THE USE OF EPHEMEROPTERA AS SAPROBIC INDICATORS IN AUSTRIA

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Since the 1980s a great variety of Austrian freshwaters have been sampled intensively. Unaffected water courses as well as sections with different types and degrees of human impacts have been studied covering organic pollution, acidification, channelization, regulation, a.o.m.
Experiences based on these collections also allowed a critical assessment of the pertinent bibliography and of unpublished studies. As a result of this analysis it can be stated that determination to the species level is necessary for all investigations concerning saprobic or environmental river quality. The following paper lists all Austrian species of Ephemeroptera together with their saprobic valencies, indicative weights and saprobic indices observed.

INTRODUCTION

River water quality assessment has a long tradition in Austria and is an essential component of the Austrian water protection philosophy. Mandated by the «Water Quality Assessment Act» (Wassergüte-Erhebungsverordnung 1991), the investigation of Austrian waters is regimented by law in terms of rivers, sampling sites, methodology, and sampling frequency. The national system of biological monitoring is based on the «Saprobic System», but includes some additional population and habitat characteristics.
The practical use of saprobic water quality monitoring is ruled by the Austrian standards M 6232. Whereas the overall methodology is more or less standardized, the coexistence of several different lists of saprobic indicators causes consistency problems in creating a federal water quality map of Austria. To overcome this problem Austrian limnologists and hydrobiologists were called upon by the Ministery of Agriculture and Forestry to produce one standard list of saprobic indicators (MOOG, 1995). The ephemeropteran section of the Austrian saprobic list has been revised and is presented in this paper.

METHODS

The authors have attempted to carefully sample the actual stock of Austrian Ephemeroptera including data on habitat use. To achieve this goal, a large variety of Austrian freshwaters was intensively sampled beginning in the 1980s. Relatively natural water courses as well as sections with varying degrees of human disturbances were studied; i.e. organic pollution, acidification, channelization, regulation, etc. In total more than 2,270 sites, covering about 800 rivers and brooks were sampled, ranging between 135 to 2,500 m a.s.l. within the entire area of Austria .
Additional records which have been considered in this review, have been taken from the following sources:

* findings submitted by colleagues, namely ARGE Limnology Innsbruck, Wolfram Graf, Klaus und Ursula Grasser, Johann Hinteregger, Uwe H. Humpesch, Gerhard Hutter, Emil Koekkeok, Claudia Kriechbaum, Christian Moritz, Thomas Ofenböck, Thomas Ritzelfeld, Andreas Römer, Reinhard Saxl, Astrid Schmidt-Kloiber, Gerhard Tautermann, Kurt Traer & Gabriele Wieser
* records obtained from museum collections
* reports by the Upper Austrian and by the Carinthian Water Authority
* unpublished diploma theses and dissertations
* unpublished reports and studies
* literature records
* sapro-biologic literature

The sum of records and the references consulted are too voluminous to be cited here in detail. Readers who seek additional details are encouraged to contact the authors.
These results are based on experience and well documented autoecological requirements. Because the sampling distribution does not unbiasely cover each species' natural distribution, and relatively few pristine areas were included due to the nature of findings, we refrained from statistical analyses of saprobic ranking.
The saprobic ratings given are based on the 10-point-system following ZELINKA & MARVAN (1961). Species with unknown saprobic tolerances are not categorized. Species with little available information on saprobity are given a strongly preferred (*) or preferred (+) rating corresponding to their known and existing saprobic range. Additionally, the rare occurence of a species in a category beyond its normal saprobic range is indicated with a plus (+) sign.
The Zelinka & Marvan ranking system was chosen because of the recomendation by the UN/ECE Task Force on Monitoring & Assessment for the harmonization of methodology: «It is recommended in assessing the saprobic state of a river, to use the saprobity index according to Zelinka & Marvan combined with the most recent species indication list.»

