Some considerations about the rheophilic elements of the benthic fauna (ord. Ephemeroptera, Plecoptera and Trichoptera) of the Upper Tisa Region

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Introduction

Many present-day rivers in the temperate zone flow directly within coarse-grained gravel masses that have been inherited from deglaciation out-wash and valley fill deposits (Gregory and Maizels, 1991). The Upper Tisa is one of such rivers. From the confluence of Bila Tisa with Chorna Tisa and up to the mouth of River Someş, River Tisa can be divided into two main sections:

a) the section from Rahiv to Troznik (in Ukrainian territory), characterised by stony bottom (with boulders, gravel, cobbles and pebbles).

b) the section from Jánd to Vásárosnamény, and a little further (in the Hungarian territory) characterised by sandy bottom (except for the left bank where there are some locations with stony substratum consisting of boulders).

Keywords: Ephemeroptera, Plecoptera and Trichoptera, Upper Tisa Region

Sampling sites

a) River Bila Tisa (#1, #3, #4, #8, #9)

#1 near Luhi village, 100 m from the confluence with Bila Rivulet. The substratum consists of boulders (in the central part of the stream) and gravel. The stony surfaces are covered with silt (very thin layer).

#3 5 km upstream from #1; many waterfalls, boulders with a thick layer of algae.

#4 downstream from the main sources, typical mountain stream.

#8 near Breboja village; boulders and cobbles on a sandy bed, covered with algae (bioderma).

#9 near Rostoki village, the same aspect like for #8; much waste (of domestic origin) in the water.

b) River Chorna Tisa (#5, #6, #7)

#5 2 km downstream from the main sources; boulders and cobbles.

#6 upstream from the reservation; cobbles and pebbles.

#7 near Svidovec village, cobbles and pebbles.

c) River Tisa (#10, #11, #12, #14, #16, #17, #18, #19, #20, #21, #22).

#10 near Rahiv; at the left bank, high velocity of the current; boulders, pebbles on a sandy bed; a thick layer of bioderma and silt on the stony surfaces.

#11 upstream from Dilove village; boulders, gravel, remarkable velocity of the current.

#12 near Bustina, upstream from the confluence with Tereblia; #12 A: boulders, high velocity of water current; #12 B: a slow-moving zone but also with boulders.

#14 downstream from Bustina, the same biotope like for #12.

#16 near Vinogradiv; a braided stream, pebbles, gravels, boulders near the right bank.

#17 near Hust, braided stream, a lot of gravel beaches, heterogenity of habitats (waterfalls, benthic zones, shoals, boulders with moss clumps).

#18 near Troznik (the last sampling point in Ukrainian territory), gravel and sand.

#19 near the Hungarian border where the river flows between narrow dykes; sand, coarse sand, muddy deposits at the right bank and boulders on the left one.

#10, #21, #22 near Tivadar, the same aspect.

d) The main tributaries (#2, #13, #15).

#2 Bila Rivulet, upstream from the confluence with Bila Tisa, boulders and pebbles.

#13 Tereblia near Bustina; gravel with Spyrogira, small waterfalls, pebbles.

#15 Teresva, 5 km upstream from the confluence with River Tisa; lentic zones with much algae on the gravel and small waterfalls with boulders.

In general, the conditions for the benthic fauna are very good:

- large stony surfaces accesible for larval populations
- an optimal velocity of the current, determined by the irregular bottom surface
- large amounts of bioderma representing the main food for many rheophilic species
- large fish populations controlling invertebrate populations.

We can assume that River Tisa has a relatively moderate load of suspended sediment. This situation determines, at least in the upper section of the river, the diversity of the benthic habitats. Despite such conditions, the considerable quantities of organic matter in the form of bioderma may be understood as a result of the dissolved organic matter and suspended particles containing nitrogen and phosphorus. Thus, the present conditions are favourable for the benthic fauna.

