* prefer greater lowland streams and rivers with slower current and a cobble-gravel bottom from hyporhitral to epipotamal zones (Hynes 1941; Berthélemy 1966; Illies 1978; Grauvogl 1992). They were found predominantly at altitudes up to 500 m a.s.l., despite Aubert (1959) mentioning a maximum altitude of 1,000 m a.s.l. or Despax (1951) and Illies (1955) even as high as 1,500 m a.s.l.; e.g., in Sardinia it lives in small springs (Consiglio 1975). Small specimens live among stones and gravel while bigger larvae (over 6 mm) are able to burrow into the sediment (Hynes 1941). According to Elliott (1987), *L. geniculata* is clearly univoltine. Studies by Hynes (1941) and Neveu et al. (1979) have also shown this species to be univoltine, although Hynes (1977) supposed a two-year cycle. The eggs, representing an overwintering stage, hatch in early spring and the last instars occur from June to July. Adult emergence is known to take place from August to November, depending on the region and altitude. Imagos are sporadically found in April and May (Hynes 1977), which may support the possibility of a two-year cycle. According to Graf et al. (2002), the larvae are very probably detritivorous shredders and grazers with a higher preference for algae than other species of the *Leuctra* genus (Hynes 1941).

This paper presents new information on ecological preferences, probable ways of dissemination, associated macroinvertebrate assemblages (Ephemeroptera, Plecoptera and Trichoptera) and the supposed life cycle of *L. geniculata* on the north-eastern border of its conjunctive area.

## Material and methods

The larvae of *L. geniculata* were collected using the PERLA method (Kokeš et al. 2006), i.e., semiquantitative three minute multihabitat kick sampling with use of a pond net (500 $\mu$m mesh size) followed by sorting of the material in laboratory. The rest of samples was taken by the qualitative saprobiological method, i.e., predominant sampling in riffle stretches with only sorting of alive material in the field. Specimens' lengths, maturation stages, dates of records, site characteristics and used sampling methods are presented in Table 1.

Scanning electron microscope photos were taken by SEM JEOL JSM-6300 (critical point dried, gold-coated).

## Results and discussion

*Morphology*

The species is classified into the *L. geniculata* group (Aubert 1954, 1959; Raušer 1962), which is presently considered monotypic (Ravizza 2002). The male of this group is characterized by a single sclerotized process on tergum VI and larvae are, analogously to the *L. braueri* group, characterized by antennae with a whorl of hairs around the apex of each antennal segment (Ravizza 2002). Critical distinguishing characters of *L. geniculata* larvae are as follows: broad, densely haired and with a flattened head (equal in width or wider than the thorax), with pronounced outgrowths on the basal antennal segments 5–18 (Fig. 2) and sparsely haired wing pads. The legs and cerci are densely haired (Fig. 2). The last instar larvae are robust, 8 to 11 mm in body length, strongly haired with a grey-brown colour pattern (Hynes 1977; Raušer 1980; Elliott 1987). Due to the different habitus (robustness, dense hairs) and antennal projections, later larval stages (over 4 mm) are easily distinguishable and confusion with other *Leuctra* species is not likely. Scanning electron microscope photos of ovarioles and the egg capsule with the external chorionic sculpture of *L. geniculata* are presented in Fig. 3. López-Rodríguez et al. (2004) published only optic microscope photos of *L. geniculata* eggs and Ubero-Pascal et al. (2001) took SEM photos of selected chorionic sculptures but did not find specific attachment structures enabling them to be easily distinguished from the eggs of the other species.