Table 1. Literature review of the saprobic index classification of Ephemeroptera: Baetidae.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Baetis:																									
B. alpinus	1,3	1,3	1,0/1,2	1,3	1,0/1,2	1,2	1,0	1,2	0,3	1,3		1,0	1,3	1,4	0,2	0,3	0,2		0,3						
B. buceratus	2,1	2,1	2,0	2,1	2,0									2,1		2,1									
B. fuscatus	2,1			2,1	2,0	2,1	2,1	2,1	2,3			1,5		2,1		2,1	2,3								
B. lutheri	1,6	1,6	1,5	1,6	1,5		1,6		1,3			1,5		1,6		1,6									
B. melanonyx	1,1	1,1	1,0	1,1	1,0				0,8	1,1		1,0	1,1												
B. muticus	1,5	1,5	1,5/1,4	1,5	1,5/1,4	1,4	1,4	1,4	1,6	1,5		1,0	1,5	1,4		1,3	1,5		1,5						
B. niger		1,8	2,0	1,8	2,0		1,8		1,7			2,0		1,8		1,8							1,4		
B. rhodani	1,6	1,7	2,3	1,7	2,3	2,3	1,6	2,3	2	1,7		1,5	1,7	1,6	1,1	1,4	1,1	1,2	1,2				2,1	0,3	1,2	1,5
B. scambus		1,9	2,0	1,9	2,0		1,9		1,2			1,5		1,9	1,5	1,9					1,5			1,5	
B. vernus	2,1	2,1	2,0/2,1	2,1	2,0/2,1	2,1	2,0	2,1	2,1	2,1		2,0	2,1	2,0	2,15	2,0	?								
Centroptilum:																									
C. luteolum		1,9	2,0/1,9	1,9	2,0/1,9	1,9	1,9	1,9	1,9	1,9		2,0	1,9	1,9	1,9	1,9	1,9	1,9			1,8	1,7		1,8	
C. pennulatum		1,9	2,0	1,4	2,0		1,4							1,4		1,4									
Cloeon:																									
C. dipterum		2,1	2,0/2,2	2,1	2,0/2,2	2,2	2,1	2,2	2			2,0		2,1	2,0	2,1	2,0	2,0	2,0	2,0					
C. simile		1,8	2,0/2,2	1,8	2,0/2,2	2,2	1,8	2,2	2		2,5	2,0		1,8		1,8									

1. Oberösterreich 1995
2. Oberösterreich vor 1991
3. Bayern 1993
4. Polzer & Traer 1991
5. Bayern 1990
6. Friedrich 1990
7. Steiermark 1989
8. Schmedtje & Kohmann 1988
9. Braukmann 1987
10. Innsbruck 1987
11. Ziese 1987
12. Bayern 1985
13. Margreiter-Kownacka et al. 1984
14. Wegl 1983
15. Gulyas 1983
16. Sladecek et al. 1981
17. Sladecek 1973
18. Cyrus & Sladecek 1969
19. Sladecek 1964
20. Zelinka & Sladecek 1964
21. Zelinka & Marvan 1961
22. Dittmar 1960
23. Zelinka 1960
24. Zlinka, Marvan & Kubicek 1959
25. Billy, Hanuska & Winkler 1952