The natural geological conditions (coarse sedimentary particles such as boulders and gravel) are supplemented by the favourable quality of the water. The type of substratum, consisting of cobbles (boulders and gravel) and pebbles hold a wider range of taxa than silt or clay which, in turn, host more taxa than sand (Găldean,1994). Factors such as structural stability and complexity, available food resources and continuity over time are likely to be relevant in influencing the colonisation of these habitats by macro-invertebrates.

The main types of benthic associations identified in River Tisa

1. The moss clump association of stenotopic species (#4):
   - Baetis gr. alpinus
   - Rhithrogena hercynia
   - Rhithrogena semicolorata
   - Perla pallida
   - Perlodes intricata
   - Hydatophylax sp.
   - Glossosomatidae
2. Stony surface with very "clean" bioderma (#3, #6):
   - Baetis scambus
   - Baetis lutheri
   - Rhithrogena semicolorata
   - Ecdyonurus submontanus
   - Brachycentrus subnubilus
   - Perla pallida
3. Gravel with moss clumps and a very fine layer of silt (#17):
   - Epeorus sylvicola
   - Rhithrogena semicolorata
   - Ecdyonurus aurantiacus
   - Centroptilum luteolum
   - Heptagenia coerulans
   - Caenis rivulorum
   - Ephemerella ignita
   - Hydropsyche sp.
4. "Palingenia" type (#19, #20, #21):
   - Palingenia longicauda
   - Centroptilum luteolum
   - Caenis horaria
   - Heptagenia flava
   - Electrogena lateralis

From quantitative analyses it can be seen that at all of the sampling points it was ephemeropterans that showed the greatest numeric value in relation to the zoobenthos community.

Among the most abundant Ephemeroptera species in River Tisa are included Oligoneuriella rhenana, Baetis scambus, Centroptilum luteolum, Ecdyonurus insignis, Heptagenia sulphurea, Choroterpes picteti, Ephemerella ignita, Caenis macrura, Caenis luctuosa.

Ephemeropterans (see Table 1.) are very conservative in their choice of new biotopes; a wide range of species are of relic character and the relatively narrow ecological range of most species guarantees considerable sensitivity to changes in the quality of water.

Oligoneuriella rhenana is considered to be stenotopic and specialized, unable to tolerate changes in its biotope. Its presence in the sampling stations 10-20 (River Tisa) and also in rivers Chorna Tisa and Bila Tisa has great significance: the actual conditions of the biotope there are very good. On the other hand, the presence of Ephemerella ignita at the same sampling station demonstrates the tendency of the water to become more eutrophic. The proportion of Ephemerella ignita is about 20-30%.

The total proportion of resistant species (Baetis vernus, Baetis rhodani and Ephemerella ignita) does not exceed 10%.

The species of the genera Heptagenia and Electrogena, most of which require more oxygen, have a good representation in the sampling areas. The regular discharge of the affluents and, as a consequence, the regular flood of River Tisa (except for the spring period) provide an optimal oxygen level and control the decomposition processes. For mayfly larvae (especially for torrentile ones) the reduction of the speed of the stream and covering the bottom with mud are very dangeours phenomena. Under such conditions (which must be avoided for River Tisa), even the resistant species like Ephemerella ignita can be affected.

Vannote et al. (1980) developed the River Continuum Concept according to which, correspondingly to the particle size (mainly of organic matter), available light and water quality, different proportions of the functional groups are present. Besides, each species adapted to certain conditions is replaced by another one along the continuum. In the case of the Upper Tisa Region it is very interesting to observe a prior replacement within the family Baetidae (Ephemeroptera), and in the Trichoptera group. Namely, Baetis alpinus and Baetis melanonyx are replaced by Baetis scambus; species of the family Rhyacophylidae are replaced by species of the families Limnephilidae and Hydropsychidae (Trichoptera).

