

Euro-limpacs



Project no. **GOCE-CT-2003-505540**

Project acronym: **Euro-limpacs**

**Integrated Project to evaluate the Impacts of Global
Change on European Freshwater Ecosystems**

Instrument type: **Integrated Project**

Priority name: **Sustainable Development**

Deliverable No. 92

Habitat preferences of selected indicators

Due date of deliverable: **Month 34**

Submission date: **18/12/2006**

Start date of project: **01.02.04** Duration: **5 Years**

Organization name of lead contractor for this deliverable:
ALTERRA, Green World Research, Wageningen, The Netherlands



**Integrated Project to evaluate the Impacts of Global Change
on
European Freshwater Ecosystems**

WP2: Climate-hydromorphology interactions

Task 2: Hydromorphological changes and aquatic and riparian
biota

Subtask 2.3: Autecological and laboratory experiments

Deliverable No. 92

Habitat preferences of selected indicators

Compiled by

Piet Verdonschot & Wouter Lengkeek
ALTERRA, Green World Research, Wageningen, The Netherlands

Contents

1. Analysis of macroinvertebrate habitat preferences in Dutch lowland streams.

Task 2 of Workpackage 2, in combination with task 3 and 5, deals with the major question: ‘What is the relation between discharge dynamics, hydromorphology in terms of habitat stability and diversity and the occurrence of indicator species in other words how tolerant are indicator species to habitat (in)stability?’

The first step was the selection of indicator species. Indicator species should be representative of the important stream habitats (proposed sand and detritus patches) under study. Furthermore, indicator species should be indicative for direct effects of habitat change, thus become more (indicator of disturbance) or less (indicator of reference) abundant if the habitat is disrupted.

This report compiles the selection of indicators and the analysis of their habitat preferences. This was necessary before testing the tolerance for habitat instability and to examine the causes of habitat binding of selected indicators. the report also adds to Deliverable 94.

2. Material and methods

A total of 604 habitat-specific macroinvertebrate community samples were taken from 16 different Dutch lowland streams and contained 547 taxa. The samples were taken from eight of in total 10 predefined habitat types. Table 1 presents the number of samples obtained from each habitat type separately for each stream.

To investigate taxon-specific habitat preferences, first, the species distributions over the eight habitat types were tested against random distributions with chi-squared analyses. Then, two independent methods were used to determine preferences for specific habitat types:

- (1) Weighted-averaging with the program C_2 was used to calculate species optima and tolerances (Juggins 2003).
- (2) Indexes of representation (IR) were calculated according to the methods described by Hildrew and Townsend (1976). (Note that from the total of 547 taxa, 192 taxa were distributed in a manner that significantly deviated from random, $P < 0.05$. No Bonferroni correction was used and it can therefore be expected that with 547 significance tests being carried out, significant non-random distributions should occur in 27 taxa based on random expectations, i.e. 27 of the 192 significant chi-square results may have occurred randomly).

Some taxa occurred in low numbers, or were not identified to the species level, troubling reliable interpretations on habitat preferences. Therefore, not all taxa were used. Taxa were deemed meaningful for further interpretation when:

- (1) More than five specimens were encountered in the samples
- (2) The distributions over the eight habitat types significantly deviated from random distributions
- (3) Taxa were identified to the species level unless higher groups could be assumed to have similar habitat requirements.

This ultimately left 128 taxa that could be used to interpret habitat preferences.

Table 1. Streams, habitat types and numbers of obtained samples.

stream	habitat type	number of samples	stream	habitat type	number of samples
Bosbeek	leaves	3	Reusel	detritus	7
	detritus	9		gravel	3
	sand	3		vegetation	5
total Bosbeek	3	15		sand	4
Bunderbosbeek	gravel	2	total Reusel	4	19
Elsbeek	leaves	11	Rodebeek	leaves	2
	detritus	1		detritus	6
	gravel	17		gravel	3
	clay	1		sand	4
	mud	15	total Rodebeek	4	15
	branches/wood	9	Rosep	detritus	6
	vegetation	8		vegetation	12
	sand	17		sand	3
total Elsbeek	8	79	total Rosep	3	21
Fredbeek	leaves	3	Seelbeek	grind	2
	detritus	6		Springendal	leaves
	gravel	2	detritus		64
	sand	4	gravel		69
total Fredbeek	4	15	clay		2
Jufferbeek	gravel	1	mud		60
	sand	1	branches/wood		2
total Jufferbeek	2	2	vegetation		35
Koudebeek	leaves	3	sand		80
	detritus	6	total Springendal	8	380
	sand	6	Strabekervloedgraaf	gravel	2
total Koudebeek	3	15		Tongerensebeek	leaves
Oude beek	gravel	7	detritus		3
	detritus	5	gravel		3
	vegetation	4	vegetation		4
	sand	3	sand		3
total Oudebeek	5	19	total Tong. beek	5	16
Platsbeek	gravel	2			

3. Results

3.1 Taxon habitat preferences

Weighted-averaging methods in the program C_2 are conventionally used to calculate taxon specific optima and tolerances for continuous habitat variables (Juggins 2003). However, when investigating preferences for several habitat types, variables are used as binominal variables; i.e. a sample is taken from the habitat type 'leaves' (score 1) or not (score 0). Because eight habitats were sampled, the majority of the variable scores for any specific taxon will thus be zero. This can cause a problem, especially for calculating tolerances. Therefore, a preliminary analysis is carried out, to investigate if the C_2 optimum and tolerance results are meaningful for these data.

For this preliminary analysis, the optima, tolerances and IR-values for the habitat-type 'leaves' were used. The weighted-averaged tolerances are strongly correlated with the optima ($r=0.62$, $n=128$, $P<0.001$, Figure 1), following a curved trend of increasing tolerance with optimum until an optimum of 0.5 after which tolerance decreases with increasing optimum. This indicates non-independence of the two values, strongly suggesting that these methods can not be used to explore habitat preferences within these data, as the calculated tolerances seem not appropriate. In addition, the optima are compared to the IR-values (Figure 2). Again these are highly correlated ($r=0.79$, $n=128$, $P<0.001$), suggesting that, in large part, the same information is comprised in the IR values as is comprised in the weighted-averaged optima, at least for these data. Therefore, in subsequent analyses, the weighted average optima and tolerances are not used and interpretations on habitat preferences are based on the IR results only. For completeness, the C_2 results for optima and tolerances for all other habitat types are included in Appendix 1.

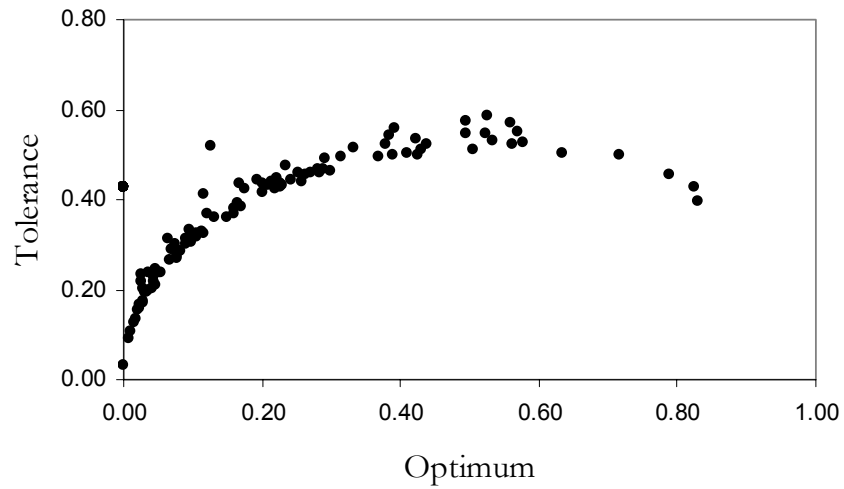


Figure 1. Correlation between optimum and tolerance as calculated by the program C2 for the leaves habitat-type.

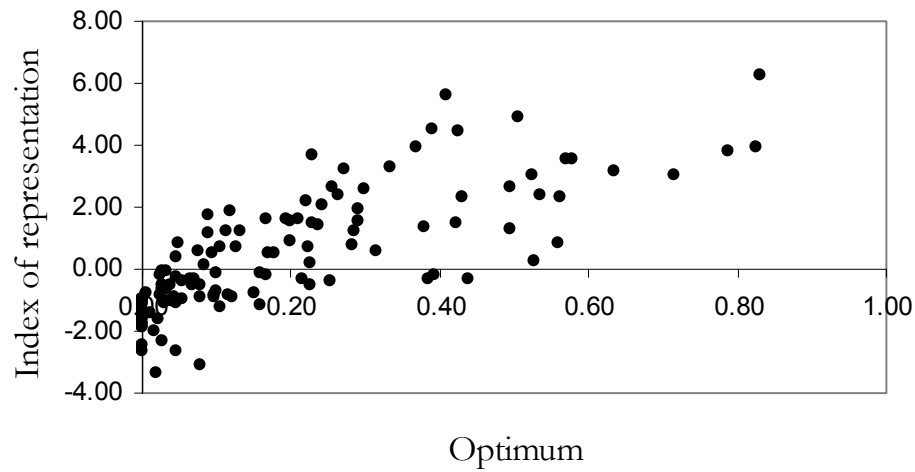


Figure 2. Correlation between the optimum and IR for the leaves habitat type.

Table 2 presents the results of the chi-square and IR analyses for the 128 non-randomly distributed species. According to Tolcamp (1980), IR-values are especially meaningful when they deviate more than two from zero (marked gray in table 2), with positive

values indicating a preference for the habitat type and negative values indicating aversion. Each habitat type has a substantial number of species representing either preference or aversion (Table 2) except for habitat type clay, which has only four. However, this result should be interpreted with caution, because the low number of representative taxa for clay could be caused by the low number of samples for that habitat type (3, Table 1).

Table 2. Index of Representation (IR) results. Presented for each taxon are: (1) the IR-value for each of the eight sampled habitat types, (2) N, which represents the abundance of a taxon in all samples and (3) the chi- and P- value that resulted from testing for non-random distribution. Gray markings indicate IR-values that deviate more than 2 from zero.

taxon name/ habitat type	index of representation								N	chi	P<
	leaves	detritus	clay	mud	branches/ wood	Veg- itation	sand	gravel			
Agabus sp larve	3.31	-0.04	-0.23	-1.17	1.79	0.68	-1.53	-1.43	11	20.42	0.005
Agapetus fuscipes	-2.48	-0.87	-0.51	-1.75	-0.97	-1.59	-2.11	8.42	52	89.13	0.001
Amphinemura standfussi	3.94	-0.60	-0.72	-1.40	0.06	-1.69	-3.66	3.46	105	46.58	0.001
Apsectrotanypus trifascipennis	-0.93	2.92	-0.49	0.37	-0.94	2.33	-0.74	-3.03	49	25.81	0.001
Asellus aquaticus	1.63	-0.48	-0.65	-0.17	5.19	4.99	-3.30	-2.73	85	73.50	0.001
Athripsodes aterrimus	-1.24	0.54	-0.32	-1.00	-0.62	4.97	-1.64	-0.47	21	30.87	0.001
Aulodrilus japonicus	-0.82	4.36	-0.65	-1.68	-1.24	2.45	-0.90	-2.70	84	38.59	0.001
Baetis rhodani	-1.88	-1.59	-0.34	-1.69	-0.65	-0.99	-1.75	7.57	23	70.78	0.001
Baetis vernus	-0.75	-0.55	-0.33	-1.65	-0.63	4.78	-1.23	0.44	22	28.67	0.001
Bereodes minutus	3.05	-0.16	-0.24	-1.22	-0.47	2.28	-1.59	-1.50	12	21.11	0.005
Brillia modesta	6.23	-0.27	-0.77	-1.24	1.24	-0.11	-3.63	-0.69	119	56.25	0.001
Caenis horaria	-0.54	0.77	-0.31	-0.88	-0.59	4.69	-1.01	-1.89	19	28.68	0.001
Calopteryx virgo	-1.04	0.60	-0.19	-0.93	-0.36	4.74	-1.22	-1.14	7	27.78	0.001
Centroptilum luteolum	-1.11	0.41	-0.20	-1.00	2.24	3.27	-0.53	-1.22	8	19.89	0.01
Chaetocladius gr piger	0.41	-1.22	-0.44	0.07	3.90	0.29	-2.53	2.11	39	28.02	0.001
Chaetopteryx villosa	-0.69	2.56	-0.32	-1.00	-0.62	0.41	-2.11	1.04	21	14.21	0.05
Chironomus sp	-0.42	0.01	-0.40	3.52	1.86	0.74	-2.22	-1.22	32	23.17	0.005
Clinotanypus nervosus	-1.36	1.17	-0.24	0.42	-0.47	3.14	-0.97	-1.50	12	16.71	0.05
Cloeon dipterum	0.74	-0.75	-0.30	0.51	-0.57	3.49	-0.93	-1.84	18	18.22	0.05
Conchapelopia sp	3.67	0.62	-0.80	-1.23	5.02	2.53	-3.48	-2.65	128	66.72	0.001
Corynoneura celeripes	3.53	0.36	-0.25	-1.27	1.57	0.44	-1.66	-1.56	13	22.14	0.005
Corynoneura coronata agg	1.41	-1.56	-0.25	0.30	3.62	2.10	-1.66	-0.92	13	25.71	0.001
Corynoneura lobata agg	-0.62	-1.50	-0.24	-1.22	1.67	3.14	-1.59	1.84	12	22.76	0.005
Corynoneura scutellata agg	0.89	-0.27	-0.19	-0.93	2.44	2.49	-1.22	-1.14	7	16.74	0.05
Cricotopus gr sylvestris	-0.21	-1.22	-0.20	-1.00	-0.38	4.32	-1.30	0.41	8	23.24	0.005
Cryptochironomus sp	-1.75	-0.90	-0.32	0.96	1.05	2.50	0.86	-1.42	20	15.01	0.05
Dendrocoelum lacteum	3.78	0.60	-0.19	-0.93	-0.36	-0.89	-1.22	-1.14	7	19.25	0.01