*Description and ecological characteristics of the sites in the Czech Republic*

The first record (2003) on the territory of the Czech Republic is from the Střela River (Fig. 4), a left-side tributary of the Berounka River downstream from the city of Plzeň (Pilsen). This earliest seasonal record dates from 27 May when six larvae were found downstream of the weir in the village of Nebřeziny, in a relatively undisturbed stretch of the river (see Table 1 for the site characteristics). More than 30 taxa of macroinvertebrates with a rich EPT (Ephemeroptera, Plecoptera, Trichoptera) fauna (14 taxa) were detected at this site in 2003 (Table 2), including species preferring the hyporhitral zone, such as *Isoperla oxylepis,* or species preferring the epipotamal zone (*Perla burmeisteriana*, *Heptagenia sulphurea*, *Potamanthus luteus*). On 4 September 2004, one female was found at the same site, together with

Table 1. Characteristics of *Leuctra geniculata* finding sites in the Czech Republic ("/" = no data).

| Finding site (no.) | 1 | | 2 | | 3 | 4 | 5 | 6 | 7 | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water course | Střela River | | Malše River | | Zbirožský Brook | Ohře River | Libocký Brook | Ohře River | Labe River | | |
| Site | Nebřeziny | | Roudné | | Čilá | Louny | Libočany | Tvršice | Děčín | | |
| River basin | Berounka | | Vltava | | Berounka | Ohře | Ohře | Ohře | Labe | | |
| Latitude (N) | 49°55′14″ | | 48°56′01″ | | 49°56′19″ | 50°21′28″ | 50°19′57″ | 50°20′26″ | 50°46′48″ | | |
| Longitude (E) | 13°24′58″ | | 14°28′59″ | | 13°44′29″ | 13°48′13″ | 13°30′50″ | 13°35′11″ | 14°12′28″ | | |
| Collected | Horák | Špaček | Lanková | Potužák | Pařil | Skála | Skála | Skála | Špaček | | |
| Determination | Pařil | Špaček | Pařil | Kolářová | Špaček | Skála | Skála | Skála | Špaček | | |
| | 2003 | 2004 | 2004 | 2005 | 2004 | 2004 | 2004 | 2004 | 2005 | | |
| Abiotic parameters | | | | | | | | | | Min. | Max. |
| Altitude (m a.s.l.) | 318 | | 390 | | 325 | 174 | 208 | 194 | 124 | 124 | 390 |
| Strahler order | 5 | | 6 | | 5 | 6 | 5 | 6 | 8 | 5 | 8 |
| $Q_a$ ($m^3$ $s^{-1}$) | 2.9 | | 6.9 | | 0.6 | 35.7 | 1.7 | / | 309.0 | 0.6 | 309.0 |
| Average stream depth (m) | 0.4 | | 0.3 | | 0.2 | 0.4 | 0.3 | 0.5 | 1.5 | 0.2 | 1.5 |
| Average stream width (m) | 14 | | 19 | | 6.5 | 16 | 5.5 | 20 | 75 | 5.5 | 75 |
| Chemical parameters | | | | | | | | | | Min. | Max. |
| pH | | | | | | | | | | | |
| Annual average | / | 8.1 | 7.6 | 7.6 | 8.2 | 7.8 | 8.2 | 7.3 | 7.6 | | |
| Min.–max. | / | 7.6–8.8 | 7.3–7.9 | 7.4–7.7 | 8.1–8.3 | 7.6–8.1 | 7.5–8.5 | 7.0–7.6 | 7.4–9.0 | 7.0 | 9.0 |
| Conductivity (mS $m^{-1}$) | | | | | | | | | | | |
| Annual average | / | 41 | 17 | 16 | 44 | 51 | 66 | 42 | 37 | | |
| Min.–max. | / | 26–55 | 15–20 | 13–19 | 41–48 | 42–57 | 36–91 | 35–52 | 29–43 | 15 | 91 |
| Water temperature (°C) | | | | | | | | | | | |
| Annual average | / | 8.4 | 8.0 | / | / | 10.6 | 9.5 | 8.9 | 12.8 | | |
| Max. | / | 20.0 | 16.6 | / | 16.9 | 16.4 | 21.6 | 16.9 | 22.7 | / | 22.7 |
| BOD (mg $L^{-1}$) | | | | | | | | | | | |
| Annual average | / | 2.2 | 2.4 | 2.7 | / | 2.1 | 3.4 | 1.7 | 3.6 | | |
| Min.–max. | / | 1.1–5.0 | 1.3–5.1 | 1.3–5.3 | / | 1.2–3.8 | 1.5–13.0 | 1.2–2.3 | 1.8–6.7 | 1.1 | 13.0 |
| Dissolved oxygen (mg $L^{-1}$) | | | | | | | | | | | |
| Annual average | / | 11.9 | 11.5 | 11.2 | / | / | / | 12.0 | 10.8 | | |
| Min.–max. | / | 8.6–14.4 | 14.0–9.4 | 8.7–13.4 | 8.2–11.4 | / | / | 9.6–13.7 | 8.0–12.0 | 8.0 | 14.4 |
| Biological characteristics | | | | | | | | | | Min. | Max. |
| Sampling method | saprobiological method | | | PERLA | PERLA | saprobiological method | | saprobiological method | | | |
| Saprobic Index (Czech Nat. St.) | 2.0 | 2.0 | 1.8 | 1.7 | 2.0 | 1.9 | 1.7 | 1.9 | 2.1 | 1.7 | 2.1 |
| Number of EPT taxa | 14 | 16 | 14 | 37 | 23 | 7 | 10 | 9 | 15 | | |
| Total number of taxa | 30 | 33 | 24 | 77 | 58 | 21 | 19 | 30 | / | | |
| Specimens' characteristics | | | | | | | | | | | |
| Year | 2003 | 2004 | 2004 | 2005 | 2004 | 2004 | 2004 | 2005 | 2005 | | |
| Date of record | 27 May | 4 Sept. | 19 July | 12 Sept. | 27 June | 19 August | 20 August | 15 Sept. | 20 July | | |
| Number of specimens | 6 | 1♀ | 1 | 1 | 1 | 1 | 1 | 2 | 3 | | |
| Length of specimens (mm) | 4.2–5.1 | 11.7 | 4.6 | 8.5 | 8.3 | 9.5 | 13.0 | 7.5, 9.0 | 9.8, 9.9, 10.3 | | |
| Development of wing pads | 5 sps. none 6th insinuated | | none | develop. | short | short | developed | 1st short 2nd develop. | all short | | |

