

Macroinvertebrate as indicators of acidification in high-altitude Alpine lakes

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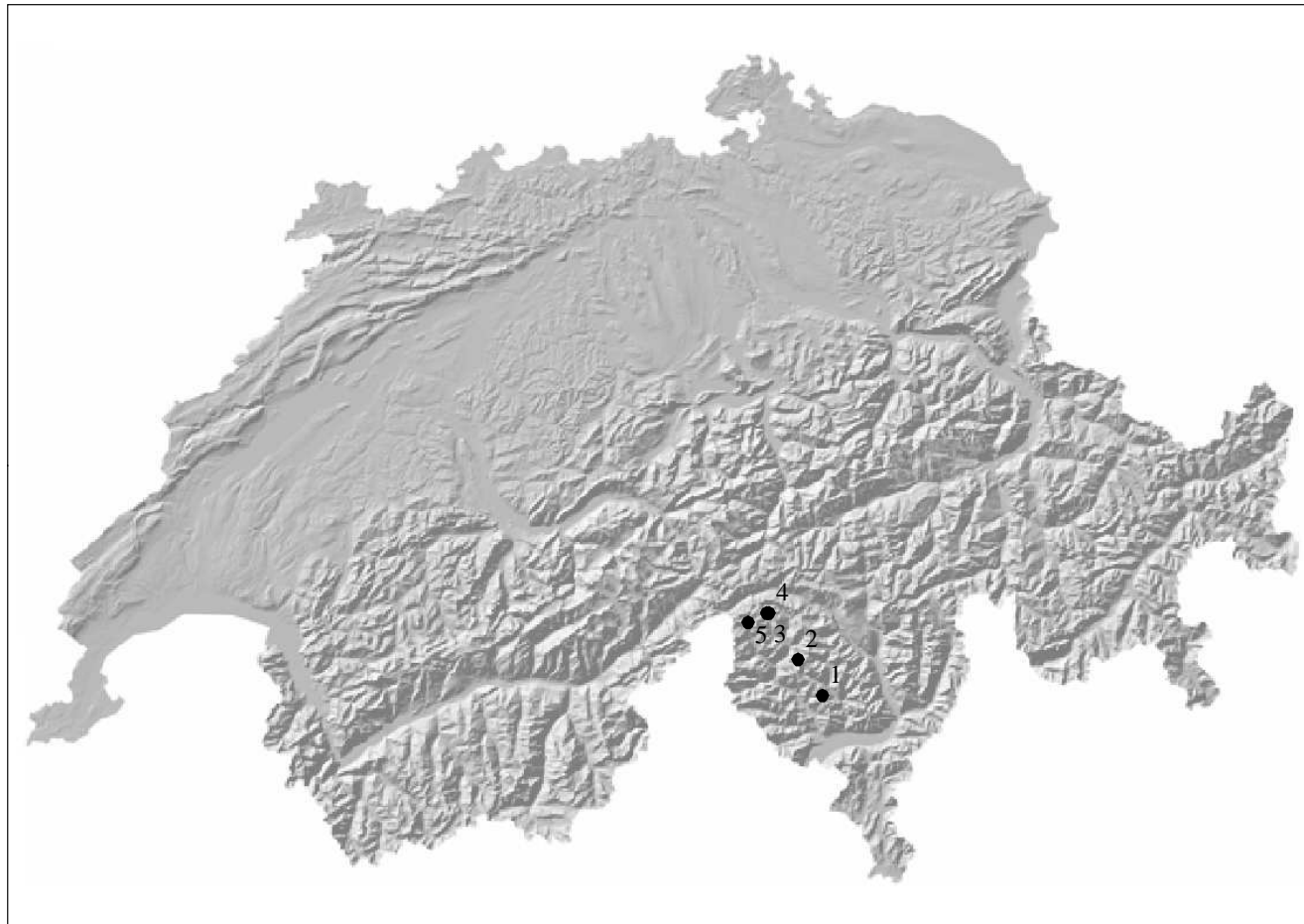
Introduction

- Chemical recovery from acidification of high-altitude Alpine lakes since mid 1990's (Steingruber and Colombo, 2010)
- However, biological recovery remains the ultimate goal of emission control programmes
- But, methods for assessment of acidification based on macroinvertebrates were mainly developed for Northern Europe and for river ecosystems

Aims

- Apply existing metrics to macroinvertebrate data from the littoral and the outlet of 5 high-altitude Alpine lakes with different pH
- To find which metrics reflect best variations in pH
- In order to better assess changes in macroinvertebrate population as a consequence of changes in acidification

Study site



Lago del Starlaresc da Sgiof 1875 m a.s.l.