taxon name/ habitat type	index of representation								N	chi	P<
	leaves	detritus	clay	mud	branches/ wood	Veg- itation	sand	gravel			
Dicranota sp	-2.65	0.58	1.83	-1.24	-1.47	-0.93	0.35	3.34	119	26.51	0.001
Diplocladius cultriger	0.58	-1.00	3.53	-0.56	3.46	1.93	-1.72	-0.38	14	32.88	0.001
Dixa gr maculata	0.85	0.46	-0.29	-0.76	-0.56	3.68	-1.90	-1.22	17	20.53	0.005
Dixa submaculata	0.52	1.01	-0.21	-1.06	-0.40	2.97	-1.38	-1.30	9	15.02	0.05
Dryopidae	-0.05	-0.38	-0.32	-1.58	4.37	2.50	-1.57	0.13	20	30.54	0.001
Dugesia gonocephala	1.84	0.88	-1.02	1.52	-1.96	-0.36	-3.10	0.56	211	21.43	0.005
Elodes minuta	5.58	2.15	-0.79	-0.92	-0.85	1.54	-3.81	-3.21	126	65.22	0.001
Eloeophila sp	-3.09	0.72	0.86	0.87	-1.01	-2.18	2.36	0.72	221	23.45	0.005
Enchytraeidae	1.24	-1.05	-0.68	-0.75	2.54	2.33	-1.29	-0.58	93	17.52	0.05
Endochironomus gr dispar	1.21	1.83	-0.31	-1.54	-0.59	1.96	-1.51	-1.35	19	15.55	0.05
Erpobdella octoculata	2.55	0.53	-0.55	-1.63	1.82	4.71	-3.00	-2.45	60	50.34	0.001
Eukiefferiella brevicar agg	0.13	-2.93	-0.53	-2.64	-1.01	-1.71	-2.86	9.74	56	122.83	0.001
Eukiefferiella claripennis	-1.11	-2.29	-0.37	-1.86	-0.71	0.48	-2.44	7.32	28	70.40	0.001
Gammarus fossarum	-0.54	2.89	-0.31	-1.54	-0.59	-1.46	0.98	-0.82	19	15.22	0.05
Gammarus pulex	2.62	2.51	-1.39	0.84	-1.15	0.50	-3.11	-2.06	388	31.35	0.001
Glossiphonia complanata	1.24	2.01	-0.47	-1.91	-0.90	3.62	-2.07	-1.82	44	30.93	0.001
Glyptotaelius pellucidus	2.62	2.39	-0.38	-0.32	0.65	0.41	-2.48	-2.33	29	24.99	0.001
Gyraulus albus	-0.20	0.71	-0.27	-1.36	-0.52	4.09	-0.66	-1.68	15	22.71	0.005
Heterotanytarsus apicalis	1.50	3.69	-0.36	-0.68	-0.69	-1.13	-1.07	-2.21	26	24.20	0.005
Heterotrissocladus marcidus	1.59	1.08	-0.59	3.50	-0.24	0.04	-2.03	-3.07	70	29.87	0.001
Hydropsyche angustipennis	-0.22	-0.61	-0.38	-1.90	-0.73	4.28	-2.48	1.96	29	33.02	0.001
Hygrobates fluviatilis	-0.96	-0.12	-0.17	-0.86	-0.33	4.04	-1.13	-0.12	6	19.47	0.01
Lebertia lineata	-1.13	0.77	-0.31	-0.88	-0.59	3.32	-1.01	-0.29	19	15.23	0.05
Lebertia stigmatifera	-0.30	2.09	-0.50	-0.93	-0.96	4.70	-1.77	-2.44	51	37.66	0.001
Leptophlebia marginata	3.05	2.51	-0.24	-1.22	-0.47	-1.16	-1.59	-1.50	12	23.52	0.005
Limnophilus extricatus	0.24	-0.04	-0.23	-1.17	-0.45	4.28	-0.87	-1.43	11	22.80	0.005
Limnophilus lunatus	-0.30	-0.57	-0.28	-0.70	3.17	4.62	-1.30	-1.73	16	37.01	0.001
Limnius volckmari	-0.96	-0.12	-0.17	-0.86	-0.33	-0.82	-1.13	3.66	6	17.16	0.05
Limnodrilus hoffmeisteri	-2.34	1.70	-0.59	-0.88	1.56	2.24	-0.42	-0.53	69	17.34	0.05
Limnophyes sp	2.37	-1.59	-0.34	0.68	2.44	2.12	-2.21	-1.11	23	25.29	0.001

taxon name/ habitat type	index of representation								N	chi	P<
	leaves	detritus	clay	mud	branches/ wood	Veg- itation	sand	gravel			
<i>Ljania bipapillata</i>	3.19	1.64	-0.40	-1.99	-0.76	3.37	-2.60	-2.45	32	41.69	0.001
<i>Lumbriculus variegatus</i>	-0.30	-0.57	-0.28	0.72	6.87	0.15	-0.76	-1.15	16	50.13	0.001
<i>Lype reducta</i>	0.55	4.59	-0.43	-1.21	-0.82	-0.08	-2.09	-1.49	37	30.27	0.001
<i>Macropelopia sp</i>	1.96	3.60	-0.65	1.41	-0.43	0.18	-2.56	-3.71	84	39.81	0.001
<i>Micropsectra gr atrofasciata</i>	1.30	-1.17	-0.43	1.97	2.77	2.28	-2.49	-1.54	38	28.59	0.001
<i>Micropsectra gr notescens</i>	1.77	3.02	-0.68	1.02	-1.30	1.40	-2.86	-2.97	93	34.42	0.001
<i>Mideopsis orbicularis</i>	-0.96	-0.12	-0.17	-0.86	-0.33	4.04	-0.24	-1.06	6	19.36	0.01
<i>Molanna angustata</i>	-1.11	0.41	-0.20	-1.00	-0.38	4.32	-0.53	-1.22	8	23.02	0.005
<i>Nais communis</i>	1.47	-0.96	-0.45	2.62	3.76	1.11	-2.27	-2.05	41	34.89	0.001
<i>Nais elinguis</i>	-0.29	-2.63	1.90	1.12	6.49	0.90	-1.01	0.03	37	55.83	0.001
<i>Nais variabilis</i>	2.22	-0.35	-0.43	0.66	4.05	0.90	-1.73	-2.25	37	30.95	0.001
<i>Nanocladus rectinervis</i>	-1.47	0.24	-0.26	-0.56	1.48	4.32	-1.72	-0.38	14	26.55	0.001
<i>Nemoura avicularis</i>	1.34	2.52	-0.30	-1.50	-0.57	-1.42	0.09	-1.29	18	14.52	0.05
<i>Nemoura cinerea</i>	2.36	0.68	-0.64	-1.00	3.69	0.58	-2.49	-0.85	82	28.28	0.001
<i>Nemurella pictetii</i>	3.96	2.09	-0.52	-1.47	-1.00	-0.48	-2.83	-0.71	55	32.24	0.001
<i>Neolimnomyia sp</i>	-2.66	-0.55	-0.48	0.96	0.18	2.56	-0.24	0.48	46	15.39	0.05
<i>Nepa cinerea</i>	0.69	-0.41	-0.20	0.01	7.48	0.10	-1.30	-1.22	8	59.81	0.001
<i>Odontomesa fulva</i>	-1.75	0.65	-0.32	-0.31	-0.60	-0.83	3.77	-1.93	20	22.71	0.005
<i>Ophidonais serpentina</i>	-0.86	-0.48	-0.27	-0.63	-0.52	7.17	-1.78	-1.68	15	59.05	0.001
<i>Oulimnius tuberculatus</i>	-1.36	1.17	-0.24	-1.22	-0.47	3.14	-1.59	0.50	12	17.64	0.05
<i>Paracladopelma laminata</i> agg	-1.40	0.71	-0.35	-1.15	-0.66	0.18	3.07	-1.65	24	16.49	0.05
<i>Paracladopelma nigrifula</i>	-1.98	1.34	-0.49	0.43	-0.93	-0.17	3.08	-2.66	48	23.64	0.005
<i>Paratendipes albimanus</i>	-0.92	0.73	-0.40	0.45	1.80	3.78	-1.13	-2.48	33	26.75	0.001
<i>Pedicia sp</i>	1.19	-1.75	-0.50	-2.09	1.14	1.42	-0.49	1.52	50	14.97	0.05
<i>Pericoma sp</i>	3.53	-1.56	-0.25	-1.27	3.62	0.44	-1.66	-0.28	13	32.75	0.001
<i>Phaenopsectra sp</i>	-0.10	-2.13	2.02	1.84	6.84	2.13	-1.94	-1.33	34	68.84	0.001
<i>Physa fontinalis</i>	-0.62	-0.83	-0.24	-0.40	-0.47	6.58	-1.59	-1.50	12	49.61	0.001
<i>Pilaria sp</i>	-1.84	1.42	-0.33	-0.44	-0.63	2.87	-1.23	-0.06	22	15.90	0.05
<i>Pisidium casertanum</i>	-0.79	2.76	0.06	-0.12	-1.32	-0.30	1.53	-2.94	190	21.11	0.005
<i>Plectrocnemia conspersa</i>	4.46	3.99	-0.89	-0.67	-1.13	2.55	-5.50	-3.12	161	84.80	0.001