33 taxa of other macroinvertebrate larvae, including 16 EPT species.

The easternmost site within the Czech Republic (390 m a.s.l.) is the epipotamal stretch of the Malše River in the village of Roudné (Fig. 4). Twenty-four additional taxa, including fourteen EPTs (e.g., potamal species *Heptagenia sulphurea* and *Oligoneuriella rhenana*) were found in mid-July 2004. The following year, the occurrence of *L. geniculata* was confirmed there by the more detailed PERLA method and a very rich EPT community was detected as well (37 EPT taxa including potamal species, such as *Perla burmeisteriana*, *Caenis luctuosa*, *Ecdyonurus insignis* and *Potamanthus luteus*).

In the Zbirožský potok brook (Fig. 4), a left tributary of the Berounka River, 4 km upstream from the village of Čilá, 57 taxa coexist with *L. geniculata* (23 EPT taxa). However, only *Perla burmeisteriana* was recorded amongst the typical epipotamal EPT taxa. This brook differs from other sites (Table 2) because it belongs to a metarhitral/hyporhitral transition zone. Only 4.5 km downstream, it joins the Berounka River, which has an epipotamal character; therefore, an upstream migration of *L. geniculata* is likely.

In the north-western part of the Czech Republic, close to the border with Germany, three sites with *L. geniculata* were found (20 kilometres from each other). Two sites are situated on the epipotamal stretch of the

Table 2. Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) collected together with *Leuctra geniculata* ("+" = presence of the species).

