FIRST CONTRIBUTION TO THE MAYFLY FAUNA FROM SLOVENIA (EPHEMEROPTERA)

DAŠA ZABRIC[1] & MICHEL SARTORI[2]

[1]Fisheries Research Institute, Zupanciceva 9, 61000 Ljubljana, Slovenia
[2]Musée de Zoologie, Pl. Riponne 6, C.P. 448, 1000 Lausanne 17, Suisse

In this work 75 species of Ephemeroptera are recorded from Slovenia. They belong to 10 families and 22 genera. Apart from species with wide distribution the majority of Slovenian mayflies belongs to the South-Central European and the Central European species. The last group includes seven Alpine endemits and an interesting species *Ecdyonurus carpathicus carpathicus* SOWA, 1973 which was known till then as a Carpathian endemit.

INTRODUCTION

Ephemeroptera are recognized as good bio-indicators and have been used for a long time to estimate water quality (SOWA, 1980). As their diversity and biomass is quite high in our running waters, it is important to know which species occur and how they are distributed in the rivers of Slovenia.

There are few published data on Slovenian mayflies. We found a list of 15 species in an unpublished manuscript by I. Sivec, all coming from the Pivka river system, and determined by V. Puthz, P. Malzacher and I. Müller-Liebenau. Quite a few data on Slovenian mayflies have been published by some authors (BRAASCH, 1980; HEFTI & TOMKA, 1986; HEFTI *et al.*, 1986; MALZACHER, 1986; ZURWERRA & TOMKA, 1986; ZURWERRA *et al.*, 1986; HEFTI *et al.*, 1987; LANDOLT *et al.*, 1991; BELFIORE & BUFFAGNI, 1994) who generally mention one species from one locality.

Two species were originately described from Slovenia: *Ecdyonurus siveci* JACOB & BRAASCH, 1984 and *Electrogena vipavensis* ZURWERRA & TOMKA, 1986.

A list of freshwater invertebrates with their saprobic values was prepared by GRBOVIA (1994). 33 mayfly species are listed. A determination key (on genus level) which is a synthesis of a few foreign keys was prepared by SIVEC & REJIC (1981).

In the present study 75 species are reported from Slovenia, many of them mentioned for the first time.

STUDY AREA, MATERIAL AND METHODS

Slovenia is a small country (20251 km^2), but is geographically diverse with mountains, plains and sea coast. According to the biogeographical division proposed by ILLIES (1978), it is situated in three regions: Alps, Dinar-western Balkan and the Hungarian plain. Slovenian streams and rivers receive about 85% of their water from mountainous regions (GRBOVIA, 1994). There is a particular kind of karstic rivers in the south-western part of the country that run partly underground and partly on the surface and are connected by underground streams. There are more than 60 lakes in Slovenia at different altitudes and of different types: glacial, lowland, periodic etc. Rivers that flow in Slovenia belong to two major drainage basins: the Danube and the Adriatic.

In Slovenia the Danube basin (17821 km^2) consists of three major catchment areas: the Sava, the Drava and the Mura Rivers. The longest Slovenian river, the Sava (with 221 km on Slovenian territory), originates in the Slovenian Alps and runs through the Dinar-West Balkan region. The highest source of the Danube basin is located at 1600 meters. The major tributary of the Adriatic basin (2430 km^2) is the River Soca catchment area. Others are drained by less important watercourses which flow into the Adriatic Sea. The northern part of the Adriatic basin belongs to the Alpine region, and the southern part to the Dinar-West Balkan region. Its highest sources are at 1400 meters.

The studied material comes from collections lodged in The Museum of Natural History of Slovenia, The National Institute of Biology and The Fisheries Research Institute of Slovenia. The collecting period spanned from 1971 to 1994 covering all four major river systems (Fig. 1). The determination was done on nymphs which were collected with a hand net. In some cases we used the rearing technique (SARTORI, 1987) to obtain the subimagos and imagos.