taxon name/ habitat type	index of representation								N	chi	P<
	leaves	detritus	clay	mud	branches/ wood	Veg- itation	sand	gravel			
<i>Polycelis felina</i>	-1.62	-0.66	-0.29	-1.45	-0.56	2.95	-1.90	3.26	17	28.54	0.001
<i>Polycelis nigra/tenuis</i>	1.54	0.04	-0.32	-1.61	-0.62	3.01	-1.64	-0.47	21	17.45	0.05
<i>Polycelis tenuis</i>	1.58	-0.83	-0.24	-1.22	8.09	0.56	-1.59	-0.83	12	73.72	0.001
<i>Polypedilum nubeculosum</i>	-0.36	0.71	-0.35	0.59	3.88	2.01	-1.37	-2.12	24	26.52	0.001
<i>Polypedilum scalaenum</i>	-3.33	1.79	0.57	0.97	-1.76	-0.60	2.25	-1.03	269	25.13	0.001
<i>Proasellus meridianus</i>	0.79	-0.18	-0.55	-0.61	6.47	3.79	-3.07	-1.64	62	69.68	0.001
<i>Procladius</i> sp	0.74	2.97	-0.56	1.14	0.80	0.72	-2.01	-3.14	63	26.06	0.001
<i>Prodiamesa olivacea</i>	-1.17	2.35	-0.83	2.83	-0.33	-2.19	1.21	-2.94	139	30.58	0.001
<i>Psammoryctides barbatus</i>	-1.57	1.16	-0.28	-1.41	-0.54	3.87	-0.76	-0.57	16	22.07	0.005
<i>Ptychoptera lacustris</i>	-1.02	0.47	-0.50	3.05	-0.96	0.11	0.36	-2.12	51	16.35	0.05
<i>Radix</i> sp	-1.18	-1.30	-0.21	1.78	4.54	-1.01	-1.38	1.79	9	32.96	0.001
<i>Rheocricotopus fuscipes</i>	2.31	1.18	-0.60	-1.35	0.58	0.97	-3.17	0.36	73	20.39	0.005
<i>Rheotanytarsus</i> sp	-1.00	-1.75	-0.36	-0.13	0.77	3.55	-2.35	2.33	26	28.33	0.001
<i>Rhyacodrilus coccineus</i>	-1.52	3.10	7.05	-1.36	-0.52	-1.30	-0.10	-0.48	15	65.75	0.001
<i>Sialis fuliginosa</i>	1.56	2.91	-0.42	1.75	-0.80	-1.48	-1.62	-2.56	35	26.16	0.001
<i>Sialis lutaria</i>	0.18	3.12	-0.39	-0.89	-0.74	1.97	-1.33	-2.37	30	22.52	0.005
<i>Silo nigricornis</i>	-1.80	-1.98	-0.32	-1.61	-0.62	1.06	0.26	4.07	21	28.04	0.001
<i>Simulium costatum</i>	-0.96	-1.06	-0.17	-0.86	-0.33	-0.82	-1.13	4.60	6	26.07	0.001
<i>Simulium erythrocephala</i>	-1.04	-1.14	-0.19	-0.93	-0.36	7.00	-1.22	-1.14	7	55.18	0.001
<i>Simulium intermedium</i>	-0.07	-1.14	-0.19	-0.93	-0.36	3.62	-1.22	0.60	7	17.28	0.05
<i>Simulium ornatum</i>	-0.93	-1.15	-0.28	-0.70	-0.54	2.38	-1.84	2.89	16	20.50	0.005
<i>Simulium trifasciatum</i>	-0.35	-0.33	-0.39	-1.96	-0.75	-0.26	-2.56	5.48	31	41.49	0.001
<i>Slavina appendiculata</i>	3.26	0.41	-0.48	-0.35	1.24	1.18	-1.89	-2.29	47	22.86	0.005
<i>Specaria josinae</i>	-0.29	3.23	-0.34	-1.10	-0.65	0.88	-0.40	-2.07	23	17.47	0.05
<i>Sperchon glandulosus</i>	4.93	0.41	-0.46	-0.97	-0.87	-0.34	-1.98	-1.38	42	32.29	0.001
<i>Sperchon setiger</i>	-0.11	-0.38	-0.26	-1.32	-0.50	0.34	-1.72	3.32	14	16.36	0.05
<i>Sperchon</i> sp nymf	-0.53	1.35	-0.23	-1.17	-0.45	3.38	-1.53	-0.74	11	18.04	0.05
<i>Sperchon squamosus</i>	2.04	-0.26	-0.39	0.14	-0.74	2.52	-2.52	-0.68	30	18.08	0.05
<i>Sperchon thienemanni</i>	-0.52	1.92	-0.45	-2.26	-0.86	5.30	-2.95	-0.24	41	46.84	0.001
<i>Sphaerium corneum</i>	-1.62	1.58	-0.29	-0.76	-0.56	3.68	-0.84	-1.22	17	21.82	0.005

taxon name/ habitat type	index of representation								N	chi	P<
	leaves	detritus	clay	mud	branches/ wood	Veg- itation	sand	gravel			
<i>Spirosperma ferox</i>	-1.41	1.65	-0.25	-1.27	-0.49	3.75	-0.45	-1.56	13	23.33	0.005
<i>Stictochironomus</i> sp	-0.87	3.11	-0.45	-2.23	-0.85	-0.71	1.21	-0.91	40	19.13	0.01
<i>Stylaria lacustris</i>	0.58	-1.00	3.53	-1.32	-0.50	5.12	-1.14	-1.62	14	45.88	0.001
<i>Tanytarsus</i> sp	-0.50	0.20	0.75	0.85	3.94	1.84	-1.00	-2.15	97	26.08	0.001
<i>Thienemanniella flaviforceps</i> agg	-0.93	-1.15	-0.28	-0.70	-0.54	6.85	-1.30	-1.15	16	53.05	0.001
<i>Tipula lateralis</i>	0.52	-1.30	-0.21	-0.11	4.54	1.97	-1.38	-0.53	9	28.66	0.001
<i>Tubifex ignotus</i>	-1.64	1.96	-0.38	-1.37	-0.73	3.17	-0.46	-1.04	29	20.47	0.005
<i>Tvetenia discoloripes</i> agg	-1.00	-1.22	-0.29	-1.45	-0.56	2.23	-1.90	3.82	17	28.20	0.001
<i>Velia caprai</i>	2.32	-0.83	-0.24	-0.40	-0.47	3.14	-1.59	-1.50	12	21.15	0.005
<i>Wettina podagrica</i>	0.85	-0.16	-0.24	-0.40	-0.47	3.14	-0.97	-1.50	12	14.22	0.05
<i>Zavreliomyia</i> sp	4.49	2.61	-0.70	0.73	0.87	0.52	-4.39	-3.17	100	58.29	0.001

3.2 Habitat type comparison

Information on taxon specific habitat preferences can be obtained from Table 2. However, more general information on the habitat type differences can be obtained by assembling the taxa-specific IR results:

Table 3. Significant IR correlations between different habitat types.

habitat types	r	n	P
leaves vs sand	-0.62	128	<0.001
leaves vs gravel	-0.32	128	<0.001
detritus vs branches	-0.42	128	<0.001
detritus vs vegetation	-0.20	128	0.02
detritus vs gravel	-0.53	128	<0.001
mud vs branches/ wood	+0.25	128	0.01
mud vs vegetation	-0.19	128	0.03
mud vs gravel	-0.38	128	<0.001
branches/ wood vs sand	-0.18	128	0.04
vegetation vs gravel	-0.25	128	0.01

Habitat type leaves

Strong negative correlations of the habitat type leaves with the habitat types sand and gravel, suggest that taxa that preferred leaves generally had an aversion to sand and gravel and vice versa (Table 3). Furthermore, Figure 3 shows that several preference indicator taxa (IR value >2) for leaves are also preference indicators for detritus, branches/ wood and vegetation. Figure 3 confirms the correlation results; preference indicators for leaves often have aversion to (IR value <-2) gravel and sand.

Habitat type detritus

According to the correlation analysis, taxa with a preference for detritus generally had aversion to the habitat types branches/ wood, vegetation and gravel (Table 3). By contrast, on some occasions, taxa indicating preference for detritus also preferred vegetation and leaves (Figure 4). Furthermore, Figure 4 shows that preference for detritus, next to vegetation and gravel, frequently coincides with aversion to sand.

Habitat type clay

Few samples are available and therefore this habitat type is not included in the correlation analysis. From Figure 5 it appears that taxa preferring clay mostly have aversion to branches/ wood and vegetation.

Habitat type mud

In general, preference for the mud habitat type was positively correlated to preference for branches/ wood and seemed to coincide with aversion to vegetation and gravel (Table 3). However, in spite of the positive relationship, several preference indicators for mud were aversion indicators for sand (Figure 6). Furthermore, preference indication for mud coincided with that for branches/ wood and detritus on several occasions (Figure 6).

Habitat type branches/ wood

Preference for branches/ wood was correlated with aversion to sand (Table 3). In addition, preference indicators frequently also indicated leaves and especially vegetation (Figure 7).

Habitat type vegetation

By far most indicator taxa were found for habitat type vegetation (65). Although the correlation analysis showed that preference for vegetation coincided with aversion to gravel (Table 3), vegetation seemed a relatively distinct habitat type, as the percentages of taxa that were also indicator for other habitat types were low overall (Figure 8).

Habitat type sand

This habitat type shared no preference indicators with any other habitat type (Figure 9). Several of the taxa preferring sand had aversion to leaves (which was also negatively correlated, Table 3), vegetation and gravel (Figure 9).

Habitat type gravel

IR values for this habitat type negatively correlated to that of four other habitat types; leaves, detritus, mud and vegetation (Table 3), indicating the strong distinction of this habitat. However, Figure 10 shows it that gravel preference indicators also indicate preference for vegetation on several occasions.

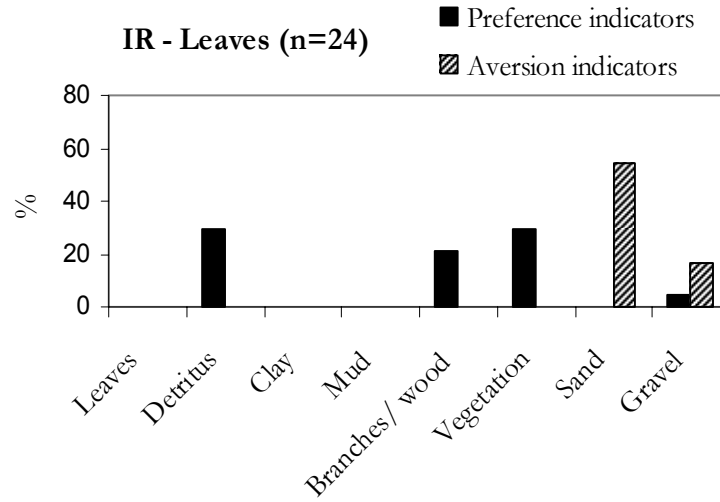


Figure 3. The percentage of total leaves-indicator taxa (24) that also indicate preference or aversion for other habitat types.

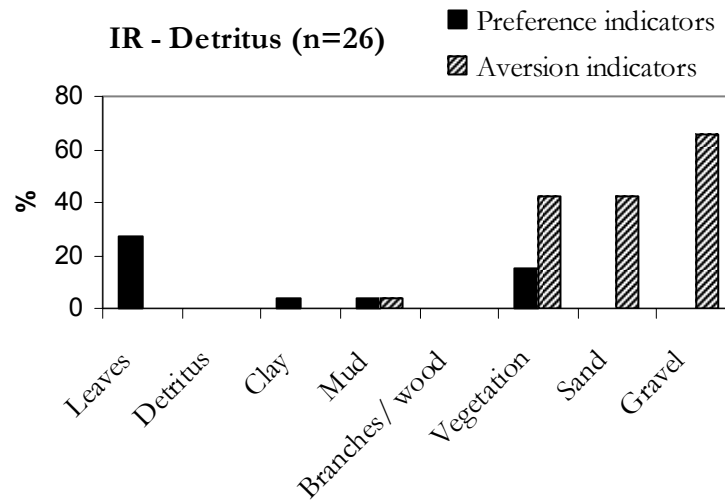


Figure 4. The percentage of total detritus-indicator taxa (26) that also indicate preference or aversion for other habitat types.

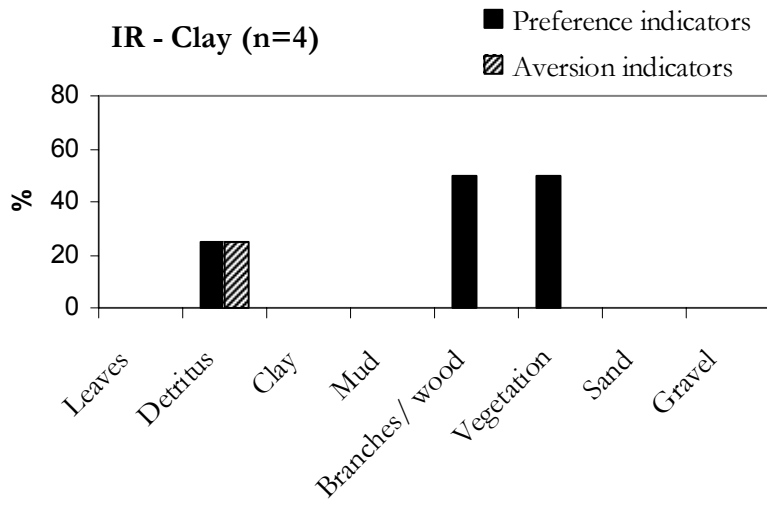


Figure 5. The percentage of total clay-indicator taxa (4) that also indicate preference or aversion for other habitat types.

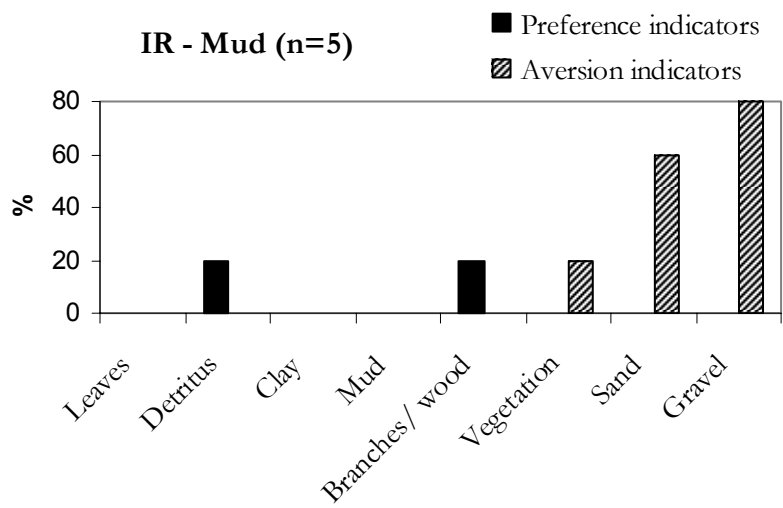


Figure 6. The percentage of total mud-indicator taxa (5) that also indicate preference or aversion for other habitat types.