| Finding sites/Number of site | 1 | | 2 | | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| Water course | Střela | | Malše | | Zbirožský Brook | Ohře | Libocký Brook | Ohře | Labe |
| Site | Nebřeziny | | Roudné | | Čilá | Louny | Libočany | Tvršice | Děčín |
| Year | 2003 | 2004 | 2004 | 2005 | 2004 | 2004 | 2004 | 2005 | 2005 |
| Ephemeroptera | | | | | | | | | |
| *Baetis buceratus* Eaton, 1870 | | + | | | | | | | |
| *Baetis fuscatus* (L., 1761) | + | + | + | + | + | + | + | + | + |
| *Baetis lutheri* Müller-Liebenau, 1967 | | | | + | | | + | | |
| *Baetis muticus* (L., 1758) | | | | | + | | | | |
| *Baetis rhodani* (Pictet, 1843–1845) | + | + | + | + | | | + | + | + |
| *Baetis scambus* Eaton, 1870 | + | | + | + | | | | | |
| *Baetis* cf. *vardarensis* Ikonomov, 1962 | | | | | | | | + | |
| *Baetis vernus* Curtis, 1834 | + | | | + | | | | + | |
| *Caenis luctuosa* (Burmeister, 1839) | | | | + | | | | | + |
| *Caenis macrura* Stephens, 1835 | | | | | + | + | | | |
| *Caenis pseudorivulorum* Keffermüller, 1960 | | + | | | | + | | | |
| *Centroptilum luteolum* (Müller, 1776) | | | | + | + | | | | |
| *Ecdyonurus insignis* (Eaton, 1870) | | | + | + | | | | | |
| *Ecdyonurus torrentis* Kimmins, 1942 | | | | + | | | | | |
| *Ephemera danica* Müller,1764 | | | | + | + | | | | |
| *Ephemerella ignita* (Poda, 1761) | + | + | + | + | + | + | | + | + |
| *Habrophlebia lauta* Eaton, 1884 | | | | | + | | | | |
| *Heptagenia coerulans* Rostock, 1877 | + | | | | | | | | + |
| *Heptagenia* sp. juv. | | | | | | | | | |
| *Heptagenia sulphurea* (Müller, 1776) | + | | + | | | | | | + |
| *Oligoneuriella rhenana* (Imhoff, 1852) | | | + | | | | | | + |
| *Paraleptophlebia* sp. | | | | + | | | | | |
| *Potamanthus luteus* (L., 1767) | | + | | + | | + | | | + |
| *Rhithrogena semicolorata* (Curtis, 1834) | | | | + | | | | | |
| Plecoptera | | | | | | | | | |
| *Isoperla oxylepis* (Despax, 1936) | + | | | | | | | | |
| *Isoperla* sp. | | | | + | | | | | |
| *Leuctra albida* Kempny, 1899 | | | + | | + | | | | |
| *Leuctra fusca* (L., 1758) | | + | | + | | | | | |
| *Leuctra* sp. juv. | + | | | | | | + | | |
| *Nemoura* sp. | | | | + | | | | | |
| *Perla burmeisteriana* Claassen, 1836 | + | | + | + | + | | | | |
| Trichoptera | | | | | | | | | |
| *Anabolia furcata* Brauer, 1857 | | | | | + | | | | |
| *Annitella obscurata* (McLachlan, 1876) | | | | | + | | | | |
| *Athripsodes cinereus* (Curtis, 1834) | | | | + | | | | | + |
| *Brachycentrus subnubilus* Curtis, 1834 | | | + | + | | | | | |
| *Ceraclea annulicornis* (Stephens, 1836) | | | | + | + | | | | |
| *Ceraclea dissimilis* (Stephens, 1836) | | | | | | | | | + |
| *Halesus* sp. | | | | | + | | + | | + |
| *Hydropsyche bulbifera* McLachlan, 1878 | | | | | | | + | | |
| *Hydropsyche contubernalis* McLachlan, 1865 | | | | | | | | | + |
| *Hydropsyche incognita* Pitsch, 1993 | | | + | + | | | | + | + |
| *Hydropsyche instabilis* (Curtis, 1834) | + | + | | | | | | | |
| *Hydropsyche pellucidula* (Curtis, 1834) | + | + | | + | + | | + | | + |
| *Hydropsyche siltalai* Döhler, 1963 | + | | | + | | | | | |
| *Hydropsyche* sp. | | | + | + | + | | | | |
| *Hydroptila* sp. | | + | | | | | | + | |
| *Chaetopteryx major* McLachlan, 1876 | | | | + | | | | | |
| *Chaetopteryx* sp. | | | + | | | | | | |
| *Chaetopteryx villosa* (F., 1798) | | | | + | + | | | | |
| *Cheumatopsyche lepida* (Pictet, 1834) | | + | | + | | | | | |
| *Lepidostoma hirtum* (F., 1775) | | | | + | + | | | | |
| *Lype reducta* (Hagen, 1868) | | | | | + | | | | |
| *Mystacides azurea* (L., 1761) | | | | + | + | + | | | |
| *Mystacides longicornis* (L., 1758) | | + | | | | | | | |
| *Notidobia ciliaris* (L., 1761) | | | | + | | | | | |
| *Odontocerum albicorne* (Scopoli, 1763) | | | | | + | | | | |
| *Oecetis furva* (Rambur, 1842) | | | | + | | | | | |
| *Polycentropus flavomaculatus* (Pictet, 1834) | | + | | + | + | + | + | + | |
| *Psychomyia pusilla* (F., 1781) | | + | | + | | | + | | |
| *Rhyacophila dorsalis* (Curtis, 1834) | | | + | + | | | | | |