RESULTS

So far 75 species from Slovenia are known (Table 1). They belong to 10 families and 22 genera. The genus *Rhithrogena* is the most diversified with 21 species found. This reflects the strong influence of alpine elements, since most of the European species of *Rhithrogena* are located in the Alps. The location of Slovenia in the Eastern Alps is also shown by the mixing of species from the Alps (*R. alpestris, R. colmarsensis*) and the Carpathians (*R. corcontica, R. circumtatrica*).

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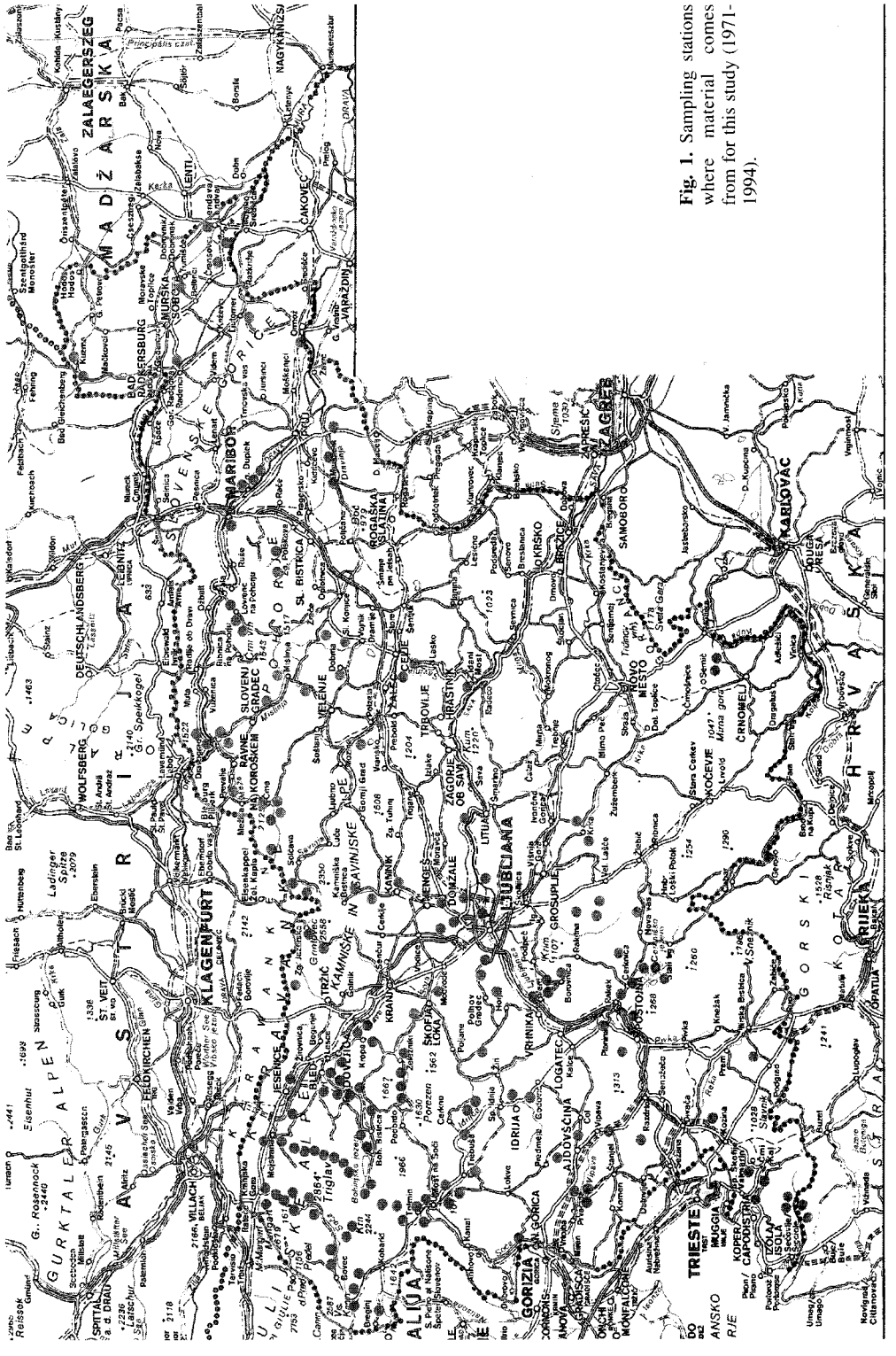

Fig. 1. Sampling stations where material comes from for this study (1971-1994).