Baetis alpinus, Baetis melanonyx and Baetis sinaicus are the most rheophilic species within the genus Baetis. They are also the most stenoic of all baetids, but they display the reduced degree of specialization of the group. These species are very characteristic for stony substrata without moss or siltic deposits (#3).

Other Baetis species (i.e. B. scambus, B. niger, B. vernus) prefer silty sediments and they are characteristic for the surface of the moss (#10, 11).

All the species of the family Siphlonuridae are absent: they find no fine debris deposits which can accumulate on sandy bottoms (Găldean, 1994). This type of deposit is missing, too.

According to Janeva (1979), Baetis scambus is tipical for beta-mesosaprobic running waters. Its presence in River Tisa in many sampling areas prove the good quality of waters, normal for the altitude of 300-400 m. For Centroptilum luteolum I consider the situation to be the same.

Oligoneuriella rhenana and Ephemerella ignita have one generation annually. After oviposition in the autumn, eggs remain in diapause until spring next year or even during the summer. Older larvae develop very quickly during 2-3 mouths in the summer (Landa, 1968).

Taking into account the fact that Oligoneuriella rhenana and Ephemerella ignita are present from sampling point #7 to #19 (or even #20), and from #1 to #17 respectively, it is possible to conclude that they have the most adequate strategy for the conditions of the biotopes of River Tisa.

The high flood of the waters in the spring results in the strong transformation of the stony substratum (boulders, cobbles, gravel).

The Plecoptera group exhibits a special situation: only 3-4 species are present, which are more abundant on stony substrata and moss on the large stones. The preference of moss clumps in Protonemura and Leuctra larvae (bryorheal - Wulfhorst, 1994) is not only indicative of the oxygen content but also refers to the carrying capacity of this type of "substratum". Under the specific conditions of River Tisa, the organic load on moss clumps is moderate.

As a conclusion, I emphasize that there are two main types of trophic substratum for reophilic larvae of the groups Plecoptera, Ephemeroptera and Trichoptera:

a) stony bottom
b) moss clumps

Both of them have rich food sources (bacteria, algae, fine detritus, fine-particle organic matter) and seem to have been very stable up to now.

A real ecotonal zone (sensu Gopal, 1994) is missing: the deposit of branches and leaf which are important trophic and shelter substrata for amphipods (Gammaridae) are destroyed by the high flood of the waters in the springtime.

From the analysis of the rheophilic groups identified in the sampling areas (#1 - #21), the difficulty of an accurate biological division of the investigated zone of River Tisa is evident.

Nevertheless, the following important findings must be noted:

1. The remarkable percentage of Plecoptera in samples #10 (Rahiv) - #18 (Troznik).

2. The constant presence of Oligoneuriella rhenana.

3. The remarkable percentage (25%-42%) of Ecdyonurus species at sampling points #16, #17 and #18.

4. The dominance of Centroptilum luteolum (60% for sampling point #20) and Heptagenia species (over 85% for the stony substratum at sampling point #21).

5. The low numeric level of Hydropsyche populations.

6. The difference between the main tributaries Tereblia and Teresva: Tereblia seems to be a little eutrophic (Hydropsyche larvae represent 25% and Caenis larvae 22%), while Teresva is dominated by Protonemura (68%) and Oligoneuriella (17%).

7. The high level of the Caenis populations from Chorna Gora (#16) may be explained with local conditions: sites with reduced velocity of the current, and large pebble bars (it is a braided section). The layer of moss and detritus on the cobbles is thick but grazing invertebrates consume this trophic resource.

In my opinion, the Upper Tisa, as an ecosystem, has a high level of biodiversity but it is also characterised by a considerable uniformity of biotopes and benthic communities. This fact implies the vulnerability of the system in case the general conditions change. The lotic system of River Tisa is not "trained" to react to negative phenomena like pollution or the effects of hydrochemical improvements.

There are two main dependence categories for River Tisa:

a) the regular flow of the affluence

b) the survival of the natural dynamics of the alluvial sediments (i.e. boulders, gravel, cobbles, pebbles) and the absence of muddy and detritus deposits.