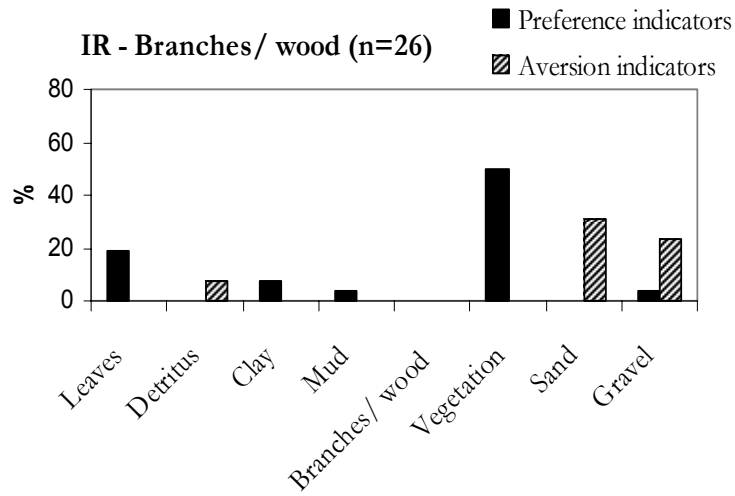


Figure 7. The percentage of total branches/wood-indicator taxa (26) that also indicate preference or aversion for other habitat types.

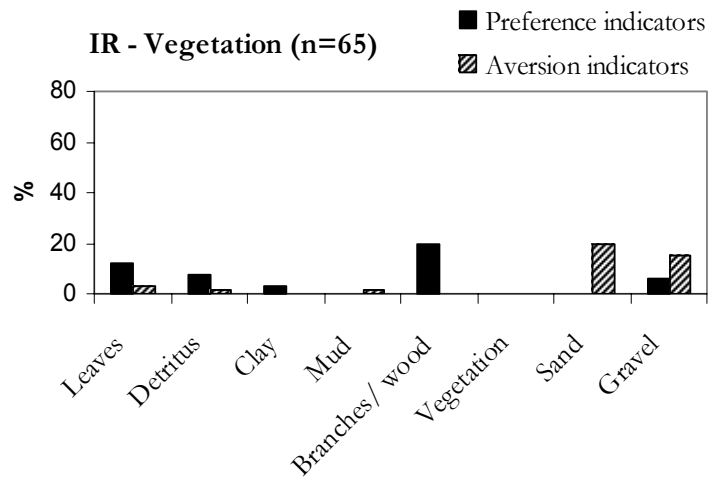


Figure 8. The percentage of total vegetation-indicator taxa (65) that also indicate preference or aversion for other habitat types.

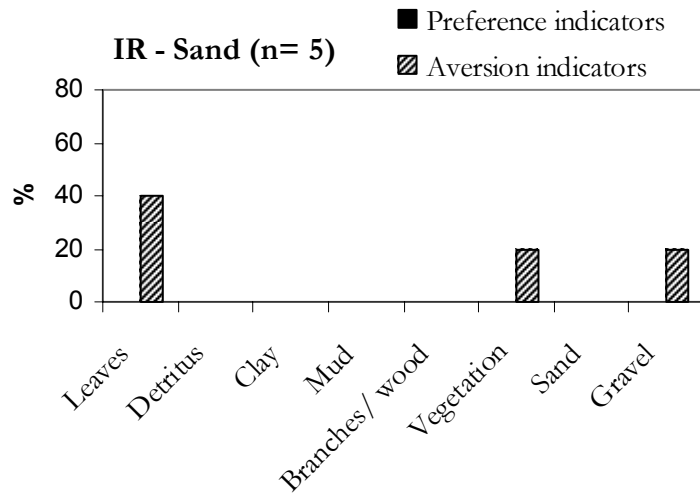


Figure 9. The percentage of total sand-indicator taxa (5) that also indicate preference or aversion for other habitat types.

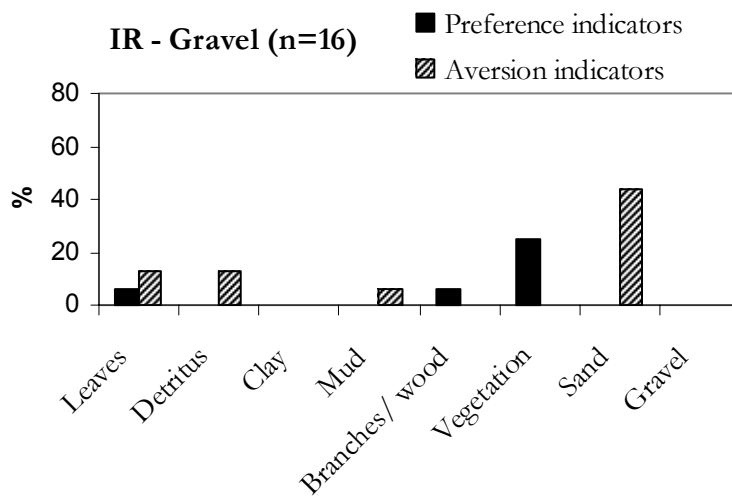


Figure 10. The percentage of total gravel-indicator taxa (16) that also indicate preference or aversion for other habitat types.

3.3 Habitat ranking

Table 4 translates the IR analysis results to a 10-habitat type ranking system, which can be a useful tool for water managers. This system is based on 10 predefined habitat types, as presented in Table 4. Habitat types for specific taxa were ranked according to the positive IR values in Table 2, with a sum of ranks that always equals 10. For example, if a taxon has an IR value of 4.1 for leaves and 1.2 for detritus and all negative for the other habitat types, the habitat type leaves receives a ranking of:

$$(10 / (4.1+1.2)) \times 4.1 = 7.7 = \text{rank } 8.$$

Detritus then receives:

$$(10 / (4.1+1.2)) \times 1.2 = 2.3 = \text{rank } 2.$$

The rest of the habitat types receive rank 0, the sum of ranks equals 10. However, because the ultimate ranks are round down to whole numbers, the sum not always equals 10 naturally. In such cases, the rank closest to a higher or lower value is round down to a higher or lower rank. For example: A taxa received the ranks 3.4, 2.3 and 4.3 for leaves, detritus and clay respectively, and 0 for the rest of the habitat types. Rounding down to whole numbers would give ranks 3, 2 and 4, which equals 9 not 10. In this case, since rank 3.4 was closer to receiving another round down rank than 2.3 and 4.3, it received rank 4 rather than 3 to make the sum of ranks equal 10.

There were no samples obtained from two of the 10 predefined habitat types; rocks and surface water. In the samples there were no characteristic surface water taxa encountered and therefore the habitat type surface water receives rank 0 for all taxa in this analysis. By contrast, taxa that received high ranking for gravel generally were taxa that are known to prefer rocky habitats as well. Therefore, the ranks scored for gravel were equally divided over the types gravel and rocks. Hence for those two habitat types ranks can be expressed in halves (Table 4).

Table 4. 10-Habitat type ranking results.

taxon name / habitat type	rank									
	leaves	detritus	clay	mud	branches/ wood	Vegetation	sand	gravel	rocks	surf ace water
Agabus sp larve	6	0	0	0	3	1	0	0	0	0
Agapetus fuscipes	0	0	0	0	0	0	0	5.0	5.0	0
Amphinemura standfussi	5	0	0	0	0	0	0	2.5	2.5	0
Apsectrotanypus trifascipennis	0	5	0	1	0	4	0	0	0	0
Asellus aquaticus	1	0	0	0	5	4	0	0	0	0
Athripsodes aterrimus	0	1	0	0	0	9	0	0	0	0
Aulodrilus japonicus	0	6	0	0	0	4	0	0	0	0
Baetis rhodani	0	0	0	0	0	0	0	5.0	5.0	0
Baetis vernus	0	0	0	0	0	9	0	0.5	0.5	0
Bereodes minutus	6	0	0	0	0	4	0	0	0	0
Brillia modesta	8	0	0	0	2	0	0	0	0	0
Caenis horaria	0	1	0	0	0	9	0	0	0	0
Calopteryx virgo	0	1	0	0	0	9	0	0	0	0
Centroptilum luteolum	0	1	0	0	4	5	0	0	0	0
Chaetocladius gr piger	1	0	0	0	6	0	0	1.5	1.5	0
Chaetopteryx villosa	0	6	0	0	0	1	0	1.5	1.5	0
Chironomus sp	0	0	0	6	3	1	0	0	0	0
Clinotanypus nervosus	0	2	0	1	0	7	0	0	0	0
Cloeon dipterum	2	0	0	1	0	7	0	0	0	0
Conchapelopia sp	3	1	0	0	4	2	0	0	0	0
Corynoneura celeripes	6	0	0	0	3	1	0	0	0	0
Corynoneura coronata agg	2	0	0	0	5	3	0	0	0	0
Corynoneura lobata agg	0	0	0	0	2	5	0	1.5	1.5	0
Corynoneura scutellata agg	2	0	0	0	4	4	0	0	0	0
Cricotopus gr sylvestris	0	0	0	0	0	9	0	0.5	0.5	0
Cryptochironomus sp	0	0	0	2	2	5	1	0	0	0
Dendrocoelum lacteum	9	1	0	0	0	0	0	0	0	0
Dicranota sp	0	1	3	0	0	0	1	2.5	2.5	0
Diplocladius cultriger	0	0	4	0	4	2	0	0	0	0
Dixa gr maculata	2	1	0	0	0	7	0	0	0	0
Dixa submaculata	1	2	0	0	0	7	0	0	0	0
Dryopidae	0	0	0	0	6	4	0	0	0	0
Dugesia gonocephala	4	2	0	3	0	0	0	0.5	0.5	0
Elodes minuta	6	2	0	0	0	2	0	0	0	0
Eloeophila sp	0	1	2	2	0	0	4	0.5	0.5	0
Enchytraeidae	2	0	0	0	4	4	0	0	0	0
Endochironomus gr	2	4	0	0	0	4	0	0	0	0

taxon name / habitat type	rank									
	leaves	detritus	clay	mud	branches/ wood	Vegetation	sand	gravel	rocks	surf ace water
dispar										
<i>Erpobdella octoculata</i>	3	1	0	0	2	5	0	0	0	0
<i>Eukiefferiella brevicealcar</i> agg	0	0	0	0	0	0	0	5.0	5.0	0
<i>Eukiefferiella claripennis</i>	0	0	0	0	0	1	0	4.5	4.5	0
<i>Gammarus fossarum</i>	0	7	0	0	0	0	3	0	0	0
<i>Gammarus pulex</i>	4	4	0	1	0	1	0	0	0	0
<i>Glossiphonia complanata</i>	2	3	0	0	0	5	0	0	0	0
<i>Glyphotaelius pellucidus</i>	4	4	0	0	1	1	0	0	0	0
<i>Gyraulius albus</i>	0	1	0	0	0	9	0	0	0	0
<i>Heterotanytarsus apicalis</i>	3	7	0	0	0	0	0	0	0	0
<i>Heterotrissocladus</i> marcidus	2	2	0	6	0	0	0	0	0	0
<i>Hydropsyche</i> angustipennis	0	0	0	0	0	7	0	1.5	1.5	0
<i>Hygrobates fluviatilis</i>	0	0	0	0	0	10	0	0	0	0
<i>Lebertia lineata</i>	0	2	0	0	0	8	0	0	0	0
<i>Lebertia stigmatifera</i>	0	3	0	0	0	7	0	0	0	0
<i>Leptophlebia marginata</i>	5	5	0	0	0	0	0	0	0	0
<i>Limnephilus extricatus</i>	1	0	0	0	0	9	0	0	0	0
<i>Limnephilus lunatus</i>	0	0	0	0	4	6	0	0	0	0
<i>Limnius volckmari</i>	0	0	0	0	0	0	0	5.0	5.0	0
<i>Limnodrilus hoffmeisteri</i>	0	3	0	0	3	4	0	0	0	0
<i>Limnophyes</i> sp	3	0	0	1	3	3	0	0	0	0
<i>Ljania bipapillata</i>	4	2	0	0	0	4	0	0	0	0
<i>Lumbriculus variegatus</i>	0	0	0	1	9	0	0	0	0	0
<i>Lype reducta</i>	1	9	0	0	0	0	0	0	0	0
<i>Macropelopia</i> sp	3	5	0	2	0	0	0	0	0	0
<i>Micropsectra</i> gr atofasciata	2	0	0	2	3	3	0	0	0	0
<i>Micropsectra</i> gr notescens	3	4	0	1	0	2	0	0	0	0
<i>Mideopsis orbicularis</i>	0	0	0	0	0	10	0	0	0	0
<i>Molanna angustata</i>	0	1	0	0	0	9	0	0	0	0
<i>Nais communis</i>	2	0	0	3	4	1	0	0	0	0
<i>Nais elinguis</i>	0	0	2	1	6	1	0	0	0	0
<i>Nais variabilis</i>	3	0	0	1	5	1	0	0	0	0
<i>Nanocladus rectinervis</i>	0	0	0	0	3	7	0	0	0	0
<i>Nemoura avicularis</i>	4	6	0	0	0	0	0	0	0	0
<i>Nemoura cinerea</i>	3	1	0	0	5	1	0	0	0	0
<i>Nemurella pictetii</i>	7	3	0	0	0	0	0	0	0	0
<i>Neolimnomyia</i> sp	0	0	0	2	1	6	0	0.5	0.5	0
<i>Nepa cinerea</i>	1	0	0	0	9	0	0	0	0	0