Table 1. List of the mayfly species actually known in Slovenia, divided between the two major drainage systems. *: data from the literature; ?: uncertain identification that has to be confirmed later on.

	Adriatic Basin	Danube Basin
SIPHLONURIDAE		
Siphlonurus EATON, 1868		
S. aestivalis (EATON, 1903)	X	
S. lacustris EATON, 1870	X	X
AMELETIDAE		
Ameletus BENGTSSON, 1885		
**A. inopinatus* EATON, 1887		
BAETIDAE		
Baetis LEACH, 1815		
B. alpinus (PICTET, 1843)	X	X
B. fuscatus (LINNAEUS, 1761)	X	X
B. liebenauae KEFFERMÜLLER, 1974		X
B. lutheri MÜLLER-LIEBENAU, 1967	X	X
B. melanonyx (PICTET, 1843)		X
B. muticus (LINNAEUS, 1758)	X	X
B. rhodani (PICTET, 1843)	X	X
B. scambus EATON, 1870	X	X
B. vardarensis IKONOMOV, 1962		X
B. vernus CURTIS, 1834		X
Acentrella BENGTSSON, 1912		
A. sinaica BOGOESCU, 1931		X
Centroptilum EATON, 1869		
C. luteolum (MÜLLER, 1776)	X	X
Pseudocentroptilum BOGOESCU, 1947		
P. pennulatum (EATON, 1870)	X	X
Cloeon LEACH 1815		
C. dipterum (LINNAEUS, 1761)		X
**C. simile* EATON,1870		
Procleon BENGTSSON, 1915		
P. bifidum (BENGTSSON, 1912)		X
OLIGONEURIIDAE		
Oligoneuriella ULMER, 1924		
**O. rhenana* (IMHOFF, 1825)		
HEPTAGENIIDAE		
Epeorus EATON, 1881		
E. alpicola (EATON, 1871)		X
E. sylvicola (PICTET, 1865)	X	X
Rhithrogena EATON, 1881		
R. allobrogica SOWA & DEGRANGE, 1987	X	
R. alpestris EATON, 1885		X
?*R. beskidensis* ALBA-T. & SOWA, 1987		X
R. braaschi JACOB, 1974	X	X
R. carpatoalpina KLONOWSKA *et al.*, 1987		X
R. circumtatrica SOWA & SOLDÁN, 1986		X
R. colmarsensis SOWA, 1984		X
?*R. corcontica* SOWA & SOLDÁN, 1986		X
?*R. degrangei* SOWA, 1969		X
R. diensis SOWA & DEGRANGE, 1987	X	X
R. endenensis METZLER *et al*, 1985	X	
R. gratianopolitana SOWA *et al.*, 1986	X	
R. iridina (KOLENATI, 1839)	X	X
R. landai SOWA & SOLDÁN, 1984	X	X
R. loyolaea NAVÁS, 1922	X	X
R. puthzi SOWA, 1984	X	X
?*R. reatina* SOWA & BELFIORE, 1984	X	
R. savoiensis ALBA-T. & SOWA, 1987		X
R. semicolorata (CURTIS, 1834)	X	X
R. sp. 1 (hybrida group)	X	
R. taurisca BAUERNFEIND, 1992	X	X
Ecdyonurus EATON, 1865		
**E. aurantiacus* (BURMEISTER, 1839)		
E. carpathicus carpathicus SOWA, 1973	X	X
**E. siveci* JACOB & BRAASCH, 1984		X
E. dispar (CURTIS, 1834)	X	
**E. forcipula* (PICTET, 1843)		
E. insignis (EATON, 1870)	X	
?*E. macani* THOMAS & SOWA, 1970	X	X
E. picteti (MEYER-DÜR, 1864)	X	X
E. torrentis KIMMINS, 1942		X
E. venosus (FABRICIUS, 1775)	X	X
E. zelleri (EATON, 1885)	X	
Electrogena ZURWERRA & TOMKA, 1985		
E. gridellii (GRANDI, 1953)	X	
E. lateralis (CURTIS, 1834)	X	
E. quadrilineata (LANDA, 1969)	X	X
**E. rivuscellana* SARTORI & LANDOLT, 1991		X
**E. vipavensis* ZURWERRA & TOMKA, 1986	X	
Heptagenia WALSH, 1862		
**H. flava* ROSTOCK, 1877		
H. sulphurea (MÜLLER, 1776)		X
EPHEMERELLIDAE		
Ephemerella WALSH, 1862		
E. ignita (PODA, 1761)	X	X
E. mucronata (BENGTSSON, 1909)		X
**E. notata* EATON, 1887		
Torleya LESTAGE, 1917		
T. major (KLAPALEK, 1905)	X	X
CAENIDAE		
Caenis STEPHENS, 1835		
C. horaria (LINNAEUS, 1758)		X
C. luctuosa (BURMEISTER, 1839)	X	
C. macrura STEPHENS, 1835	X	X
LEPTOPHLEBIIDAE		
Paraleptophlebia LESTAGE, 1916		
P. submarginata (STEPHENS, 1835)	X	X
Habroleptoides SCHÖNEMUND, 1929		
H. confusa SARTORI & JACOB, 1986	X	X
Habrophlebia EATON, 1881		
H. fusca (CURTIS, 1834)	X	X
H. lauta EATON, 1884	X	X
POTAMANTHIDAE		
Potamanthus PICTET, 1843		
P. luteus (LINNAEUS, 1767)	X	X
EPHEMERIDAE		
Ephemera LINNAEUS, 1758		
E. danica MÜLLER, 1764	X	X
E. vulgata LINNAEUS, 1758	X	X