It can be asserted that River Tisa lies in a "wild" state determined by the absence of the negative anthropogenic influences. Nevertheless, it is necessary to re-emphasize its vulnerability.

Deforestation may become perhaps the most important cause of river degradation. The main consequence of deforestation is the siltation of river headwaters. Other effects can include reduction of precipitation, changes in flow regime and the undermining of river banks.

Some criteria considering River Tisa as a representative (maybe unique) wetland (from the faunistic point of view)

1. Comparing the benthic associations of River Tisa with other ones found in rivers belonging to the Tisa catchment area (which are very similar in riverbed morphology, hydrological conditions, trophic resources for the fauna), the faunistic richness of River Tisa is remarkable.

2. River Tisa represents the most important reserve of species in the entire catchment area. The studies having done on rivers Someş, Mureş, Iza, and Criş confirm this assessment.

3. The lotic ecosystem of River Tisa has a theoretical value as well: it represents a natural pattern of the ecological structure of a non-disturbed European river.

The braided sectors of the River Tisa (#12, #14 and especially #17) have the most remarkable biodiversity. Braided channels are marked by the succesive branchings and rejoinings of the flow around alluvial islets and shoals. The main channel is divided into several channels which meet and redivide (type described by Reineck and Singh, 1980). This fact creates a multitude of habitats characterised by different velocities of the current, differently grained deposits (coarse or fine) and varying quantities and qualities of bacterial and algal bioderma.

For Oligoneuriella rhenana populations, the most favourable habitats are cobble-sized gravel beds.

Pebbles are most favourable for species of the Baetidae family and for ones belonging to Ephemerellidae.

It is very important to preserve this type of sediment and to avoid the utilisation (exploitation) of gravel and pebbles for different purposes of building.

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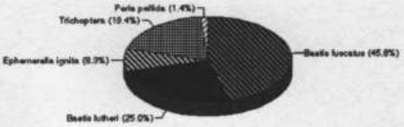
#1 BILA TISA



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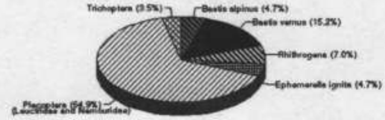

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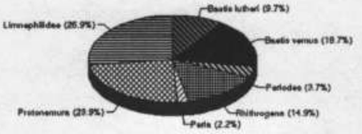

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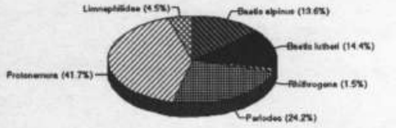

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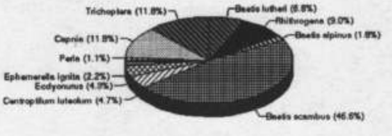

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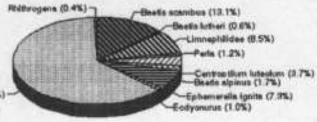

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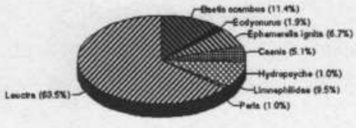