Laghetto Superiore 2128 m a.s.l.
Laghetto Inferiore 2074 m a.s.l.



Lago di Tomè 1692 m a.s.l.



Lago Bianco 2077 m a.s.l.



Chemical characterization of lakes

(Average values 2007)

No.	Name	Abbr.	pH	Alkalinity meq/m ³	Definition
1	Lago del Starlaresc da Sgiof	STA	5.5	3	sensitive to acidification
2	Lago di Tomè	TOM	5.7	5	sensitive to acidification
3	Laghetto Superiore	SUP	6.7	33	low alkalinity
4	Laghetto Inferiore	INF	6.7	36	low alkalinity
5	Lago Bianco	BIA	7.6	441	alkaline

Biological characterization of outlets

(rel. abundances %, average values 2007)

Taxonomic groups	STA pH=5.5	TOM pH=5.7	SUP pH=6.7	INF pH=6.7	BIA pH=7.6
OLIGOCHAETA	1	0	41	32	46
DIPTERA	77	61	48	56	41
Chironomidae	68	52	28	35	40
EPHEMEROPTERA	0	0	0	1	1
PLECOPTERA	14	36	6	6	11
TRICHOPTERA	2	1	1	1	0
TURBELLARIA	0	0	4	6	6

Biological characterization of littorals

(rel. abundances %, average values 2007)

Taxonomic groups	STA pH=5.5	TOM pH=5.7	SUP pH=6.7	INF pH=6.7	BIA pH=7.6
OLIGOCHAETA	3	21	8	12	30
DIPTERA	89	62	45	75	55
Chironomidae	72	62	44	73	55
EPHEMEROPTERA	0	0	0	0	0
PLECOPTERA	0	0	4	1	0
TRICHOPTERA	1	7	5	2	0
NEMATODA	4	1	34	6	10
HYDRACARINA	0	7	2	3	6

Applied metrics

General metrics

- Total number of taxa
- Number families, taxa and rel. abundance of Ephemeroptera (E)
- Number families, taxa and rel. abundance of Plecoptera (P)
- Number families, taxa and rel. abundance of Trichoptera (T)
- Number families, taxa and rel. abundance of EPT
- Number taxa and rel. abundance of Diptera
- Number taxa and rel. abundance of Chironomidae
- Number taxa and rel. abundance of Oligochaeta
- Rel. abundance of Predators

Applied metrics

Specific metrics

- Braukmann index (Braukmann and Biss, 2004)
- Raddum index (Raddum et al. 1988; Fjellheim and Raddum, 1990)
- NIVA index (Bækken and Kjellberg, 2004)
- AWICfam index (Davy-Bowker et al. 2003)
- AWICsp index (Davy-Bowker et al. 2003)
- MEDIN index (Henrikson and Medin, 1986)
- MILA index (Johnson and Goedkoop, 2007)
- LAMM index (McFarland et al. 2010)
- Number and rel. abundance of acid sensitive taxa according to literature

Application of general metrics to outlets

General metrics	STA pH=5. 5	TOM pH=5. 7	SUP pH=6. 7	INF pH=6. 7	BIA pH=7. 6
Total number of taxa	35	40	41	46	55
Rel. Abundance Ephemeroptera %	0	0	0.3	0.9	1.3
Number of families Ephemeroptera	0	0	1	1	2
Number of taxa Ephemeroptera	0	0	1	2	2
Rel. Abundance Plecoptera %	14.2	36.0	5.9	6.0	10.7
Number of families Plecoptera	2	3	3	3	3
Number of taxa Plecoptera	1	3	5	6	6
Rel. Abundance Trichoptera %	1.5	1.1	1.2	0.4	0.6
Number of families Trichoptera	3	3	3	3	4
Number of taxa Trichoptera	4	4	4	3	5
Rel. Abundance Ephemeroptera/Plecoptera/Trichoptera %	15.7	37.2	7.3	7.2	12.6
Number of families Ephemeroptera/Plecoptera/Trichoptera	5	6	7	7	9
Number of taxa Ephemeroptera/Plecoptera/Trichoptera	5	7	10	11	13
Rel. Abundance Diptera %	76.7	60.7	47.5	55.6	40.4
Number of taxa Diptera	19	23	23	27	30
Rel. Abundance Chironomidae %	67.7	52.1	27.9	35.0	39.8
Number of taxa Chironomidae	16	21	21	24	27
Rel. Abundance Oligochaeta %	0.7	0.3	40.7	31.5	45.8
Number of taxa Oligochaeta	3	3	4	4	7
Rel. Abundance Predators%	11.3	10.5	6.1	7.5	2.7