35% of the whole species have a wide distribution. The same percentage applies to the South-Central European species. 25% are Central European species. Among them there are seven Alpine and one Carpatian endemit, *E. c. carpathicus*. The smallest part (5%) belongs to North-Central European species.
Almost half of the species are distributed in both river basins. One third was found only in the Danube basin (half of all Baetidae) and a bit less than one fifth is restricted to the Adriatic basin (three species of the genus *Electrogena* out of five).

DISCUSSION

The comparison of the Slovenian list of species with some European countries shows that 86% of the species are present also in Austria (BAUERNFEIND, 1994), 77% in Switzerland (STUDEMANN *et al.*, 1992), 68% in Slovakia, 65% in Czech Republic (LANDA & SOLDÁN, 1985) and 63% in Italy (BELFIORE, 1983).
The presence of 7 Alpine endemits and the important similarity with Austrian and Swiss mayfly composition (86% and 77% respectively) shows that Slovenian mayfly fauna is strongly influenced by the Alpine region. It is especially rich in Heptageniidae (41 species). The presence of *E. carpathicus carpathicus* SOWA, 1973 in Slovenia is surprising. This species was first described in Poland. Another subspecies was described later from Bulgaria: *Ecdyonurus carpathicus vitoshensis* by JACOB & BRAASCH, 1984. Differential diagnosis between both subspecies for male imagoes and nymphs can be found in HEFTI *et al.* (1988, 1989). The biochemical analyses show no interspecific difference between both taxa, but this is not in contradiction with their subspecific status (HEFTI *et al.*, 1989). Up to now, distribution of *E. c. carpathicus* ranged from Polish to Rumanian Carparthians whereas *E. c. vitoshensis* was recorded in the Yugoslavian, Bulgarian and Hellenic Balkans. The finding of *E. c. carpathicus* in Slovenia indicates that the area of this subspecies is not only limited to the Carpathians and maybe even touches the area of the other subspecies. So far it has been found in three localities in Slovenia that are distributed in both basins. The determination was done on nymphs only.

This work constitutes a first contribution and is far from complete. Several habitats have been poorly prospected, mainly lentic habitats, as well as lakes and ponds. Mayfly fauna of the lower courses of large rivers is currently also underrated. This explains the relatively low number of species belonging to the tribes Cloeonini and Centroptilini (Baetidae) for instance, or to the Caenidae. Therefore, it is necessary to obtain more samples from the Dinar-western Balkan region and from different types of rivers and lakes to complete the survey of Slovenian mayflies.

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