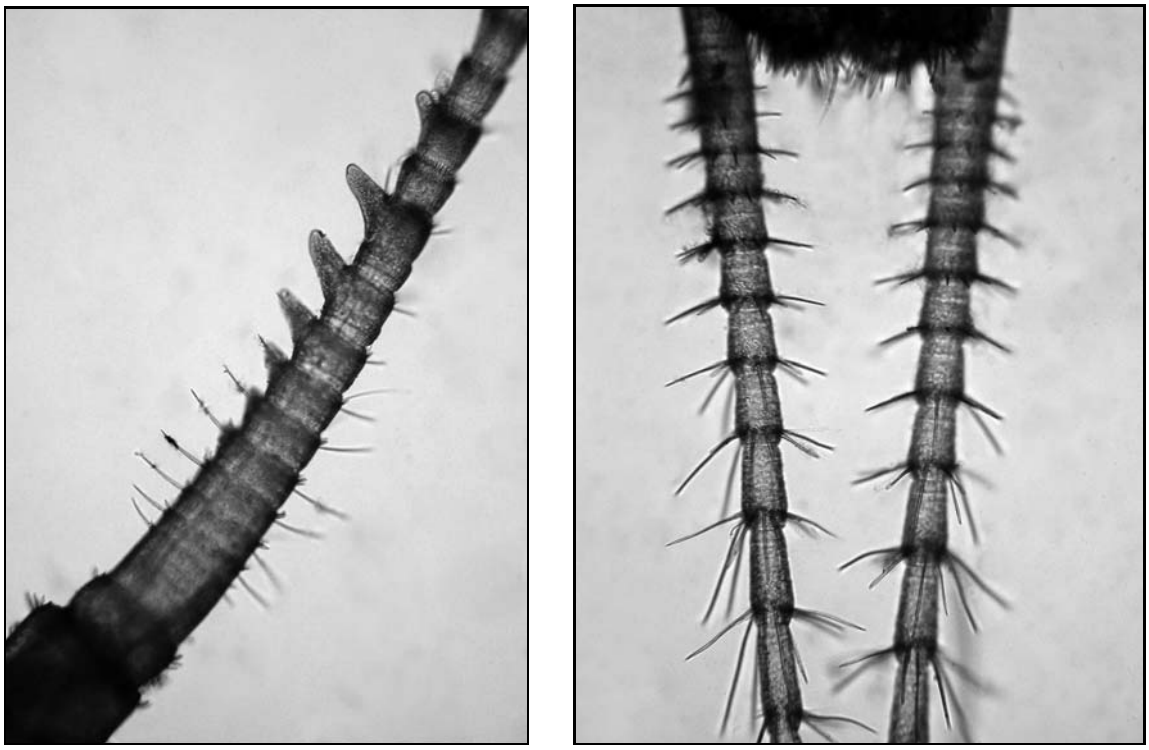

Fig. 2. Basal antennal segment (left) and cerci (right) of a *Leuctra geniculata* larva (river Střela in Nebřeziny, 27 May 2003).

