Environmental factors affecting *Margaritifera margaritifera* glochidia and juveniles

Jouni Taskinen, Heini Hyvärinen, Tuomo Sjönberg, Eero Mäenpää, Jukka Pakkala, Päivi Berg and Mari Saarinen-Valta

LIFE/NAT/FI-000611

RMK Nature protection conference, Narva, 3-4 Nov 2022

Kuva: Jouni Salonen

Substrate, metals and oxygen → freshwater pearl mussel FPM

- Effect of low oxygen on survival of juvenile FPM
- Influence of substrate grain size on burrowing of juvenile FPM
- Impact of pH, Al and Fe on survival of FPM glochidia and juveniles

Background:

Siltation is connected to decline of FPM → Low oxygen is believed to cause mortality of gravel-burrowed juveniles

However, no published information about tolerance of low oxygen by juvenile FPM

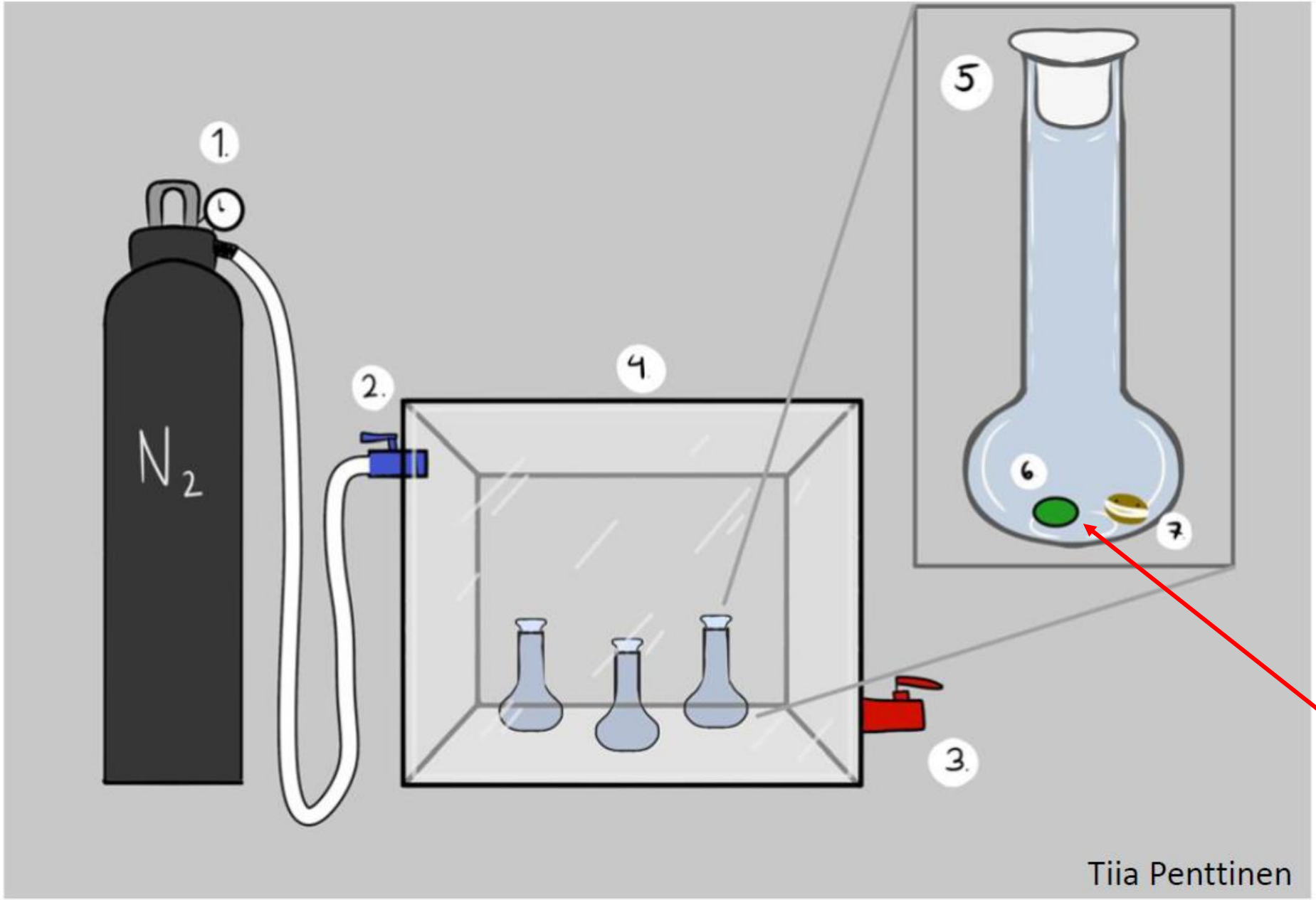
Materials and methods:

- Lake Konnevesi water filtered and UV-radiated
- 9-11 month old FPM juveniles of River Ähtävänjoki population (from lab-infected, farmed 1-year brown trout)
- Experiment conducted in 19 C temperature

1. Effect of low dissolved oxygen on the viability of juvenile *Margaritifera margaritifera*

- Laboratory experiment, 3 treatments with 18 juveniles each:
- **High oxygen concentration (control) (6.2-8.8 mg/l)**
- **Medium oxygen concentration (0.4-5.0 mg/l)**
- **Low oxygen concentration (0.04-1.3 mg/l)**
- Experiment lasted for 10 days

Measurement of oxygen from sealed flask: PreSens Microx 4 Fiber Optic Oxygen Transmitter (PreSens, Regensburg, Germany) with non-invasive oxygen sensor spots (spot diameter 5 mm)



Experiment equipment:

1. Nitrogen gas tank, used for oxygen removal from water and the chamber atmosphere
2. Inlet for nitrogen gas
3. Outlet for oxygen to exit
4. Chamber made of transparent plastic
5. 25 ml measurement glass flask
6. 5 mm diameter oxygen sensor spot
7. Juvenile mussel

Viability of the juvenile checked with magnifying glass: foot or valve movement within 10 min. No movement => microscope inspection.

TABLE 1 The range of oxygen (O_2) concentrations and saturations throughout the experiments, mean O_2 concentrations and saturation at the beginning and end of the experiments, and the number of viable and non-viable juvenile mussels after exposure to varying concentrations of dissolved O_2 (mg L^{-1}) for up to 10 days

Treatment	O_2 concentration (mg L^{-1}) and saturation (%)							
	Range		Mean, start of experiment		Mean, end of experiment			
	mg L^{-1}	%	mg L^{-1}	%	mg L^{-1}	%	No. viable juveniles	No. non-viable juveniles
High O_2	8.8–6.2	98–70	8.4	95	7.3	83	18	0
Medium O_2	5–0.4	57–4	4.1	47	2.1	24	18	0
Low O_2	1.3–0.04	15–0	0.9	10	0.3	4	0	18

Results/10-day experiment:

- All juveniles survived in medium and high oxygen
- None alive in low O2 conditions after 10 days
- However, 2 juveniles out of 18 survived up to 9 days

Conclusions:

- Low oxygen condition close-to-anoxic epidodes detrimental
- However, some juveniles survived up to 9 days
- If surived, what are long-term consequences?

Effect of low dissolved oxygen on the viability of juvenile *Margaritifera margaritifera*: Hypoxia tolerance ex situ

Aquatic Conservation, 2022

Heini S.H. Hyvärinen | Tuomo Sjönberg | Timo J. Marjomäki | Jouni Taskinen

2. Influence of substrate grain size on burrowing of juvenile *Margaritifera margaritifera*

Background:

Siltation is connected to decline of FPM → Low oxygen due to clogging of gravel by fine sediments is believed to cause mortality of gravel-burrowed juveniles

But, does fine sediment trigger surfacing behaviour in juvenile FPM?

Materials and methods:

- Filtered Lake Jyväsjärvi water
- Newly detached FPM juveniles of River Haapuanoja population (from field-infected, farmed brown trout)
- Experiment conducted in 17-18 C temperature

Natural sediment from lake littoral zone sieved as

1) <120 µm
2) 120-200 µm
3) 200-250 µm
4) 250-500 µm
5) 500-650 µm

- Petri dishes with 7 mm of substrate
- 10 replicate dishes of 10 glochidia per grain size
- Proportion of burrowed juveniles checked at: 0.5, 1, 2, 4, 74 and 96 hours