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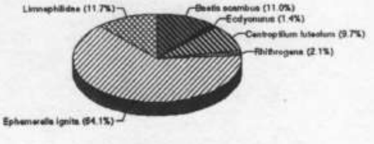
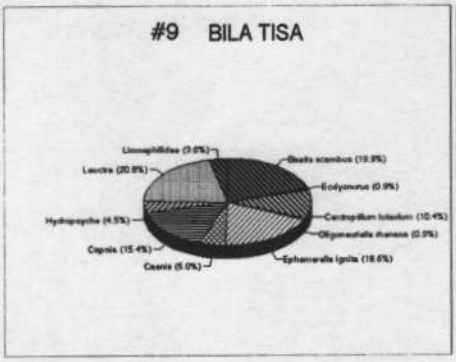
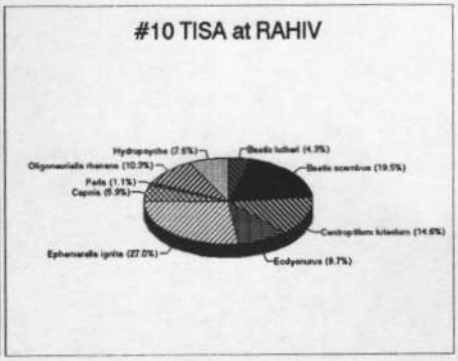
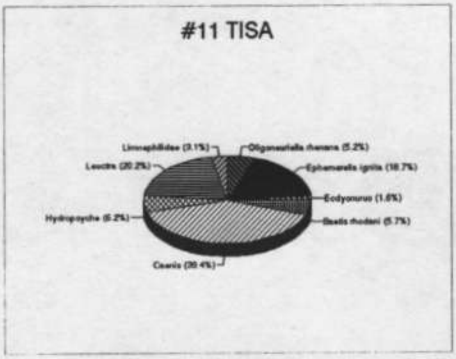
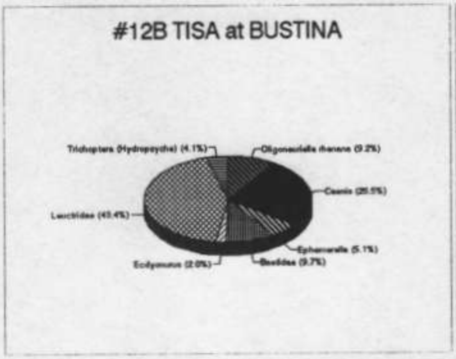
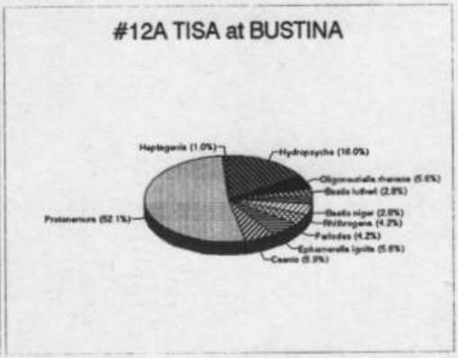


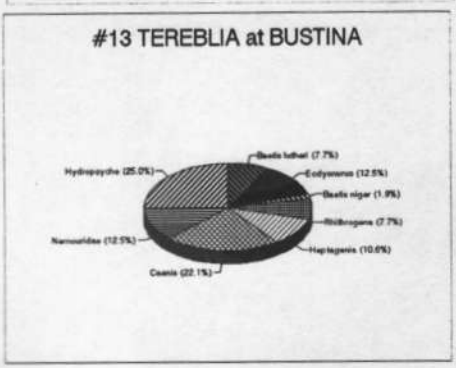

#9 BILA TISA
Limnephilidae (3.6%)
Leuctra (20.8%)
Baetis scambus (19.9%)
Ecdyonurus (0.9%)
Hydropsyche (4.5%)
Centroptilum luteolum (10.4%)
Oligoneuriella rhenana (0.9%)
Capnia (15.4%)
Caenis (5.0%)
Ephemerella ignita (18.6%)

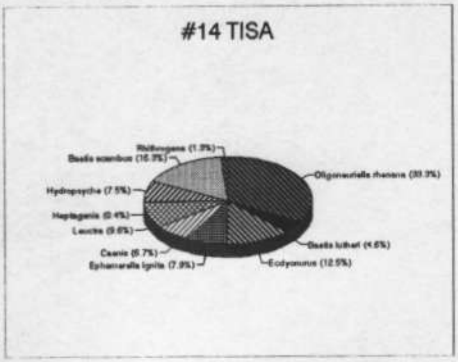

#10 TISA at RAHIV
Hydropsyche (7.6%)
Baetis lutheri (4.3%)
Oligoneuriella rhenana (10.3%)
Baetis scambus (19.5%)
Perla (1.1%)
Capnia (5.9%)
Centroptilum luteolum (14.6%)
Ephemerella ignita (27.0%)
Ecdyonurus (9.7%)