Table 2. Literature review of the saprobic index classification of Ephemeroptera: Heptageniidae. *Classified as *R. tatrica* (Syn.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Heptagenia:																												
H. coerulans			2,0	2,0	2,0		2,0	2,2				2,0		2,2	2,0	2,2	2,0	2,0			2,1			2,2				
H. flava			2,1	2,0	2,1	2,0	2,0	2,0	2,0			2,0		2,0	2,25	2,1	2,25				2,2			2,2				
H. fuscogrisea			1,8	2,0	1,8		2,0	1,8				2,0		1,8	1,75	1,8	1,75				1,8			1,8				
H. sulphurea		1,9	1,9	2,0	1,9	2,0	2,0	1,9	2,0	2,3		2,0		1,9	2,25	1,9	2,25	2,2			2,0			2,0				
Ecdyonurus:																												
E. aurantiacus			2,1		2,1			2,0						2,1	2,0	2,1							1,7					
E. dispar			1,9		1,9			1,9						1,9	2,15	1,9	2,15		2,0		1,8			2,1				
E. insignis			1,8		1,8			1,8				1,5		1,8	2,0	1,8	2,0	2,0		2,0	2,0			2,0				
E. macani			1,5		1,5	1,7		1,5	1,7	1,6				1,5	1,65	1,5	1,69	1,7			1,5		1,3	1,5				1,7
E. subalpinus			0,8		0,8									1,2		0,8												
E. submontanus			0,7		0,7			1,2				1,0		1,2		0,7												
E. torrentis			1,1		1,1									1,3		1,1											1,4	
E. venosus		1,3	1,3	1,7	1,3	1,7	1,7	1,5	1,7			1,5		1,5	2,25	1,3	1,15	2,1		2,1	2,1		1,6		1,43	2,1		
Electrogena:																												
E. lateralis			1,5	1,5	1,5	1,5	1,5		1,5						1,6	1,3	1,6	1,6	1,8	1,6	1,6			1,6				
E. quadrilineata			1,5		1,5									1,5		1,5												
Epeorus:																												
E. alpicola			0,8	1,0	0,8		1,0			0,1	0,8	1,0	0,8				0,55		0,6									
E. sylvicola		1	1,0	1,0/1,4	1,0	1,4	1,0/1,4	1,1	1,4	0,6	0,6	1,0	1,0	1,1	0,55	0,8		0,6			0,6	1,3	0,6	0,6				
Rhithrogena:																												
R. alpestris	0,6																											
R. aurantiaca																	1,5											
R. carpatoalpina	1,2																											
R. degrangei	1,0																											
R. germanica												1,0																
R. gratianopolitana	1,2																											
R. hercynia				1,0																								
R. hybrida				1,0			1,0	0,1				1,0		1,0	0,1	0,1	0,1				0,0	0,0		0,0				
R. iridina				1,5			1,5			0,3																		
R. loyolea	0,7		0,6		0,6			0,1*				1,0		1,0*		0,0*	0,1*				0,0	0,0		0,0				
					0,1*																							
R. picteti	1,0		0,5		0,5									1,0		0,5												
R. podhalensis	1,0																											
R. puthzi	0,6																											
R. semicolorata				1,5/1,6		1,6	1,5	0,1	1,6			1,5		1,2	0,3	0,5	0,3	0,3	0,3	0,3	0,3	0,3	0,3	1,2	0,3	1,3		

1. Weichselbaumer pers. com.
2. Oberösterreich 1995
3. Oberösterreich vor 1991
4. Bayern 1993
5. Polzer & Traer 1991
6. Friedrich 1990
7. Bayern 1990
8. Steiermark 1989
9. Schmedtje & Kohmann 1988
10. Braukmann 1987
11. Innsbruck 1987
12. Bayern 1985
13. Margreiter-Kownacka et al. 1984
14. Wegl 1983
15. Gulyas 1983
16. Sladecek et al. 1981
17. Sladecek 1973
18. Cyrus & Sladecek 1969
19. Sladecek 1964
20. Zelinka & Sladecek 1964
21. Zelinka & Marvan 1961
22. Zelinka 1960
23. Dittmar 1960
24. Zelinka, Marvan & Kubicek 1959
25. Buck 1959
26. Vondrejs 1958
27. Obr 1956
28. Billy, Hanuska & Winkler 1952

Table 3. Literature review of the saprobic index classification of Ephemeroptera: Caenidae.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Caenis:																				
C. beskidensis	1,4		2,0																	
C. horaria		2,2	2,0	2,2	2,0	2,2	1,8	2,0	2,2		2,2									
C. luctuosa		1,5	2,0	1,5	2,0	1,5			1,5		1,5									
C. macrura	1,6	1,6	2,0	1,6	2,0	1,7	0,9	2,0	1,7	0,8	1,6	0,75	0,8	0,8	0,8	0,8	1,6	0,7	0,7	1,7
C. pseudorivulorum		1,6		1,6					1,4		1,4									
C. rivulorum			2,0		2,0		0,9	2,0												
C. robusta		2,2	2,0	2,2	2,0				2,2		2,2									
Brachycercus:																				
B. harisella		1,8	2,0	1,8	2,0	1,8		2,0	1,8		1,8							1,4			

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7. Braukmann 1987
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12. Sladecek 1973
13. Cyrus & Sladecek 1969
14. Sladecek 1964
15. Zelinka & Sladecek 1964
16. Zelinka & Marvan 1961
17. Dittmar 1960
18. Zelinka, Marvan & Kubicek 1959
19. Vondrejs 1958
20. Billy, Hanuska & Winkler 1952