taxon name / habitat type	rank									
	leaves	detritus	clay	mud	branches/ wood	Vegetation	sand	gravel	rocks	surf ace water
<i>Odontomesa fulva</i>	0	1	0	0	0	0	9	0	0	0
<i>Ophidonais serpentina</i>	0	0	0	0	0	10	0	0	0	0
<i>Oulimnius tuberculatus</i>	0	2	0	0	0	7	0	0.5	0.5	0
<i>Paracladopelma laminata</i> agg	0	2	0	0	0	0	8	0	0	0
<i>Paracladopelma nigrifulva</i>	0	3	0	1	0	0	6	0	0	0
<i>Paratendipes albimanus</i>	0	1	0	1	3	5	0	0	0	0
<i>Pedicia</i> sp	2	0	0	0	2	3	0	1.5	1.5	0
<i>Pericoma</i> sp	5	0	0	0	5	0	0	0	0	0
<i>Phaenopsectra</i> sp	0	0	2	1	5	2	0	0	0	0
<i>Physa fontinalis</i>	0	0	0	0	0	10	0	0	0	0
<i>Pilaria</i> sp	0	3	0	0	0	7	0	0	0	0
<i>Pisidium casertanum</i>	0	6	0	0	0	0	4	0	0	0
<i>Plectrocnemia conspersa</i>	4	4	0	0	0	2	0	0	0	0
<i>Polycelis felina</i>	0	0	0	0	0	5	0	2.5	2.5	0
<i>Polycelis nigra/tenuis</i>	3	0	0	0	0	7	0	0	0	0
<i>Polycelis tenuis</i>	2	0	0	0	8	0	0	0	0	0
<i>Polypedilum nubeculosum</i>	0	1	0	1	5	3	0	0	0	0
<i>Polypedilum scalaenum</i>	0	3	1	2	0	0	4	0	0	0
<i>Proasellus meridianus</i>	1	0	0	0	6	3	0	0	0	0
<i>Procladius</i> sp	1	5	0	2	1	1	0	0	0	0
<i>Prodiamesa olivacea</i>	0	4	0	4	0	0	2	0	0	0
<i>Psammoryctides barbatus</i>	0	2	0	0	0	8	0	0	0	0
<i>Ptychoptera lacustris</i>	0	1	0	8	0	0	1	0	0	0
<i>Radix</i> sp	0	0	0	2	6	0	0	1.0	1.0	0
<i>Rheocricotopus fuscipes</i>	4	2	0	0	1	2	0	0.5	0.5	0
<i>Rheotanytarsus</i> sp	0	0	0	0	1	5	0	2.0	2.0	0
<i>Rhyacodrilus coccineus</i>	0	3	7	0	0	0	0	0	0	0
<i>Sialis fuliginosa</i>	2	5	0	3	0	0	0	0	0	0
<i>Sialis lutaria</i>	0	6	0	0	0	4	0	0	0	0
<i>Silo nigricornis</i>	0	0	0	0	0	2	0	4.0	4.0	0
<i>Simulium costatum</i>	0	0	0	0	0	0	0	5.0	5.0	0
<i>Simulium erythrocephala</i>	0	0	0	0	0	10	0	0	0	0
<i>Simulium intermedium</i>	0	0	0	0	0	9	0	0.5	0.5	0
<i>Simulium ornatum</i>	0	0	0	0	0	5	0	2.5	2.5	0
<i>Simulium trifasciatum</i>	0	0	0	0	0	0	0	5.0	5.0	0
<i>Slavina appendiculata</i>	5	1	0	0	2	2	0	0	0	0
<i>Specaria josinae</i>	0	8	0	0	0	2	0	0	0	0
<i>Sperchon glandulosus</i>	9	1	0	0	0	0	0	0	0	0
<i>Sperchon setiger</i>	0	0	0	0	0	1	0	4.5	4.5	0
<i>Sperchon</i> sp nymf	0	3	0	0	0	7	0	0	0	0

taxon name / habitat type	rank									
	leaves	detritus	clay	mud	branches/ wood	Vegetation	sand	gravel	rocks	surf ace water
Sperchon squamosus	4	0	0	0	0	6	0	0	0	0
Sperchon thienemanni	0	3	0	0	0	7	0	0	0	0
Sphaerium corneum	0	3	0	0	0	7	0	0	0	0
Spirosperma ferox	0	3	0	0	0	7	0	0	0	0
Stictochironomus sp	0	7	0	0	0	0	3	0	0	0
Stylaria lacustris	1	0	4	0	0	5	0	0	0	0
Tanytarsus sp	0	0	1	1	5	3	0	0	0	0
Thienemanniella flaviforceps agg	0	0	0	0	0	10	0	0	0	0
Tipula lateralis	1	0	0	0	6	3	0	0	0	0
Tubifex ignotus	0	4	0	0	0	6	0	0	0	0
Tvetenia discoloripes agg	0	0	0	0	0	4	0	3.0	3.0	0
Velia caprai	4	0	0	0	0	6	0	0	0	0
Wettina podagrica	2	0	0	0	0	8	0	0	0	0
Zavreliomyia sp	5	3	0	1	1	0	0	0	0	0

References

Juggins. S. 2003. C2 User guide. Software for ecological and palaeoecological data analysis and visualisation. University of Newcastle, Newcastle upon Tyne, UK. 69 pp.

Hildrew AG and Townsend CR (1976) The distribution of two predators and their prey in an iron rich stream. *Journal of Animal Ecology*, 45, 41-57.

Tolkamp HH (1980) Organism-substrate relationships in lowland streams. PhD thesis. Centre for Agricultural Publishing and Documentation, Wageningen.

Appendix 1 Weighted-average optima and tolerances and IR values for 128 taxa with significant non-random distributions over the eight habitat types.

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Agabus sp larve	Opt	0.33	0.10	0.00	0.00	0.33	0.24	0.00	0.00	11	20.42	0.005
	Tol	0.52	0.32	0.09	0.33	0.52	0.47	0.30	0.36			
	IR	3.31	-0.04	-0.23	-1.17	1.79	0.68	-1.53	-1.43			
Agapetus fuscipes	Opt	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.98	52	89.13	0.001
	Tol	0.03	0.12	0.09	0.03	0.27	0.04	0.05	0.14			
	IR	-2.48	-0.87	-0.51	-1.75	-0.97	-1.59	-2.11	8.42			
Amphinemura standfussi	Opt	0.37	0.15	0.00	0.02	0.00	0.06	0.01	0.40	105	46.58	0.001
	Opt	0.49	0.36	0.09	0.12	0.07	0.24	0.08	0.50			
	Tol	3.94	-0.60	-0.72	-1.40	0.06	-1.69	-3.66	3.46			
Apsectrotanypus trifascipennis	IR	0.10	0.53	0.00	0.07	0.00	0.23	0.08	0.00	49	25.81	0.001
	Opt	0.32	0.53	0.09	0.26	0.27	0.45	0.29	0.36			
	Tol	-0.93	2.92	-0.49	0.37	-0.94	2.33	-0.74	-3.03			
Asellus aquaticus	IR	0.21	0.12	0.00	0.02	0.30	0.34	0.00	0.02	85	73.50	0.001
	Opt	0.43	0.34	0.09	0.14	0.48	0.50	0.06	0.13			
	Opt	1.63	-0.48	-0.65	-0.17	5.19	4.99	-3.30	-2.73			
Athripsodes aterrimus	Tol	0.11	0.15	0.00	0.04	0.00	0.49	0.08	0.13	21	30.87	0.001
	IR	0.32	0.38	0.09	0.19	0.27	0.52	0.29	0.35			
	Opt	-1.24	0.54	-0.32	-1.00	-0.62	4.97	-1.64	-0.47			
Aulodrilus japonicus	Tol	0.10	0.50	0.00	0.10	0.00	0.19	0.11	0.01	84	38.59	0.001
	IR	0.30	0.51	0.09	0.31	0.27	0.40	0.32	0.08			
	Opt	-0.82	4.36	-0.65	-1.68	-1.24	2.45	-0.90	-2.70			
Bactis rhodani	Opt	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.98	23	70.78	0.001
	Tol	0.43	0.06	0.09	0.33	0.27	0.08	0.08	0.13			
	IR	-1.88	-1.59	-0.34	-1.69	-0.65	-0.99	-1.75	7.57			
Bactis vernus	Opt	0.01	0.02	0.00	0.00	0.00	0.94	0.00	0.03	22	28.67	0.001
	Tol	0.09	0.16	0.09	0.33	0.27	0.26	0.07	0.18			
	IR	-0.75	-0.55	-0.33	-1.65	-0.63	4.78	-1.23	0.44			
Bereodes minutus	Opt	0.72	0.03	0.00	0.00	0.00	0.26	0.00	0.00	12	21.11	0.005
	Opt	0.50	0.18	0.09	0.33	0.27	0.48	0.30	0.36			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vege- tation	sand	gravel	N	chi	P<
Brillia modesta	Tol	3.05	-0.16	-0.24	-1.22	-0.47	2.28	-1.59	-1.50	119	56.25	0.001
	IR	0.83	0.06	0.00	0.01	0.00	0.03	0.01	0.05			
	Opt	0.39	0.26	0.09	0.12	0.07	0.19	0.08	0.23			
Caenis horaria	Tol	6.23	-0.27	-0.77	-1.24	1.24	-0.11	-3.63	-0.69	19	28.68	0.001
	IR	0.04	0.10	0.00	0.01	0.00	0.85	0.00	0.00			
	Opt	0.24	0.38	0.09	0.15	0.27	0.45	0.06	0.36			
Calopteryx virgo	Opt	-0.54	0.77	-0.31	-0.88	-0.59	4.69	-1.01	-1.89	7	27.78	0.001
	Tol	0.00	0.35	0.00	0.00	0.00	0.65	0.00	0.00			
	IR	0.43	0.53	0.09	0.33	0.27	0.53	0.30	0.36			
Centropitulum luteolum	Opt	-1.04	0.60	-0.19	-0.93	-0.36	4.74	-1.22	-1.14	8	19.89	0.01
	Tol	0.00	0.41	0.00	0.00	0.01	0.51	0.07	0.00			
	IR	0.43	0.62	0.09	0.33	0.10	0.63	0.33	0.36			
Chaetocladius gr piger	Opt	-1.11	0.41	-0.20	-1.00	2.24	3.27	-0.53	-1.22	39	28.02	0.001
	Opt	0.05	0.29	0.00	0.01	0.03	0.23	0.26	0.14			
	Tol	0.24	0.51	0.09	0.10	0.18	0.47	0.49	0.39			
Chironomus sp	IR	0.41	-1.22	-0.44	0.07	3.90	0.29	-2.53	2.11	32	23.17	0.005
	Opt	0.25	0.16	0.00	0.28	0.05	0.25	0.00	0.01			
	Tol	0.46	0.39	0.09	0.47	0.23	0.46	0.05	0.12			
Chaetopteryx villosa	IR	-0.42	0.01	-0.40	3.52	1.86	0.74	-2.22	-1.22	21	14.21	0.05
	Opt	0.10	0.44	0.00	0.02	0.00	0.05	0.00	0.39			
	Opt	0.31	0.52	0.09	0.13	0.27	0.23	0.30	0.51			
Cloeon dipterum	Tol	-0.69	2.56	-0.32	-1.00	-0.62	0.41	-2.11	1.04	18	18.22	0.05
	IR	0.13	0.00	0.00	0.01	0.00	0.85	0.01	0.00			
	Opt	0.52	0.11	0.09	0.13	0.27	0.56	0.17	0.36			
Clinotanypus nervosus	Tol	0.74	-0.75	-0.30	0.51	-0.57	3.49	-0.93	-1.84	12	16.71	0.05
	IR	0.00	0.46	0.00	0.13	0.00	0.33	0.08	0.00			
	Opt	0.43	0.53	0.09	0.35	0.27	0.50	0.29	0.36			
Conchapelopia sp	Opt	-1.36	1.17	-0.24	0.42	-0.47	3.14	-0.97	-1.50	128	66.72	0.001
	Tol	0.23	0.11	0.00	0.04	0.15	0.42	0.02	0.04			
	IR	0.43	0.33	0.09	0.20	0.36	0.51	0.13	0.19			
	Opt	3.67	0.62	-0.80	-1.23	5.02	2.53	-3.48	-2.65			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Corynoneura celeripes	Tol	0.58	0.31	0.00	0.00	0.04	0.08	0.00	0.00	13	22.14	0.005
	IR	0.53	0.49	0.09	0.33	0.20	0.28	0.30	0.36			
	Opt	3.53	0.36	-0.25	-1.27	1.57	0.44	-1.66	-1.56			
Corynoneura coronata agg	Opt	0.24	0.00	0.00	0.38	0.23	0.05	0.00	0.11	13	25.71	0.001
	Tol	0.48	0.44	0.09	0.54	0.47	0.24	0.30	0.35			
	IR	1.41	-1.56	-0.25	0.30	3.62	2.10	-1.66	-0.92			
Corynoneura lobata agg	Opt	0.03	0.00	0.00	0.00	0.03	0.08	0.00	0.86	12	22.76	0.005
	Tol	0.20	0.44	0.09	0.33	0.20	0.34	0.30	0.43			
	IR	-0.62	-1.50	-0.24	-1.22	1.67	3.14	-1.59	1.84			
Corynoneura scutellata agg	Opt	0.20	0.20	0.00	0.00	0.20	0.40	0.00	0.00	7	16.74	0.05
	Opt	0.44	0.44	0.09	0.33	0.44	0.53	0.30	0.36			
	Tol	0.89	-0.27	-0.19	-0.93	2.44	2.49	-1.22	-1.14			
Cryptochironomus sp	IR	0.00	0.15	0.00	0.15	0.02	0.29	0.37	0.02	20	15.01	0.05
	Opt	0.43	0.38	0.09	0.38	0.14	0.47	0.50	0.14			
	Tol	-1.75	-0.90	-0.32	0.96	1.05	2.50	0.86	-1.42			
Cricotopus gr sylvestris	IR	0.39	0.00	0.00	0.00	0.00	0.26	0.00	0.35	8	23.24	0.005
	Opt	0.56	0.44	0.09	0.33	0.27	0.50	0.30	0.54			
	Opt	-0.21	-1.22	-0.20	-1.00	-0.38	4.32	-1.30	0.41			
Dendrocoelum lacteum	Tol	0.79	0.21	0.00	0.00	0.00	0.00	0.00	0.00	7	19.25	0.01
	IR	0.46	0.46	0.09	0.33	0.27	0.45	0.30	0.36			
	Opt	3.78	0.60	-0.19	-0.93	-0.36	-0.89	-1.22	-1.14			
Diplocladius cultriger	Tol	0.31	0.03	0.03	0.03	0.26	0.29	0.00	0.06	14	32.88	0.001
	IR	0.50	0.18	0.18	0.18	0.47	0.48	0.30	0.25			
	Opt	0.58	-1.00	3.53	-0.56	3.46	1.93	-1.72	-0.38			
Dicranota sp	Opt	0.05	0.20	0.01	0.11	0.00	0.07	0.18	0.38	119	26.51	0.001
	Tol	0.21	0.41	0.12	0.31	0.27	0.25	0.38	0.49			
	IR	-2.65	0.58	1.83	-1.24	-1.47	-0.93	0.35	3.34			
Dixa gr maculata	Opt	0.05	0.18	0.00	0.03	0.00	0.69	0.00	0.06	17	20.53	0.005