#11 TISA
Limnephilidae (3.1%)
Oligoneuriella rhenana (5.2%)
Leuctra (20.2%)
Ephemerella ignita (18.7%)
Ecdyonurus (1.6%)
Hydropsyche (6.2%)
Baetis rhodani (5.7%)
Caenis (39.4%)

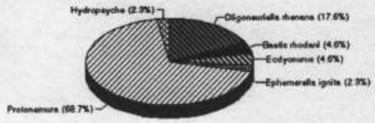

#12B TISA at BUSTINA
Trichoptera (Hydropsyche) (4.1%)
Oligoneuriella rhenana (9.2%)
Caenis (25.5%)
Leuctridae (45.4%)
Ephemerella (5.1%)
Ecdyonurus (2.0%)
Baetidae (9.7%)


#12A TISA at BUSTINA
Heptagenia (1.0%)
Hydropsyche (16.0%)
Oligoneuriella rhenana (5.6%)
Baetis lutheri (2.8%)
Baetis niger (2.8%)
Rhithrogena (4.2%)
Protonemura (52.1%)
Perlodes (4.2%)
Ephemerella ignita (5.6%)
Caenis (5.9%)

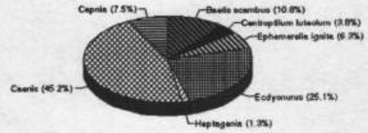

#13 TEREBLIA at BUSTINA
Baetis lutheri (7.7%)
Hydropsyche (25.0%)
Ecdyonurus (12.5%)
Baetis niger (1.9%)
Rhithrogena (7.7%)
Nemouridae (12.5%)
Heptagenia (10.6%)
Caenis (22.1%)


#14 TISA
Rhithrogena (1.3%)
Baetis scambus (16.3%)
Oligoneuriella rhenana (30.3%)
Hydropsyche (7.5%)
Heptagenia (0.4%)
Leuctra (9.6%)
Baetis lutheri (4.6%)
Caenis (6.7%)
Ephemerella ignita (7.9%)
Ecdyonurus (12.5%)

#15 TERESVA



#16 TISA at CHORNA GORA



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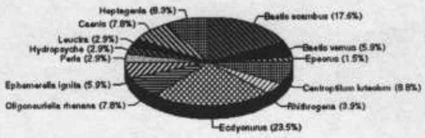

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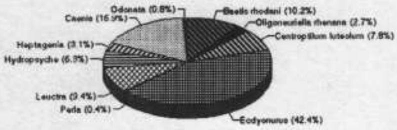

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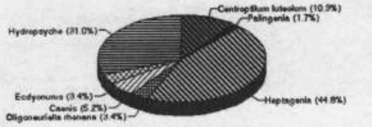

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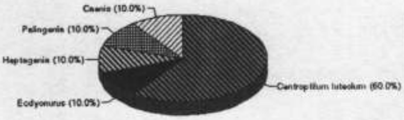

#21 TISA

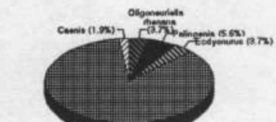

Table 1. Distribution of the mayflies along the Upper Tisa from headwaters to Tivadar village