Table 4. Literature review of the saprobic index classification of Ephemeroptera: remaining families.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Leptophlebiidae:																									
Leptophlebia:																									
L. marginata		1,9		1,9					1,8				1,9		1,9										1,8
L. vespertina		1,8	1,5	1,8	1,5		1,8		1,8		1,5		1,8		1,8										
Habroleptoides:																									
H. confusa		1,1	1,5/1,6	1,1	1,5/1,6	1,6	1,1	1,6	1,1	1,1		1,1	1,4	1,05	2,3	1,05		1,1							
Paraleptophlebia:																									
P. cincta		1,7	2,0	1,7			1,7		1,5				1,7		1,7										
P. submarginata	1,6	1,6	2,0/1,5	1,6	2,0	1,5	1,6	1,5	1,5	1,6	1,5	1,6	1,6	1,5	1,6	1,5				1,5	1,3				1,5
P. werneri		1,2		1,2									1,3		1,2										
Habrophlebia:																									
H. fusca	1,5	1,5	1,5	1,5	1,5		1,6		1,7		1,5		1,6	1,55	1,5	1,55									
H. lauta		1,4	1,5	1,4	1,5		1,5		1,6		1,5		1,5	1,55	1,4	1,55				1,5	1,6				
Oligoneuriidae																									
Oligoneuriella																									
O. rhenana	2,0	2,0	1,5	2,0	1,5		1,9				1,5		1,9	1,75	2,0	1,8		1,8		1,8			1,8		1,8
Pothamantidae																									
Potamanthus																									
P. luteus	2,2	2,2	2,0/2,1	2,2	2,0/2,1	2,1	2,0	2,1			2,0		2,0	2,25	2,2	2,2	2,2	2,2	2,2	2,2			2,2		2,2
Polymitarcyidae																									
Ephoron																									
E. virgo		2,3	2,0	2,3	2,0		2,3				2,0		2,3	2,3	2,3	2,3	2,3			2,4			2,4		2,4
Siphlonuridae																									
Ameletus																									
A. inopinatus		0,1	1,0	0,1	1,0		0,1		0,1		1,0		0,1	0,1	0,1	0,1	0,1	0,0	0,1	0,1		0,1	0,1		
Siphlonurus																									
S. lacustris		0,8	2,0	0,8	2,0				2,2		2,0		1,2												
S. aestivalis		2,0	2,0	2,0	2,0				2,0		2,0		2,0												
S. armatus		1,8	2,0	1,8	2,0								1,8												
Ephemeridae																									
Ephemera																									
E. danica	1,5	1,5	2,0/1,8	1,5	2,0/1,8	1,8	1,6	1,8	1,7	1,5	2,0		1,6	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5		1,5	1,4	1,5
E. lineata		2,1		2,1									2,1		2,1										
E. vulgata	2,2	2,2	2,0	2,2	2,0		2,2		2,0		2,0		2,2	2,0	2,2	2,0									1,5
Ephemerellidae																									
Ephemerella																									
E. ignita	1,8	1,9	2,0/1,9	1,9	2,0/1,9	1,9	2,1	1,9	1,9	1,9	2,0	1,9	2,1	1,95	2,1	1,95	1,8	1,8	1,8	1,8	1,8	1,8	1,8	1,59	1,8
E. notata	2	1,8	2,0	1,8	2,0		2,0		0,8	1,8			2,0		2,0						1,7				
E. mucronata	0,6		1,5/1,4		1,5/1,4	1,4	1,3	1,4	0,4		1,0		1,3			0,4		0,4							
E. major	1,5	1,5	2,0/1,4	1,5	2	1,4	1,5	1,4	1,6	1,5	2,0	1,5	1,5	1,5	1,4	1,5		1,5							
E. mesoleuca		2,1		2,1									2,1		2,1										

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19. Zelinka & Sladecek 1964
20. Zelinka & Marvan 1961
21. Dittmar 1960
22. Zelinka 1960
23. Zelinka, Marvan & Kubicek 1959
24. Buck 1959
25. Vondrejs 1958

EPHEMEROPTERA AS SAPROBIC INDICATORS

The application of mayflies as indicators of saprobic conditions began with KOLKWITZ & MARSSON (1902, 1908, 1909). The lists of LIEBMANN (1951) and SLADECEK (1973, 1981) are widely used and MAUCH (1976) summarizes previously published saprobiological knowledge. Several national saprobic lists exist, because the saprobic system is presently one of the most commonly used biological assessment methods in many European countries, namely Austria, Croatia, Czech Republic, Germany, Latvia, Poland, Romania and the Slovak Republik. In Bulgaria, Denmark, Hungary, Lichtenstein, the Netherlands and Switzerland, the saprobic system is used occasionally or only in common investigation sites in transboundary rivers.