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Dixa submaculata	Tol	0.25	0.45	0.09	0.19	0.27	0.54	0.30	0.27	9	15.02	0.05
	IR	0.85	0.46	-0.29	-0.76	-0.56	3.68	-1.90	-1.22			
	Opt	0.10	0.29	0.00	0.00	0.00	0.62	0.00	0.00			
Dryopidae	Opt	0.33	0.51	0.09	0.33	0.27	0.55	0.30	0.36	20	30.54	0.001
	Tol	0.52	1.01	-0.21	-1.06	-0.40	2.97	-1.38	-1.30			
	IR	0.03	0.24	0.00	0.00	0.05	0.38	0.01	0.28			
Dugesia gonocephala	Opt	0.19	0.47	0.09	0.33	0.25	0.54	0.11	0.49	211	21.43	0.005
	Tol	-0.05	-0.38	-0.32	-1.58	4.37	2.50	-1.57	0.13			
	IR	0.12	0.35	0.00	0.05	0.00	0.33	0.02	0.14			
Elodes minuta	Opt	0.33	0.48	0.09	0.23	0.27	0.48	0.13	0.35	126	65.22	0.001
	Tol	1.84	0.88	-1.02	1.52	-1.96	-0.36	-3.10	0.56			
	IR	0.41	0.38	0.00	0.02	0.00	0.17	0.01	0.02			
Eloeophila sp	IR	0.50	0.50	0.09	0.13	0.06	0.38	0.07	0.14	221	23.45	0.005
	Opt	5.58	2.15	-0.79	-0.92	-0.85	1.54	-3.81	-3.21			
	Tol	0.08	0.20	0.01	0.14	0.01	0.09	0.31	0.15			
Enchytraeidae	IR	0.27	0.41	0.10	0.35	0.11	0.28	0.47	0.36	93	17.52	0.05
	Opt	-3.09	0.72	0.86	0.87	-1.01	-2.18	2.36	0.72			
	Opt	0.11	0.30	0.00	0.11	0.03	0.28	0.11	0.05			
Endochironomus gr dispar	Tol	0.33	0.48	0.09	0.33	0.19	0.47	0.32	0.22	19	15.55	0.05
	IR	1.24	-1.05	-0.68	-0.75	2.54	2.33	-1.29	-0.58			
	Opt	0.13	0.44	0.00	0.00	0.00	0.39	0.02	0.02			
Erpobdella octoculata	Tol	0.36	0.53	0.09	0.33	0.27	0.52	0.14	0.14	60	50.34	0.001
	IR	1.21	1.83	-0.31	-1.54	-0.59	1.96	-1.51	-1.35			
	Opt	0.30	0.20	0.00	0.03	0.14	0.29	0.01	0.03			
Eukiefferiella brevicalcar agg	Opt	0.46	0.41	0.09	0.18	0.35	0.46	0.11	0.17	56	122.83	0.001
	Tol	2.55	0.53	-0.55	-1.63	1.82	4.71	-3.00	-2.45			
	IR	0.08	0.01	0.00	0.00	0.00	0.01	0.01	0.90			
Eukiefferiella claripennis	Opt	0.28	0.08	0.09	0.33	0.27	0.08	0.08	0.31	28	70.40	0.001
	Tol	0.13	-2.93	-0.53	-2.64	-1.01	-1.71	-2.86	9.74			
	IR	0.04	0.00	0.00	0.00	0.00	0.03	0.00	0.93			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Gammarus fossarum	Opt	0.22	0.44	0.09	0.33	0.27	0.17	0.30	0.27	19	15.22	0.05
	Opt	-1.11	-2.29	-0.37	-1.86	-0.71	0.48	-2.44	7.32			
	Tol	0.03	0.81	0.00	0.00	0.00	0.00	0.02	0.14			
	IR	0.24	0.58	0.09	0.33	0.27	0.45	0.21	0.52			
	Opt	-0.54	2.89	-0.31	-1.54	-0.59	-1.46	0.98	-0.82			
Gammarus pulex	Tol	0.26	0.34	0.00	0.07	0.01	0.28	0.01	0.03	388	31.35	0.001
	IR	0.44	0.48	0.09	0.26	0.09	0.45	0.10	0.17			
	Opt	2.62	2.51	-1.39	0.84	-1.15	0.50	-3.11	-2.06			
Glyphotaelius pellucidus	Opt	0.49	0.16	0.00	0.02	0.01	0.32	0.00	0.00	29	24.99	0.001
	Tol	0.55	0.40	0.09	0.15	0.08	0.51	0.30	0.36			
	IR	2.62	2.39	-0.38	-0.32	0.65	0.41	-2.48	-2.33			
Glossiphonia complanata	Opt	0.28	0.40	0.00	0.01	0.00	0.21	0.05	0.05	44	30.93	0.001
	Tol	0.46	0.50	0.09	0.11	0.27	0.41	0.22	0.22			
	IR	1.24	2.01	-0.47	-1.91	-0.90	3.62	-2.07	-1.82			
Gyraulus albus	Opt	0.17	0.11	0.00	0.00	0.00	0.70	0.02	0.00	15	22.71	0.005
	Opt	0.43	0.37	0.09	0.33	0.27	0.53	0.17	0.36			
	Tol	-0.20	0.71	-0.27	-1.36	-0.52	4.09	-0.66	-1.68			
Heterotanytarsus apicalis	IR	0.42	0.52	0.00	0.02	0.00	0.03	0.02	0.00	26	24.20	0.005
	Opt	0.54	0.54	0.09	0.13	0.27	0.17	0.13	0.36			
	Tol	1.50	3.69	-0.36	-0.68	-0.69	-1.13	-1.07	-2.21			
Heterotrissocladius marcidus	IR	0.17	0.43	0.00	0.12	0.01	0.21	0.07	0.00	70	29.87	0.001
	Opt	0.39	0.52	0.09	0.34	0.08	0.43	0.27	0.05			
	Opt	1.59	1.08	-0.59	3.50	-0.24	0.04	-2.03	-3.07			
Hydropsyche angustipennis	Tol	0.02	0.14	0.00	0.00	0.00	0.47	0.00	0.37	29	33.02	0.001
	IR	0.16	0.37	0.09	0.33	0.27	0.54	0.30	0.52			
	Opt	-0.22	-0.61	-0.38	-1.90	-0.73	4.28	-2.48	1.96			
Hygrobatas fluviatilis	Tol	0.00	0.09	0.00	0.00	0.00	0.82	0.00	0.09	6	19.47	0.01
	IR	0.43	0.34	0.09	0.33	0.27	0.45	0.30	0.34			
	Opt	-0.96	-0.12	-0.17	-0.86	-0.33	4.04	-1.13	-0.12			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vege- tation	sand	gravel	N	chi	P<
Lebertia lineata	Opt	0.03	0.26	0.00	0.12	0.00	0.41	0.06	0.12	19	15.23	0.05
	Tol	0.18	0.46	0.09	0.34	0.27	0.51	0.24	0.34			
	IR	-1.13	0.77	-0.31	-0.88	-0.59	3.32	-1.01	-0.29			
Lebertia stigmatifera	Opt	0.44	0.18	0.00	0.02	0.00	0.33	0.03	0.01	51	37.66	0.001
	Tol	0.52	0.41	0.09	0.13	0.27	0.49	0.17	0.09			
	IR	-0.30	2.09	-0.50	-0.93	-0.96	4.70	-1.77	-2.44			
Leptophlebia marginata	Opt	0.52	0.48	0.00	0.00	0.00	0.00	0.00	0.00	12	23.52	0.005
	Opt	0.55	0.55	0.09	0.33	0.27	0.45	0.30	0.36			
	Tol	3.05	2.51	-0.24	-1.22	-0.47	-1.16	-1.59	-1.50			
Limnodrilus hoffmeisteri	IR	0.03	0.27	0.00	0.10	0.09	0.32	0.12	0.07	69	17.34	0.05
	Opt	0.17	0.46	0.09	0.31	0.29	0.49	0.33	0.27			
	Tol	-2.34	1.70	-0.59	-0.88	1.56	2.24	-0.42	-0.53			
Limnophyes sp	IR	0.26	0.03	0.00	0.13	0.11	0.42	0.00	0.05	23	25.29	0.001
	Opt	0.46	0.17	0.09	0.35	0.32	0.51	0.30	0.23			
	Opt	2.37	-1.59	-0.34	0.68	2.44	2.12	-2.21	-1.11			
Limnephilus extricatus	Tol	0.53	0.05	0.00	0.00	0.00	0.39	0.03	0.00	11	22.80	0.005
	IR	0.59	0.26	0.09	0.33	0.27	0.57	0.19	0.36			
	Opt	0.24	-0.04	-0.23	-1.17	-0.45	4.28	-0.87	-1.43			
Limnephilus lunatus	Tol	0.06	0.16	0.00	0.01	0.04	0.71	0.01	0.00	16	37.01	0.001
	IR	0.31	0.46	0.09	0.14	0.25	0.58	0.14	0.36			
	Opt	-0.30	-0.57	-0.28	-0.70	3.17	4.62	-1.30	-1.73			
Limnius volckmari	Opt	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.93	6	17.16	0.05
	Tol	0.43	0.29	0.09	0.33	0.27	0.45	0.30	0.29			
	IR	-0.96	-0.12	-0.17	-0.86	-0.33	-0.82	-1.13	3.66			
Ljania bipapillata	Opt	0.64	0.20	0.00	0.00	0.00	0.16	0.00	0.00	32	41.69	0.001
	Tol	0.50	0.42	0.09	0.33	0.27	0.38	0.30	0.36			
	IR	3.19	1.64	-0.40	-1.99	-0.76	3.37	-2.60	-2.45			
Lumbriculus variegatus	Opt	0.21	0.11	0.00	0.36	0.14	0.07	0.07	0.04	16	50.13	0.001
	Opt	0.44	0.33	0.09	0.52	0.38	0.28	0.28	0.20			
	Tol	-0.30	-0.57	-0.28	0.72	6.87	0.15	-0.76	-1.15			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
<i>Lype reducta</i>	IR	0.17	0.61	0.00	0.03	0.00	0.08	0.03	0.08	37	30.27	0.001
	Opt	0.39	0.50	0.09	0.17	0.27	0.29	0.17	0.29			
	Tol	0.55	4.59	-0.43	-1.21	-0.82	-0.08	-2.09	-1.49			
<i>Macropelopia</i> sp	IR	0.29	0.31	0.00	0.18	0.02	0.05	0.01	0.13	84	39.81	0.001
	Opt	0.47	0.48	0.09	0.40	0.14	0.23	0.12	0.35			
	Opt	1.96	3.60	-0.65	1.41	-0.43	0.18	-2.56	-3.71			
<i>Mideopsis orbicularis</i>	Tol	0.00	0.04	0.00	0.00	0.00	0.91	0.04	0.00	6	19.36	0.01
	IR	0.43	0.28	0.09	0.33	0.27	0.38	0.28	0.36			
	Opt	-0.96	-0.12	-0.17	-0.86	-0.33	4.04	-0.24	-1.06			
<i>Micropsectra</i> gr <i>atrofasciata</i>	Tol	0.50	0.01	0.00	0.09	0.04	0.10	0.00	0.26	38	28.59	0.001
	IR	0.57	0.09	0.09	0.33	0.24	0.34	0.05	0.51			
	Opt	1.30	-1.17	-0.43	1.97	2.77	2.28	-2.49	-1.54			
<i>Micropsectra</i> gr <i>notescens</i>	Opt	0.09	0.13	0.00	0.63	0.00	0.14	0.00	0.01	93	34.42	0.001
	Tol	0.31	0.37	0.09	0.53	0.27	0.38	0.06	0.08			
	IR	1.77	3.02	-0.68	1.02	-1.30	1.40	-2.86	-2.97			
<i>Molanna angustata</i>	Opt	0.00	0.18	0.00	0.00	0.00	0.64	0.18	0.00	8	23.02	0.005
	Tol	0.43	0.42	0.09	0.33	0.27	0.52	0.42	0.36			
	IR	-1.11	0.41	-0.20	-1.00	-0.38	4.32	-0.53	-1.22			
<i>Nais communis</i>	Opt	0.23	0.11	0.00	0.30	0.10	0.18	0.02	0.07	41	34.89	0.001
	Opt	0.43	0.32	0.09	0.47	0.30	0.39	0.13	0.26			
	Tol	1.47	-0.96	-0.45	2.62	3.76	1.11	-2.27	-2.05			
<i>Nais elinguis</i>	IR	0.39	0.00	0.00	0.08	0.10	0.18	0.02	0.22	37	55.83	0.001
	Opt	0.54	0.44	0.04	0.31	0.33	0.43	0.17	0.46			
	Tol	-0.29	-2.63	1.90	1.12	6.49	0.90	-1.01	0.03			
<i>Nais variabilis</i>	IR	0.22	0.15	0.00	0.27	0.07	0.23	0.05	0.01	37	30.95	0.001
	Opt	0.43	0.36	0.09	0.46	0.27	0.43	0.22	0.11			
	Opt	2.22	-0.35	-0.43	0.66	4.05	0.90	-1.73	-2.25			
<i>Nanocladius</i> <i>rectinervis</i>	Tol	0.00	0.17	0.00	0.06	0.08	0.53	0.00	0.17	14	26.55	0.001
	IR	0.43	0.39	0.09	0.24	0.29	0.53	0.30	0.39			
	Opt	-1.47	0.24	-0.26	-0.56	1.48	4.32	-1.72	-0.38			
<i>Nemurella pictetii</i>	Tol	0.83	0.11	0.00	0.00	0.00	0.06	0.00	0.01	55	32.24	0.001