Application of general metrics to littorals

General metrics	STA pH=5. 5	TOM pH=5. 7	SUP pH=6. 7	INF pH=6. 7	BIA pH=7. 6
Total number of taxa	27	28	41	38	31
Rel. Abundance Ephemeroptera %	0	0	0	0	0
Number of families Ephemeroptera	0	0	0	0	0
Number of taxa Ephemeroptera	0	0	0	0	0
Rel. Abundance Plecoptera %	0	0.4	4.1	1.1	0.1
Number of families Plecoptera	0	1	1	1	1
Number of taxa Plecoptera	0	1	1	1	1
Rel. Abundance Trichoptera %	0.6	6.7	4.9	2.4	0
Number of families Trichoptera	1	2	2	2	0
Number of taxa Trichoptera	1	2	3	2	0
Rel. Abundance Ephemeroptera/Plecoptera/Trichoptera %	0.6	7.1	9.0	3.5	0.1
Number of families Ephemeroptera/Plecoptera/Trichoptera	1	3	3	3	1
Number of taxa Ephemeroptera/Plecoptera/Trichoptera	1	3	4	3	1
Rel. Abundance Diptera %	88.5	61.6	45.1	74.5	55.1
Number of taxa Diptera	15	13	22	21	17
Rel. Abundance Chironomidae %	72.3	61.6	44.2	73.0	55.0
Number of taxa Chironomidae	13	12	19	19	15
Rel. Abundance Oligochaeta %	3.0	21.4	8.2	12.3	29.6
Number of taxa Oligochaeta	4	7	10	9	10
Rel. Abundance Predators%	13.8	52.7	21.5	30.3	9.9

Application of specific metrics to outlets

Specific metrics	STA pH=5. 5	TOM pH=5. 7	SUP pH=6. 7	INF pH=6. 7	BIA pH=7. 6
Braukmann index (1-5)	4	5	5	5	5
Raddum index (1-0)	0	0.5	0.5	0.5	1
NIVA index (1-4)	4	4	4	4	4
AWICfam index (6-0)	3.9	4.0	3.5	3.5	3.8
AWICsp index (10-0)	5.7	5.3	5.2	5.2	5.3
MEDIN index (1-5)	5	5	5	5	5
MILA index (100-1)	15	21	28	29	33
LAMM index (6-0)	4	4	4	4	4
Relative abundance of acid taxa species according to Table 5 %	0.0	0.3	5.6	9.1	3.6
Number of acid taxa species	0	3	4	7	8

Application of specific metrics to littorals

Specific metrics	STA pH=5. 5	TOM pH=5. 7	SUP pH=6. 7	INF pH=6. 7	BIA pH=7. 6
Braukmann index (1-5)	4	4	4	4	4
Raddum index (1-0)	0	0	0.5	0.25	0
NIVA index (1-4)	4	4	3	3	4
AWICfam index (6-0)	5.5	3.7	4.0	4.0	3.7
AWICsp index (10-0)	6.0	5.1	5.5	5.4	5.0
MEDIN index (1-5)	5	5	4	5	5
MILA index (100-1)	25	7	13	3	23
LAMM index (6-0)	6	2	4	3	4
Relative abundance of acid taxa species according to Table 5 %	0.1	0.0	0.1	0.0	6.7
Number of acid taxa species	1	0	2	0	2

Summary

- Metrics for outlets:

Total taxa

Ephemeroptera (% families, taxa)

Plecoptera (taxa)

EPT (families, taxa)

Diptera (% taxa)

Chironomidae (% taxa)

Oligochaeta (% taxa)

Predators (%)

Sensitive taxa (% taxa)

Mila index

Modified Braukmann index

- Metrics for littorals:

Total taxa

Diptera (taxa)

Chironomidae (taxa)

Oligochaeta (taxa)

Why only few metrics in littorals?

- Inhabited by very little EPT species
- Most acid sensitive species are rheophil or rheobiont and are absent in standing waters
- Other environmental factors than acidity are more important in determining differences in macroinvertebrate populations (especially substrate, presence of vegetation, temperature)

Conclusion

- In general macroinvertebrates from lake outlets are better indicators of acidity than macroinvertebrates from lake littorals
- Determination to species of especially chironomids but eventually also of oligochaetes, especially in lake littorals, are recommended
- Further studies on acid sensitivity of especially chironomid but also oligochaete species would be helpful to improve assessment of invertebrates as acidification indicators in high altitude Alpine lakes



Thanks for your attention!