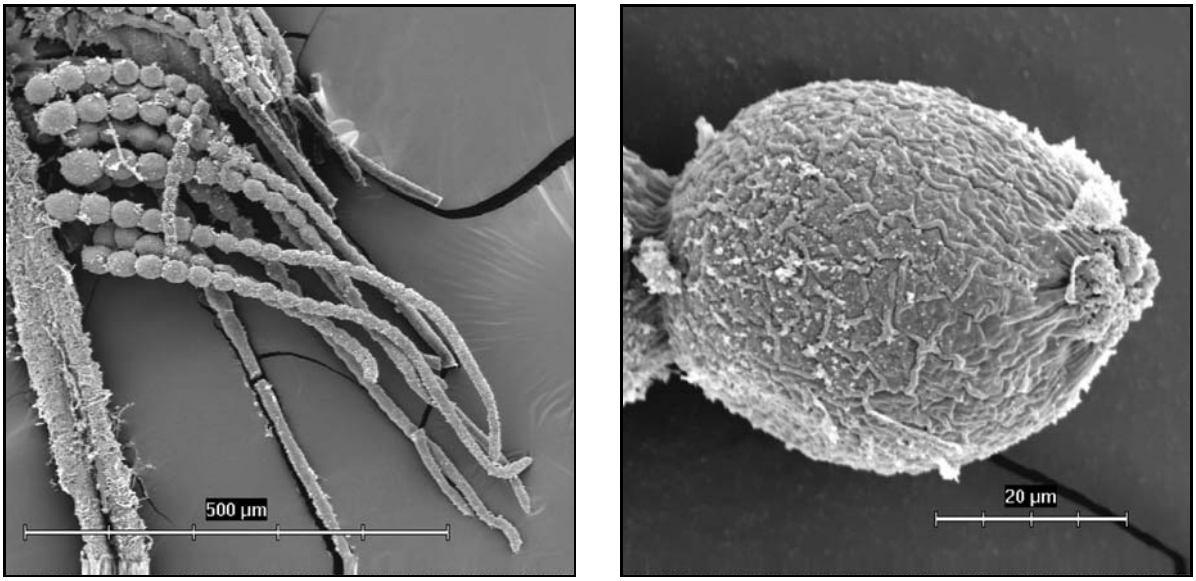


Fig. 3. Scanning electron microscope photos of ovarioles attached to the lateral oviduct (left) and single egg capsule with external chorionic sculpture (right) of *Leuctra geniculata* (river Střela in Nebřeziny, 4 September 2004).

Ohře River near the town of Louny, and the third (Libocký potok brook) on its left tributary, 300 m upstream from the Ohře River main channel (Fig. 4). The latest date of larval capture was 15 September 2005, near the village of Tvršice. The number of species identified at the three sites in the Ohře River basin varied between 19 and 30 taxa, or 7 and 10 EPT taxa, respectively (the lower number of taxa is the result of a rough saprobiological sampling method). Species with potamal preferences, *Potamanthus luteus* and *Baetis* cf. *vardarensis* were recorded in the Ohře River.

The last site (Bojková & Špaček 2006) is located only 10 km upstream from the German border in the Labe (Elbe) River, in the town of Děčín (Fig. 4), with the lowest altitude (124 m a.s.l.). This stretch is at the lower end of an epipotamal segment of the Labe River. For the details about the finding sites, see Table 1.

*Notes on the ecology of the species in the Czech Republic*

Habitats of *L. geniculata* in the Czech Republic are situated in the western and southern parts of the Bo-

Table 2. (continued)

| Finding sites/Number of site | 1 | | 2 | | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| Water course | Střela | | Malše | | Zbirožský Brook | Ohře | Libocký Brook | Ohře | Labe |
| Site | Nebřeziny | | Roudné | | Čilá | Louny | Libočany | Tvršice | Děčín |
| Year | 2003 | 2004 | 2004 | 2005 | 2004 | 2004 | 2004 | 2005 | 2005 |
| *Rhyacophila evoluta* McLachlan, 1879 | | + | | | | | | | |
| *Rhyacophila vulgaris* gr. | | | | + | | | | | |
| *Rhyacophila nubila* (Zetterstedt, 1840) | + | | | | + | | | | + |
| *Rhyacophila* sp. | | + | | | | | + | + | |
| *Sericostoma* sp. | | | | | + | | | | |