Differences between these European countries not only include sampling equipment, frequency and organisms targeted, but also varying saprobic indicator values for specific species. Tables 1-4 give an overview of formerly and currently used lists of Ephemeropteran saprobic indicators. It seems rather surprising that the specific saprobic indices differ so widely within their distributional ranges. The different ratings for a given species range over 2 full saprobic classes (e.g. *Baetis rhodani*) and only four species are similarly ranked. It is well known that species may show different environmental needs within their area of distribution. One explanation for this phenomenon is the «regional stenoecia theory» according to KÜHNELT (1942), which describes the fact that animals may alter their behaviour across changing environmental conditions at the edges of their distribution. Also the possibility that ecotypes or races may evolve leads to different environmental requirements of one and the same species in different locations.

However, these theories can not explain such varying saprobic requirements as given by these different systems. Because the saprobic potency (valency) of a species reflects its sensitivity against oxygen depletion, such large variations in oxygen requirements cannot be explained so simply.

Therefore these inconsistent saprobic indices appear are more likely to be a result of misidentifications and differing definitions of water quality classes than of varying oxygen requirements of locally separated specimens. Saprobic lists based on investigations of pristine and clean waters contain «better» (lower) indices than the saprobic lists based on investigations of lowland regions, or lists that are based on surveys of many polluted rivers.

REVISED AUSTRIAN LIST OF SAPROBIC EPHEMEROPTERAN INDICATORS

Table 5 demonstrates the revised Austrian list of saprobic Ephemeropteran indicators. In Austrian waters Ephemeroptera are to be found in xeno- and oligo, beta-meso- and alpha-mesosaprobic conditions. The specific saprobic indices range between 0,4 to 2,6. Most of the mayfly larvae prefer oligo- and/or beta-mesosaprobic conditions. The distribution of the saprobic indices shows that oligo- and beta-mesosaprobic indicators prevail in two distinct groups (Fig. 1). Some (montane) heptageniid and baetid species, perform as oligosaprobic indicators (21 species) and others as xeno-saprobic species (9 species). The most numerous groups are found in water quality class two (31 species), while the transition zone (class I-II) is indicated by 16 species only. Ten species indicate water quality conditions below class II. Of the total inventory of 111 Austrian Ephemeropteran species, the saprobic classification for 88 well documented species could be given. Of the 21 additional species for which we have only supplied a descriptive categorical rating, 11 were given numerical ranks by other authors. For 13 species of the Austrian list we have determined a substantially different saprobic ranking.

Table 6 demonstrates that, in contrast to many environmental monitoring indices that use higher taxonomic categories (genus, family) in defining levels of disturbance, only species level associations are effective. Saprobic indices range from low to high values within each of the listed genera below. Hence, we refuse to offer a genus level index and we strongly recommend that saprobic analyses are to be conducted at the species level.

Table 5. Distribution within saprobic class.Saprobic classification scheme (explanation): x: xenosaprobic; o: oligosaprobic; β: beta-mesosaprobic; α: alpha-mesosaprobic; p: polysaprobic; G: indicative weight of a species; SI: specific saprobic index.

