BIOLOGICAL INDICATORS OF EPISODIC ACIDIFICATION

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Aim **- to study biological effects of acidity at high flow episodes in streams, among benthic macro-invertebrates and fish.**

Important questions:

- **Are acid episodes reflected in abundance and community composition of these organisms?**
- **Can acid episodes be detected by an elevated metal burden in brown trout?**

Material and methods **This study is based upon results from 3 years (2000-02) monitoring, monthly water sampling complemented with more frequent high flow sampling in eight (acid or limed and neutral) streams in the ISELAW-programme (Integrated Studies of the Effects of Liming Acidified Waters).**

In autumns quantitative electro-fishing was performed and qualitative (M42-kick-method) and quantitative (modified Surber) sampling of benthic macro-invertebrates was performed in spring and autumn.

Means of chemical variables were calculated for the hydrological year, October to September. In addition – variables that were expected to have most effect at high flows was also estimated as extreme values i.e. minimum levels of pH and alkalinity/acidity and maximum levels of inorganic aluminium (Ali) for the same period. Several biological indexes and relative abundances for trout were calculated and correlations with water quality were established (*p<0.05, **p<0.01, ***p<0.001). Also ANOVA and t-tests were run on the biological results of the stream groups.

Young brown trout (1-2 years) was gathered in springtime (5 streams – once, 2000 and 2 streams - thrice, 2001). The load of Al on the gills and Hg in muscle was determined in at least 6 fishes per sampling.

Results **The streams could chemically be divided into three groups; acid, episodically acid and streams with rare pH-depressions (minimum pH>5.5, Table 1). The episodically acid streams were not statistically significant separated from the other two groups by the biological results.**

The number of benthic macro-invertebrate taxa and the relative abundance of brown trout showed an expected good correlation to minimum pH (Figure 1 and 2).

The fish biomass was correlated to number of macro-invertebrate taxa (Figure 3) – this can be a collinear response to sub optimal water quality as well as a food chain effect.

The metal burden of young brown trout (1-2 years) could be described with gill-Al and muscle-Hg; which were correlated (Figure 4). The highest values were found in the acid stream and in a limed episodically acid stream with very fluctuating pH.

- **The effect of acid episodes can be detected in the stream fauna but the results must be evaluated together with the water chemistry.**
- **The metal burden well reflects streams with permanent or severe episodic acidity.**

Table 1. Groups of streams and chemical character.

Stream group	n	mean pH	min pH	mean alkalinity/acidity meq/L	min meq/L	mean Ali µg/L	max Ali µg/L
Permanently acid stream *pH < 5.5, minimum pH < 5*	1	4.9	4.5	-0.03	-0.10	69	132
Episodically acid stream *pH < 6.3, minimum pH >5.5 (drop >1 pH)*	4	6.3	4.9	0.08	0.03	8	145
Streams with rare pH-depressions *pH > 6, minimum pH >5.5 (drop <1pH)*	3	6.7	6	0.15	0.05	15	43

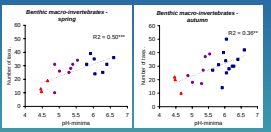

Figure 1. Number of benthic macro-invertebrate taxa in spring and autumn sampling and correlation to minimum pH in ***acid*** *,* ***episodically acid*** *and streams with* ***rare pH-depressions*** *(minimum pH >5.5). Note the higher significance of the correlation in springtime, when sampling was performed closer to the acid episodes.*

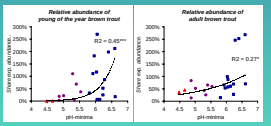

Figure 2. Relative abundance (of expected) for brown trout and minimum pH in ***acid*** *,* ***episodically acid*** *and streams with* ***rare pH-depressions*** *(minimum pH >5.5). Note the better fit for the stationary young of the year brown trout compared to the more mobile adult trout.*

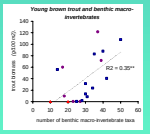

Figure 3. Biomass of young of the year brown trout and number of taxa of benthic macro-invertebrates at autumn in ***acid*** *,* ***episodically acid*** *and streams with* ***rare pH-depressions*** *(minimum pH >5.5).*

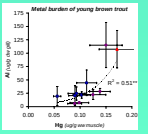

Figure 4. Metal burden of young brown trout (1-2 years) in springtime in ***acid*** *,* ***episodically acid*** *and streams with* ***rare pH-depressions*** *(minimum pH >5.5). Aluminium om gills and mercury in fish muscle (means of 6 ± sd).*

ISELAW

Integrated Studies of the Effects of Liming Acidified Waters

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