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Neolimnomyia sp	IR	0.43	0.35	0.09	0.03	0.27	0.26	0.05	0.09	46	15.39	0.05
	Opt	3.96	2.09	-0.52	-1.47	-1.00	-0.48	-2.83	-0.71			
	Tol	0.00	0.06	0.00	0.45	0.01	0.29	0.11	0.09			
Nepa cinerea	IR	0.43	0.25	0.09	0.54	0.09	0.49	0.34	0.31	8	59.81	0.001
	Opt	-2.66	-0.55	-0.48	0.96	0.18	2.56	-0.24	0.48			
	Tol	0.22	0.11	0.00	0.11	0.44	0.11	0.00	0.00			
Nemoura avicularis	IR	0.45	0.34	0.09	0.34	0.53	0.34	0.30	0.36	18	14.52	0.05
	Opt	0.69	-0.41	-0.20	0.01	7.48	0.10	-1.30	-1.22			
	Tol	0.38	0.57	0.00	0.00	0.00	0.00	0.05	0.00			
Nemoura cinerea	IR	0.52	0.53	0.09	0.33	0.27	0.45	0.23	0.06	82	28.28	0.001
	Opt	1.34	2.52	-0.30	-1.50	-0.57	-1.42	0.09	-1.29			
	Tol	0.53	0.21	0.00	0.01	0.07	0.13	0.03	0.01			
Odontomesa fulva	IR	0.53	0.44	0.09	0.12	0.27	0.36	0.18	0.12	20	22.71	0.005
	Opt	2.36	0.68	-0.64	-1.00	3.69	0.58	-2.49	-0.85			
	Tol	0.00	0.12	0.00	0.07	0.00	0.01	0.80	0.00			
Ophidonais serpentina	IR	0.43	0.37	0.09	0.29	0.27	0.10	0.46	0.36	15	59.05	0.001
	Opt	-1.75	0.65	-0.32	-0.31	-0.60	-0.83	3.77	-1.93			
	Tol	0.12	0.12	0.00	0.00	0.00	0.77	0.00	0.00			
Oulimnius tuberculatus	IR	0.41	0.41	0.09	0.04	0.27	0.54	0.30	0.36	12	17.64	0.05
	Opt	-0.86	-0.48	-0.27	-0.63	-0.52	7.17	-1.78	-1.68			
	Tol	0.00	0.13	0.00	0.00	0.00	0.65	0.00	0.21			
Paracladopelma laminata agg	IR	0.43	0.40	0.09	0.33	0.27	0.56	0.30	0.48	24	16.49	0.05
	Opt	-1.36	1.17	-0.24	-1.22	-0.47	3.14	-1.59	0.50			
	Tol	0.01	0.23	0.00	0.01	0.00	0.07	0.66	0.01			
Paracladopelma nigritula	IR	0.11	0.45	0.09	0.11	0.27	0.28	0.50	0.11	48	23.64	0.005
	Opt	-1.40	0.71	-0.35	-1.15	-0.66	0.18	3.07	-1.65			
	Tol	0.02	0.36	0.00	0.11	0.00	0.05	0.46	0.01			
Paratendipes albimanus	IR	0.13	0.50	0.09	0.32	0.27	0.22	0.52	0.09	33	26.75	0.001
	Opt	-1.98	1.34	-0.49	0.43	-0.93	-0.17	3.08	-2.66			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vege- tation	sand	gravel	N	chi	P<
Pericoma sp	Opt	0.23	0.54	0.09	0.29	0.06	0.46	0.19	0.36	13	32.75	0.001
	Tol	-0.92	0.73	-0.40	0.45	1.80	3.78	-1.13	-2.48			
	IR	0.57	0.00	0.00	0.00	0.15	0.23	0.00	0.05			
	Opt	0.55	0.44	0.09	0.33	0.40	0.47	0.30	0.23			
	Tol	3.53	-1.56	-0.25	-1.27	3.62	0.44	-1.66	-0.28			
Pedicia sp	IR	0.09	0.01	0.00	0.00	0.01	0.10	0.23	0.54	50	14.97	0.05
Phaenopsectra sp	Opt	0.30	0.12	0.09	0.05	0.12	0.32	0.45	0.52	34	68.84	0.001
	Opt	1.19	-1.75	-0.50	-2.09	1.14	1.42	-0.49	1.52			
	Tol	0.16	0.01	0.00	0.24	0.16	0.36	0.01	0.05			
Physa fontinalis	IR	0.38	0.10	0.07	0.45	0.39	0.50	0.10	0.23	12	49.61	0.001
	Opt	-0.10	-2.13	2.02	1.84	6.84	2.13	-1.94	-1.33			
	Tol	0.03	0.03	0.00	0.10	0.00	0.84	0.00	0.00			
Pilaria sp	IR	0.19	0.19	0.09	0.32	0.27	0.40	0.30	0.36	22	15.90	0.05
	Opt	-0.62	-0.83	-0.24	-0.40	-0.47	6.58	-1.59	-1.50			
	Tol	0.00	0.27	0.00	0.06	0.00	0.42	0.09	0.15			
Pisidium casertanum	Tol	0.43	0.46	0.09	0.25	0.27	0.51	0.30	0.37	190	21.11	0.005
	IR	-1.84	1.42	-0.33	-0.44	-0.63	2.87	-1.23	-0.06			
	Opt	0.15	0.37	0.00	0.08	0.00	0.20	0.18	0.02			
Plectrocnemia conspersa	Tol	0.36	0.49	0.03	0.27	0.02	0.41	0.38	0.14	161	84.80	0.001
	IR	-0.79	2.76	0.06	-0.12	-1.32	-0.30	1.53	-2.94			
	Opt	0.42	0.25	0.00	0.05	0.00	0.24	0.01	0.03			
Polycelis felina	Opt	0.50	0.44	0.09	0.22	0.06	0.43	0.07	0.16	17	28.54	0.001
	Tol	4.46	3.99	-0.89	-0.67	-1.13	2.55	-5.50	-3.12			
	IR	0.00	0.30	0.00	0.00	0.00	0.45	0.00	0.25			
Polycelis nigra/tenuis	Opt	0.43	0.49	0.09	0.33	0.27	0.53	0.30	0.46	21	17.45	0.05
	Tol	-1.62	-0.66	-0.29	-1.45	-0.56	2.95	-1.90	3.26			
	IR	0.29	0.13	0.00	0.00	0.00	0.52	0.01	0.05			
Polycelis tenuis	Opt	0.49	0.36	0.09	0.33	0.27	0.54	0.12	0.23	12	73.72	0.001
	Opt	1.54	0.04	-0.32	-1.61	-0.62	3.01	-1.64	-0.47			
	Tol	0.19	0.03	0.00	0.00	0.19	0.55	0.00	0.03			
Polycelis tenuis	IR	0.44	0.20	0.09	0.33	0.44	0.56	0.30	0.20	12	73.72	0.001
	Opt	1.58	-0.83	-0.24	-1.22	8.09	0.56	-1.59	-0.83			
	Tol	0.19	0.03	0.00	0.00	0.19	0.55	0.00	0.03			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vege- tation	sand	gravel	N	chi	P<
Polypedilum nubeculosum	Tol	0.05	0.27	0.00	0.15	0.07	0.38	0.07	0.00	24	26.52	0.001
	IR	0.24	0.46	0.09	0.37	0.27	0.50	0.27	0.36			
	Opt	-0.36	0.71	-0.35	0.59	3.88	2.01	-1.37	-2.12			
Polypedilum scalaenum	Opt	0.02	0.28	0.00	0.25	0.00	0.20	0.19	0.07	269	25.13	0.001
	Tol	0.13	0.45	0.04	0.44	0.03	0.40	0.39	0.25			
	IR	-3.33	1.79	0.57	0.97	-1.76	-0.60	2.25	-1.03			
Procladius sp	Opt	0.11	0.35	0.00	0.26	0.02	0.24	0.02	0.00	63	26.06	0.001
	Tol	0.32	0.49	0.09	0.45	0.13	0.44	0.15	0.06			
	IR	0.74	2.97	-0.56	1.14	0.80	0.72	-2.01	-3.14			
Proasellus meridianus	Opt	0.28	0.07	0.00	0.04	0.23	0.36	0.00	0.02	62	69.68	0.001
	Opt	0.47	0.26	0.09	0.20	0.44	0.50	0.07	0.13			
	Tol	0.79	-0.18	-0.55	-0.61	6.47	3.79	-3.07	-1.64			
Prodiamesa olivacea	IR	0.16	0.29	0.00	0.27	0.01	0.08	0.15	0.04	139	30.58	0.001
	Opt	0.37	0.46	0.09	0.45	0.09	0.27	0.36	0.21			
	Tol	-1.17	2.35	-0.83	2.83	-0.33	-2.19	1.21	-2.94			
Psammoryctides barbatus	IR	0.00	0.24	0.00	0.00	0.00	0.66	0.08	0.02	16	22.07	0.005
	Opt	0.43	0.47	0.09	0.33	0.27	0.52	0.30	0.15			
	Opt	-1.57	1.16	-0.28	-1.41	-0.54	3.87	-0.76	-0.57			
Ptychoptera lacustris	Tol	0.04	0.22	0.00	0.46	0.00	0.17	0.09	0.02	51	16.35	0.05
	IR	0.20	0.43	0.09	0.52	0.27	0.39	0.29	0.14			
	Opt	-1.02	0.47	-0.50	3.05	-0.96	0.11	0.36	-2.12			
Radix sp	Tol	0.00	0.00	0.00	0.31	0.38	0.00	0.00	0.31	9	32.96	0.001
	IR	0.43	0.44	0.09	0.50	0.53	0.45	0.30	0.50			
	Opt	-1.18	-1.30	-0.21	1.78	4.54	-1.01	-1.38	1.79			
Rheocricotopus fuscipes	Opt	0.43	0.17	0.00	0.02	0.01	0.12	0.02	0.24	73	20.39	0.005
	Tol	0.51	0.38	0.09	0.15	0.09	0.34	0.13	0.44			
	IR	2.31	1.18	-0.60	-1.35	0.58	0.97	-3.17	0.36			
Rhyacodrilus coccineus	Opt	0.00	0.84	0.04	0.00	0.00	0.00	0.08	0.04	15	65.75	0.001