	x	o	β	α	p	G	SI
Acentrella							
A. sinaica	+	*	+	-	-	-	-
Ameletus							
A. inopinatus	5	5	-	-	-	3	0,5
Arthroplea							
A. congener	-	-	+	-	-	-	-
Baetis							
B. alpinus	2	4	4	-	-	2	1,2
B. buceratus	-	1	4	5	-	2	2,4
B. digitatus	-	*	-	-	-	-	-
B. fuscatus	-	+	8	2	-	4	2,2
B. liebenauae	-	-	*	-	-	-	-
B. lutheri	-	4	6	+	-	3	1,6
B. melanonyx	2	5	3	-	-	2	1,1
B. muticus	1	4	5	+	-	2	1,4
B. niger	-	3	6	1	-	3	1,8
B. pentaphlebodes	-	+	7	3	-	4	2,3
B. rhodani	-	2	5	3	-	2	2,1
B. scambus	-	3	7	-	-	4	1,7
B. tricolor	-	-	*	*	-	-	-
B. vardarensis	-	-	8	2	-	4	2,2
B. vernus	+	2	3	5	-	2	2,3
Brachycercus							
B. harrisella	-	-	*	*	-	-	-
Caenis							
C. beskidensis	1	4	5	+	-	2	1,4
C. horaria	-	1	6	3	-	3	2,2
C. lactea	-	-	-	-	-	-	-
C. luctuosa	-	+	7	3	-	4	2,3
C. macrura	+	3	5	2	-	2	1,9
C. pseudorivulorum	-	3	5	2	-	2	1,9
C. rivulorum	-	3	5	2	-	2	1,9
C. robusta	-	1	6	3	-	3	2,2
Centroptilum							
C. luteolum	-	1	7	2	-	3	2,1
C. pennulatum	-	1	5	4	-	2	2,3
C. pulchrum	-	-	*	-	-	-	-
C. stenopteryx	-	-	*	-	-	-	-
Cloeon							
C. dipterum	-	+	5	4	1	2	2,6
C. simile	+	1	5	4	-	2	2,3
Ecdyonurus							
E. aurantiacus	-	-	8	2	-	4	2,2
E. austriacus	3	5	2	-	-	2	0,9
E. dispar	-	1	7	2	-	3	2,1
E. helveticus	3	5	2	-	-	2	0,9
E. insignis	-	1	6	3	-	3	2,2
E. macani	-	6	4	+	-	3	1,4
E. picteti	3	5	2	-	-	2	0,9
E. ruffii	-	-	*	-	-	-	-
E. starmachi	1	5	4	-	-	2	1,3
E. subalpinus	-	*	-	-	-	-	-
E. submontanus	4	5	1	-	-	2	0,7
E. torrentis	2	4	4	-	-	2	1,2
E. venosus	2	4	4	+	-	2	1,2
E. zelleri	5	4	1	-	-	2	0,6
Electrogena							
E. fascioculata	-	3	5	2	-	2	1,9
E. lateralis	1	5	3	1	-	1	1,4
E. quadrilineata	-	*	-	-	-	-	-
E. ujhelyii	-	2	7	1	-	3	1,9
Epeorus							
E. alpicola	5	5	+	-	-	3	0,5
E. sylvicola	+	6	4	-	-	3	1,4
Ephemera							
E. danica	+	3	6	1	-	3	1,8
E. glaucops	-	-	-	-	-	-	-
E. lineata	-	-	*	-	-	-	-
E. vulgata	-	1	6	3	-	3	2,2
Ephemerella							
E. ignita	+	2	5	3	-	2	2,1
E. major	-	4	4	2	-	2	1,8
E. mesoleuca	-	-	*	-	-	-	-
E. mucronata	+	6	4	+	-	3	1,4
E. notata	-	2	6	2	-	3	2,0
Ephoron							
E. virgo	-	+	7	3	-	4	2,3
Habroleptoides							
H. confusa	+	5	4	1	-	2	1,6
Habrophlebia							
H. fusca	1	4	4	1	-	1	1,5
H. lauta	-	3	4	3	-	2	2,0
Heptagenia							
H. coerulans	-	-	8	2	-	4	2,2
H. flava	-	-	7	3	-	4	2,3
H. fuscogrisea	-	3	6	1	-	3	1,8
H. longicauda	-	-	7	3	-	4	2,3
H. sulphurea	-	2	6	2	-	3	2,0
Isonychia							
I. ignota	-	-	*	-	-	-	-
Leptophlebia							
L. marginata	-	2	6	2	-	3	2,0
L. vespertina	+	3	6	1	-	3	1,8
Oligoneuriella							
O. rhenana	+	2	7	1	-	3	1,9
Paraleptophlebia							
P. cincta	-	-	*	-	-	-	-
P. submarginata	-	5	4	1	-	2	1,6
P. werneri	-	*	-	-	-	-	-
Potamanthus							
P. luteus	-	-	8	2	-	4	2,2
Procloeon							
P. bifidum	-	2	4	4	-	2	2,2
Rhithrogena							
R. allobrogica	1	6	3	-	-	3	1,2
R. alpestris	5	4	1	-	-	2	0,6
R. austriaca	4	4	2	-	-	2	0,8
R. beskidensis	+	2	7	1	-	3	1,9
R. carpatoalpina	2	4	4	-	-	2	1,2
R. circumtatrica	2	5	3	-	-	2	1,1
R. degrangei	3	4	3	-	-	2	1,0
R. endenensis	3	5	2	-	-	2	0,9
R. germanica	-	-	*	-	-	-	-
R. gratianopolitana	2	4	4	-	-	2	1,2
R. hercynia	-	6	4	-	-	3	1,4
R. hybrida	4	4	2	-	-	2	0,8
R. iridina	-	*	*	-	-	-	-
R. landai	3	4	3	-	-	2	1,0
R. loyolaea	4	5	1	-	-	2	0,7
R. nivata	6	4	-	-	-	3	0,4
R. picteti	2	4	4	-	-	2	1,2
R. podhalensis	3	4	3	-	-	2	1,0
R. puthzi	4	5	1	-	-	2	0,7
R. puytoraci	1	6	3	-	-	3	1,2
R. rolandi	2	4	4	-	-	2	1,2
R. savoiensis	1	4	4	1	-	1	1,5
R. semicolorata	-	3	5	2	-	2	1,9
R. taurisca	6	4	-	-	-	3	0,4
R. vaillanti	+	5	4	1	-	2	1,6
R. zelinkai	*	-	-	-	-	-	-
Siphlonurus							
S. aestivalis	-	2	6	2	-	3	2,0
S. alternatus	-	-	*	-	-	-	-
S. armatus	-	-	*	-	-	-	-
S. croaticus	+	5	4	1	-	2	1,6
S. lacustris	2	4	4	-	-	2	1,2