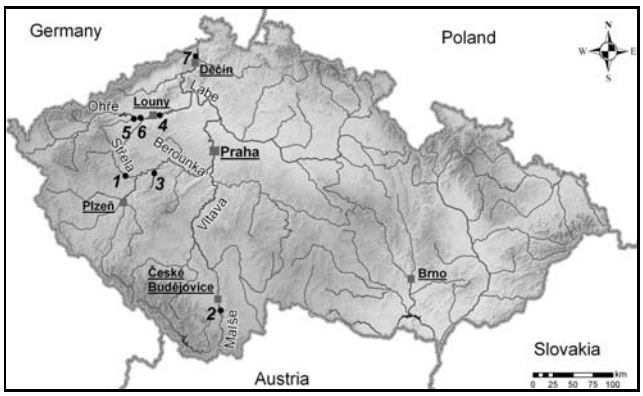


Fig. 4. Map of the Czech Republic with records of *Leuctra geniculata* (●) numbered in order of collection date (1. river Střela in Nebřeziny, 2. river Malše in Roudné, 3. Zbirožský potok Brook near Čilá, 4. river Ohře in Louny, 5. Libocký potok Brook in Libočany, 6. river Ohře in Tvršice, 7. river Labe in Děčín).

hemian massive (Hercynian) in the Labe basin. All sites were expectedly close to the German border (not further than 85 km from the border), considering that the conjunctive area of the species distribution is in western and southern Europe.

For the physiochemical data, see Table 1. The average width of the watercourses at the sites of occurrence varied from 5.5 to 75 m, the average depth from 0.2 m to 1.5 m, the altitude between 124 and 390 m a.s.l. and the average annual discharge $Q_a$ varied from 0.6 to 309 $m^3$. Due to these characteristics, we assume that in the Czech Republic this species prefers mostly lowland and upland mid-sized rivers in stream orders of 5–8, according to Strahler (1957), and can occasionally colonize smaller tributaries. Most of the river stretches consisted predominantly of cobble-gravel-sand substrates and, in some cases, *L. geniculata* inhabited fine deposits near the river bank. The adult female on the Střela River was found in a typical habitat: alder branches hanging down into the stream (López-Rodríguez et al. 2004).

The calculated Saprobic Index of the macroinvertebrate community according to the Czech National Standard (CSN 75 7716 1998) varied at the seven sites from 1.7 to 2.1 and did not fully respond to the individual saprobic valence in the Czech saprobic norm of *L. geniculata* ($S_{valence} = 1.4$; $I_{weight} = 3$), but corresponds better with the Austrian saprobic valences ($S_{valence} = 2.0$; $I_{weight}=3$) proposed by Graf et al. (2002).

Because the appropriate chemical parameters are not available for all sites, only incidental data have been used to illustrate species preferences, e.g., besides our data, those published by the Czech Hydrometeorological Institute (CHMI; http://www.chmi.cz/) and the Ministry of Agriculture of the Czech Republic (http://www.voda.mze.cz/). The CHMI data comprise the annual average values (usually one measurement per month throughout a year), as well as the maximum and minimum values of the year when the occurrence of *L. geniculata* was recorded. From the pH range (7.0 to 9.0) it follows that the species prefers neutral or slightly alkaline waters. The maximum summer temperature was observed in the Labe River (22.7℃) and the average annual water temperature at all sites varied from 8.0 to 12.8℃. The Czech maximum temperature corresponds with the maximum temperature of 24℃ from Spain (Sánchez-Ortega et al. 2003). Conductivity ranges from 15 to 91 mS $m^{-1}$ and the annual average at one of the sites reached up to 66 mS $m^{-1}$, which can indicate tolerance of the species to this parameter, often connected with slight or moderate pollution. It also corresponds with $BOD_5$ values that varied from 1.1 to 13 mg $L^{-1}$ and the annual average of the particular site varied in a narrow band from 1.7 to 3.6 mg $L^{-1}$. In accordance with the Czech National Standard (ČSN 75 7221 1998), the sites were predominantly classified in the better part of the scale from quality class I to III (the norm defines the five classes from the best (I) to the worst (V) in reverse order, in accordance with the Water Framework Directive (European Parliament & Council 2000). The range of $O_2$ concentration from 8.0 to 14.4 mg $L^{-1}$ indicates a higher oxygen demand of the species, which confirms the average $O_2$ saturation at collecting sites from 82 to 102%.