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vege- tation	sand	gravel	N	chi	P<
Rheotanytarsus sp	Tol	0.43	0.49	0.25	0.33	0.27	0.45	0.36	0.27	26	28.33	0.001
	IR	-1.52	3.10	7.05	-1.36	-0.52	-1.30	-0.10	-0.48			
	Opt	0.04	0.03	0.00	0.05	0.02	0.35	0.00	0.52			
	Opt	0.20	0.17	0.09	0.24	0.14	0.51	0.30	0.53			
	Tol	-1.00	-1.75	-0.36	-0.13	0.77	3.55	-2.35	2.33			
Sialis fuliginosa	IR	0.20	0.41	0.00	0.30	0.00	0.03	0.06	0.00	35	26.16	0.001
	Opt	0.41	0.51	0.09	0.48	0.27	0.19	0.24	0.36			
	Tol	1.56	2.91	-0.42	1.75	-0.80	-1.48	-1.62	-2.56			
Sialis lutaria	IR	0.23	0.46	0.00	0.04	0.00	0.23	0.04	0.00	30	22.52	0.005
	Opt	0.43	0.51	0.09	0.21	0.27	0.43	0.21	0.36			
	Opt	0.18	3.12	-0.39	-0.89	-0.74	1.97	-1.33	-2.37			
Silo nigricornis	Tol	0.00	0.00	0.00	0.00	0.00	0.09	0.06	0.86	21	28.04	0.001
	IR	0.43	0.44	0.09	0.33	0.27	0.30	0.25	0.38			
	Opt	-1.80	-1.98	-0.32	-1.61	-0.62	1.06	0.26	4.07			
Simulium costatum	Tol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	6	26.07	0.001
	IR	0.43	0.44	0.09	0.33	0.27	0.45	0.30	0.36			
	Opt	-0.96	-1.06	-0.17	-0.86	-0.33	-0.82	-1.13	4.60			
Simulium erythrocephala	Opt	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	7	55.18	0.001
	Tol	0.43	0.44	0.09	0.33	0.27	0.45	0.30	0.36			
	IR	-1.04	-1.14	-0.19	-0.93	-0.36	7.00	-1.22	-1.14			
Simulium intermedium	Opt	0.03	0.00	0.00	0.00	0.00	0.84	0.00	0.13	7	17.28	0.05
	Tol	0.22	0.44	0.09	0.33	0.27	0.49	0.30	0.46			
	IR	-0.07	-1.14	-0.19	-0.93	-0.36	3.62	-1.22	0.60			
Simulium ornatum	Opt	0.12	0.02	0.00	0.01	0.00	0.30	0.00	0.54	16	20.50	0.005
	Opt	0.37	0.16	0.09	0.13	0.27	0.52	0.30	0.56			
	Tol	-0.93	-1.15	-0.28	-0.70	-0.54	2.38	-1.84	2.89			
Simulium trifasciatum	IR	0.07	0.45	0.00	0.00	0.00	0.07	0.00	0.41	31	41.49	0.001
	Opt	0.29	0.56	0.09	0.33	0.27	0.28	0.30	0.56			
	Tol	-0.35	-0.33	-0.39	-1.96	-0.75	-0.26	-2.56	5.48			
Slavina appendiculata	IR	0.27	0.26	0.00	0.08	0.02	0.34	0.03	0.01	47	22.86	0.005

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Sperchon glandulosus	Opt	0.46	0.45	0.09	0.27	0.14	0.49	0.16	0.12	42	32.29	0.001
	Opt	3.26	0.41	-0.48	-0.35	1.24	1.18	-1.89	-2.29			
	Tol	0.51	0.31	0.00	0.04	0.00	0.05	0.04	0.06			
	IR	0.51	0.47	0.09	0.19	0.27	0.22	0.19	0.25			
Sperchon sp nymf	Opt	4.93	0.41	-0.46	-0.97	-0.87	-0.34	-1.98	-1.38	11	18.04	0.05
	Tol	0.07	0.33	0.00	0.00	0.00	0.53	0.00	0.07			
	IR	0.26	0.50	0.09	0.33	0.27	0.53	0.30	0.26			
Sperchon setiger	Opt	-0.53	1.35	-0.23	-1.17	-0.45	3.38	-1.53	-0.74	14	16.36	0.05
	Opt	0.10	0.07	0.00	0.00	0.00	0.13	0.00	0.70			
	Tol	0.32	0.26	0.09	0.33	0.27	0.36	0.30	0.48			
Sperchon squamosus	Opt	0.24	0.10	0.00	0.06	0.00	0.53	0.00	0.06	30	18.08	0.05
	Tol	0.44	0.31	0.09	0.25	0.27	0.51	0.30	0.25			
	IR	2.04	-0.26	-0.39	0.14	-0.74	2.52	-2.52	-0.68			
Sperchon thienemanni	Opt	0.08	0.45	0.00	0.00	0.00	0.42	0.00	0.06	41	46.84	0.001
	Opt	0.27	0.51	0.09	0.33	0.27	0.51	0.30	0.24			
	Tol	-0.52	1.92	-0.45	-2.26	-0.86	5.30	-2.95	-0.24			
Specaria josinae	IR	0.05	0.73	0.00	0.01	0.00	0.13	0.09	0.00	23	17.47	0.05
	Opt	0.23	0.49	0.09	0.10	0.27	0.37	0.32	0.36			
	Tol	-0.29	3.23	-0.34	-1.10	-0.65	0.88	-0.40	-2.07			
Spirosperma ferox	IR	0.00	0.43	0.00	0.00	0.00	0.51	0.06	0.00	13	23.33	0.005
	Opt	0.43	0.53	0.09	0.33	0.27	0.53	0.25	0.36			
	Opt	-1.41	1.65	-0.25	-1.27	-0.49	3.75	-0.45	-1.56			
Sphaerium corneum	Tol	0.00	0.63	0.00	0.07	0.00	0.22	0.07	0.02	17	21.82	0.005
	IR	0.43	0.52	0.09	0.27	0.27	0.44	0.27	0.14			
Stylaria lacustris	Opt	-1.62	1.58	-0.29	-0.76	-0.56	3.68	-0.84	-1.22	14	45.88	0.001
	Tol	0.08	0.03	0.01	0.00	0.00	0.84	0.03	0.00			
	IR	0.30	0.21	0.13	0.33	0.27	0.42	0.21	0.36			
Stictochironomus sp	Opt	0.58	-1.00	3.53	-1.32	-0.50	5.12	-1.14	-1.62	40	19.13	0.01
	Opt	0.02	0.63	0.00	0.00	0.00	0.07	0.18	0.10			

taxon name/ habitat type		leaves	detritus	clay	mud	branches /wood	Vegetation	sand	gravel	N	chi	P<
Tanytarsus sp	Tol	0.16	0.50	0.09	0.33	0.27	0.26	0.40	0.31	97	26.08	0.001
	IR	-0.87	3.11	-0.45	-2.23	-0.85	-0.71	1.21	-0.91			
	Opt	0.23	0.12	0.00	0.18	0.02	0.11	0.27	0.07			
	Tol	0.44	0.34	0.02	0.40	0.16	0.33	0.46	0.27			
	IR	-0.50	0.20	0.75	0.85	3.94	1.84	-1.00	-2.15			
Thienemanniella flaviforceps agg	Opt	0.08	0.03	0.00	0.03	0.00	0.82	0.03	0.03	16	53.05	0.001
	Opt	0.29	0.17	0.09	0.17	0.27	0.41	0.17	0.17			
	Tol	-0.93	-1.15	-0.28	-0.70	-0.54	6.85	-1.30	-1.15			
Tipula lateralis	IR	0.18	0.00	0.00	0.06	0.12	0.59	0.00	0.06	9	28.66	0.001
	Opt	0.42	0.44	0.09	0.26	0.36	0.55	0.30	0.26			
	Tol	0.52	-1.30	-0.21	-0.11	4.54	1.97	-1.38	-0.53			
Tubifex ignotus	IR	0.02	0.24	0.00	0.01	0.00	0.65	0.05	0.03	29	20.47	0.005
	Opt	0.15	0.45	0.09	0.08	0.27	0.50	0.24	0.17			
	Opt	-1.64	1.96	-0.38	-1.37	-0.73	3.17	-0.46	-1.04			
Tvetenia discoloripes agg	Tol	0.05	0.02	0.00	0.00	0.00	0.51	0.00	0.42	17	28.20	0.001
	IR	0.24	0.14	0.09	0.33	0.27	0.53	0.30	0.52			
	Opt	-1.00	-1.22	-0.29	-1.45	-0.56	2.23	-1.90	3.82			
Velia caprai	Tol	0.56	0.06	0.00	0.06	0.00	0.31	0.00	0.00	12	21.15	0.005
	IR	0.52	0.26	0.09	0.26	0.27	0.49	0.30	0.36			
	Opt	2.32	-0.83	-0.24	-0.40	-0.47	3.14	-1.59	-1.50			
Wettina podagrica	Opt	0.56	0.30	0.00	0.01	0.00	0.12	0.01	0.00	12	14.22	0.05
	Tol	0.57	0.53	0.09	0.11	0.27	0.37	0.11	0.36			
	IR	0.85	-0.16	-0.24	-0.40	-0.47	3.14	-0.97	-1.50			
Zavreliomyia sp	Opt	0.39	0.20	0.00	0.15	0.08	0.14	0.00	0.03	100	58.29	0.001
	Tol	0.50	0.41	0.09	0.37	0.28	0.36	0.05	0.18			
	IR	4.49	2.61	-0.70	0.73	0.87	0.52	-4.39	-3.17			