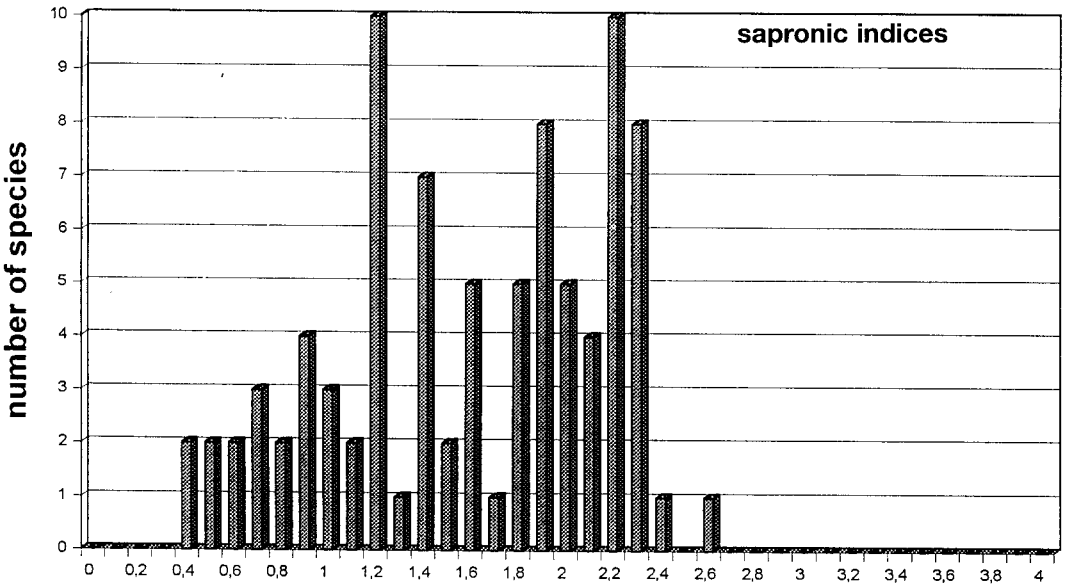

Fig. 1. Range of sapronic indices of the Austrian Ephemeroptera.

Table 6. Breakdown of saprobic index range by genus.

Genus (with more than 3 species)	Range of specific saprobic index
Baetis	1,1 - 2,4
Caenis	1,4 - 2,3
Ecdyonurus	0,6 - 2,2
Ephemerella	1,4 - 2,1
Heptagenia	1,8 - 2,3
Rhithrogena	0,4 - 1,9

In order to carry out water quality assessment throughout Austria in a consistant and meaningful fashion standard lists of saprobic ratings are needed. We present revised list of saprobic indices for most Ephemeroptera species found in Austria. Saprobic ratings for individual species in this revised list may differ widely from previously published lists. We feel that these inconsistencies are primarily based on misidentifications of species as well as on differing definitions of water quality classes and not on varying oxygen requirements of species within their distributional range. As a result of this analysis it can be stated that determination to species level is necessary for all investigations concerning saprobic or environmental river quality.

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