*L. geniculata* belongs to late summer–autumn species (Despax 1951; Kis 1974; Elliott 1987; Sánchez-Ortega et al. 2003) and, accordingly, early instar larvae (up to 5 mm in body length) without or with small wing pads were found on 27 May and 19 July. The larvae (8.3 to 10.3 mm in body length) in samples from 27 June, 20 July and 19 August had only short wing pads. Records of last larval instars (9 to 13 mm in body length) with well-developed wing pads on 20 August, 12 September and 15 September (the second of two specimens), as well as one adult on 4 September, respectively, can indicate the univoltine life cycle of this species in the

Czech Republic, as expected by the forenamed authors.

In half of the samples, Plecoptera were represented by larvae of *Perla burmeisteriana* and *Leuctra fusca*, which prefer transition between the rhitral and potamal zones. Most of the Ephemeroptera and Trichoptera larvae found together with *L. geniculata* also preferred predominantly potamal stretches (for the details see Table 2). Preferences of the species mentioned above fully correspond with the longitudinal distribution within river zones supposed by Graf et al. (2002), who proposed preferences from the epirhitral to the metapotamal zone, with its main occurrence in epipotamal stretches. The altitudinal preferences in Central Europe markedly differ from the situation in Mediterranean populations, e.g., in Sardinia, Corsica and the Pyrenees, where the species is often found in the crenal zone and springs at altitudes above 1,000 m a.s.l. (Consiglio 1975; Sánchez-Ortega et al. 2003).

Contrary to the scarce distribution of *L. geniculata*, the *Leuctra* species of similar dimensions, morphology (hair and shape of body), food demands (shredders) and larval development as the species *Leuctra braueri* Kempny, 1898 and *Leuctra nigra* (Olivier, 1811) are widely distributed in the Czech Republic. They have different habitat preferences and prefer to inhabit smaller streams from the epirhitral zone up to the springs at altitudes from 220 to 1100 m a.s.l. (Soldán et al. 1998).

The presented data on *L. geniculata* give basic information about its preferences on the north-eastern border of its area. The majority of our ecological data corresponds with the results and assumptions of the aforementioned authors (Grauvogl 1992; Graf et al. 2002; Sánchez-Ortega et al. 2003; López-Rodríguez et al. 2004), although the species was also found in watercourses with lower water quality.

*Possible ways of species dissemination*

All sites where *L. geniculata* has been recorded recently in the Czech Republic were investigated in detail between 1955 and 1960 (Křelinová 1962) and partially also between 1994 and 1996 (Soldán et al. 1998). However, *L. geniculata* was not recorded there until 2003; therefore, we suppose its dissemination to the Czech Republic took place around the turn of the century. The Labe River probably could not serve as a corridor for the species expansion to the Czech Republic because the chronology of findings was the opposite (from upper stretches to lower parts of the Labe basin – see Fig. 4) and there are no findings of *L. geniculata* in the Labe basin in Germany. Another possible way of expansion is more likely, regarding the chronology of records in the Czech Republic. It is a dissemination from the Danube basin via the south-east to the Vltava catchment (including Malše and Berounka) and/or the Ohře catchment and then faster downstream into the Labe basin. It can be expected that *L. geniculata* will disseminate eastwards to other Czech rivers and streams up to the altitude of 500 m a.s.l. (limitation by the continental climate) in both the Elbe and the Danube basins (in the latter case via the Morava River from Austria and Slovakia), respectively. The present dissemination of the species is probably related to the marked improvement of water quality in Czech rivers during the last 15 years, particularly in the epipotamal stretches that are preferred by the species. The northwards expansion of this Atlantomediterranean species could also be associated with the growth of average temperatures in the Czech Republic (Pišoft et al. 2004) related to global climate changes, but sufficient data are not available for the validation of this hypothesis.

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