SAMPLING POINTS EPHEMENOPTERA Fam. Baetidae	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15	16	17	18	19	20	21	22
1.Baetis alpinus Pictet, 1843-45		x	x	x	x	x																	
2.Baetis melanonyx Pictet, 1843-45				x				x				x	x										
3.Baetis lutheri Müller-Liebemau, 1967	x		x	x	x	x						x	x	x	x								
4.Baetis sinaicus (Bogoescu, 1931)	x																						
5.Baetis rhodani Pictet, 1843-45									x		x						x		x		x		
6.Baetis gemellus Eaton, 1885																							
7.Baetis vernus Curtis, 1834		x	x															x					
8.Baetis fuscatus Linné, 1761	x			x	x					x					x					x			
9.Baetis scambus Eaton, 1870					x	x	x	x	x	x					x		x	x					
10.Baetis buceratus Eaton, 1870																			x				
11.Baetis tricolor Tshernova, 1928																						x	
12.Baetis niger Linné, 1761												x		x			x						
13.Baetis gracilis Bogoescu & Tabacaru, 1957												x											
14.Baetis muticus Linné, 1758																				x			
15.Centroptilum luteolum (Müller, 1776)					x	x	x	x	x						x		x	x	x	x	x		
16.Centroptilum pennulatum Eaton, 1870																	x						
17.Prolöeon bifidum (Bengtsson, 1912)																		x	x	x			
Fam. Oligoneuriidae																							
18.Oligoneuriella rhenana (Imhoff, 1852)						x			x	x	x	x	x	x	x	x	x	x	x	x			

Fam. Heptageniidae	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15	16	17	18	19	20	21	22
19.Epeorus sylvicola (Pictet, 1865)																		x					
20.Rhithrogena hercynia Landa, 1969		x		x	x							x						x					
21.Rhithrogena loyolaea Navás, 1922		x	x																				
22.Rhithrogena semicolorata (Curtis, 1834)		x	x	x		x		x						x	x			x			x		
23.Ecdyonurus aurantiacus (Burmeister, 1839)															x			x	x			x	
24.Ecdyonurus austriacus Kimmins, 1958										x													
25.Ecdyonurus dispar (Curtis, 1834)					x					x					x		x			x			
26.Ecdyonurus insignis (Eaton, 1870)		x													x		x	x	x			x	
27.Ecdyonurus subalpinus Klapálek, 1907																		x					
28.Ecdyonurus submantanus Landa, 1969					x	x	x	x	x				x						x				
29.Ecdyonurus venosus (Fabricius, 1775)										x	x		x					x					
30.Electrogena lateralis (Curtis, 1834)																		x	x	x	x		
31.Heptagenia coerulans Rostock, 1877														x	x			x					
32.Heptagenia flava Rostok, 1877												x			x			x	x	x		x	
33.Heptagenia sulphurea (Müller, 1776)														x	x		x	x					x
Fam. Leptophlebiidae																							
34.Choroterpes picteti (Eaton, 1871)		x				x						x	x		x		x						
35.Leptophlebia marginata (Linné, 1767)																							
36.Paraleptophlebia submarginata (Stephens, 1835)					x																		
38.Habrophlebia fusca (Curtis, 1834)						x																	
37.Habroleptoides modesta (Hagen, 1864																							

Table 1. continue

Fam Potamanthidae	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15	16	17	18	19	20	21	22
39. Potamanthus luteus (Linné, 1767)																			x				
Fam. Polymitarcidae																							
40. Ephoron virgo (Olivier, 1791)																				x			
Fam. Ephemeridae																							
41.Ephemera danica																			x			x	
Fam. Ephemerellidae																							
42. Ephemerella ignita (Poda, 1761)	x	x			x	x	x	x		x	x	x	x		x		x	x					
43. Ephemerella major (Klapálek, 1905)										x			x		x		x						
44. Ephemerella notata Eaton, 1887					x					x													
Fam. Caenidae																							
45. Caenis horaria (Linné, 1758)																		x	x			x	
46. Caenis luctuosa (Burmeister, 1839)									x	x	x	x			x		x		x	x	x		
47. Caenis macrura Stephens, 1835																							
48 Caenis rivulorum Eaton, 1884							x			x	x	x	x		x		x						
Fam. Palingeniidae													x	x				x	x				
49. Palingenia longicauda (Olivier, 1791)																				x	x	x	x

Table 1. continue