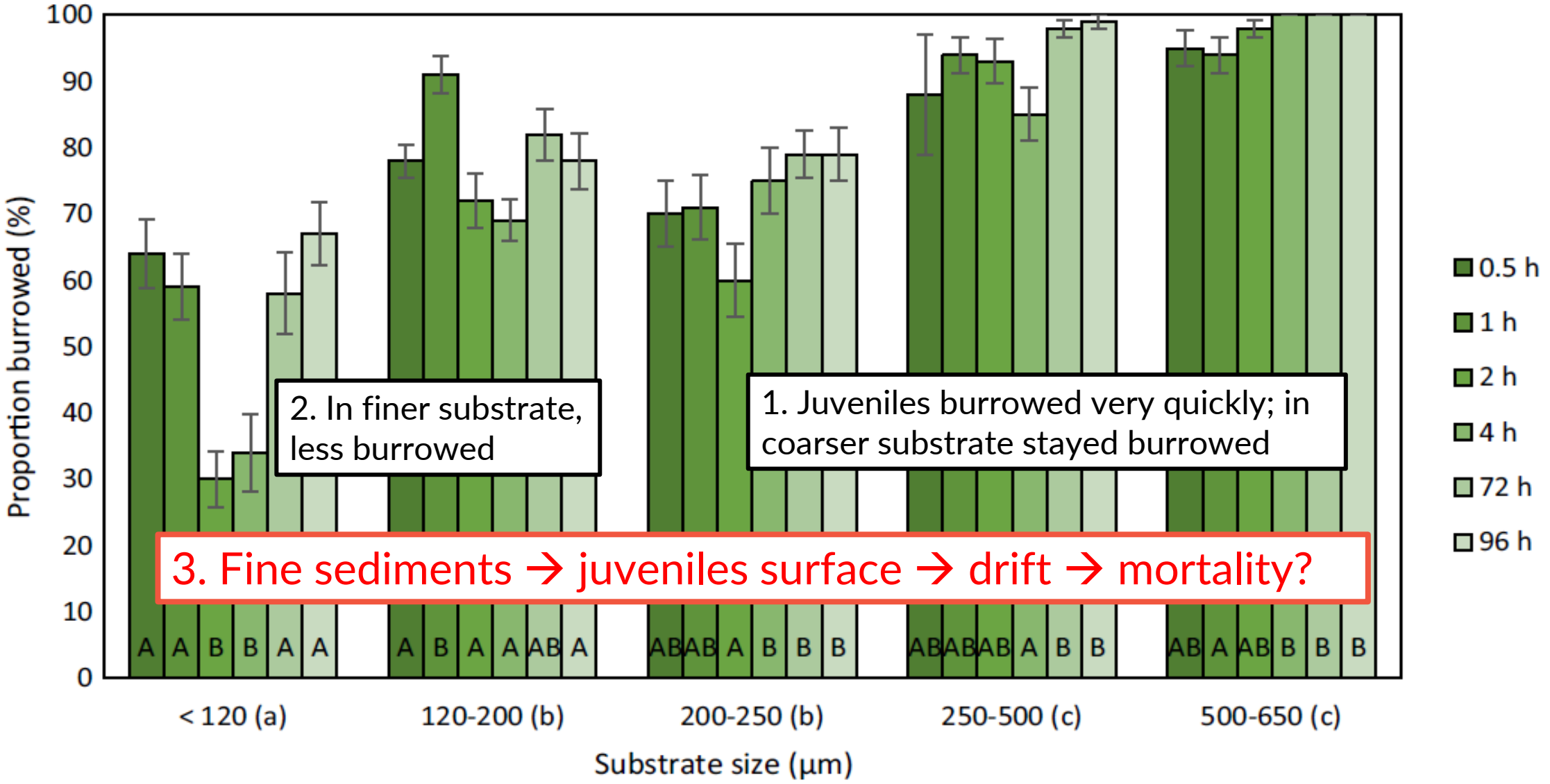


Fig. 1 Proportion (9 , substrate sizes marked five substrate sizes a rentheses) did not differ (± SE) of 10 replic n burrowed over all time mussels. Time point veniles increased with letter did not differ

Effect of substrate particle size on burrowing of the juvenile freshwater pearl mussel *Margaritifera margaritifera*

Hydrobiologia, 2021

Heini Hyvärinen · Mari Saarinen-Valta · Eero Mäenpää · Jouni Taskinen

Background:

In rivers with acidic sulfate soils, periods of low pH accompanied with high concentrations of Fe and Al may contribute to the reduced success of *M. margaritifera*

But, information on this is scarce, or lacking

Materials and methods:

- Filtered Lake Lappajärvi water
- Newly detached FPM juveniles of River Iijoki population (field-infected, farmed brown trout)
- FPM glochidia of River Ähtävänjoki population
- Experiment conducted in 17-18 C temperature (except for glochidia attached to fish in 5-10 C)

3. Impact of aluminium, iron and low pH on survival of glochidia and juveniles of *M. margaritifera*

Glochidia:
- Five replicates of 30 glochidia mussels
- 3 time points: 24, 48 and 72 h

Glochidia in gills of fish:
- Four experimental tanks (one per treatment group), 6 fish studied per time point
- 9 time points: : 1, 4, 7, 14, 21, 28, 42, 56, and 76 d.p.i.

Juveniles:
- Three replicates of 10 juvenile mussels
- 5 time points: 24, 48, 72, 120 and 168 h

Impact of low pH on survival of FPM glochidia

- Statistically significant effect in pH 5.5
- None survived even for 24 h in pH 4.5

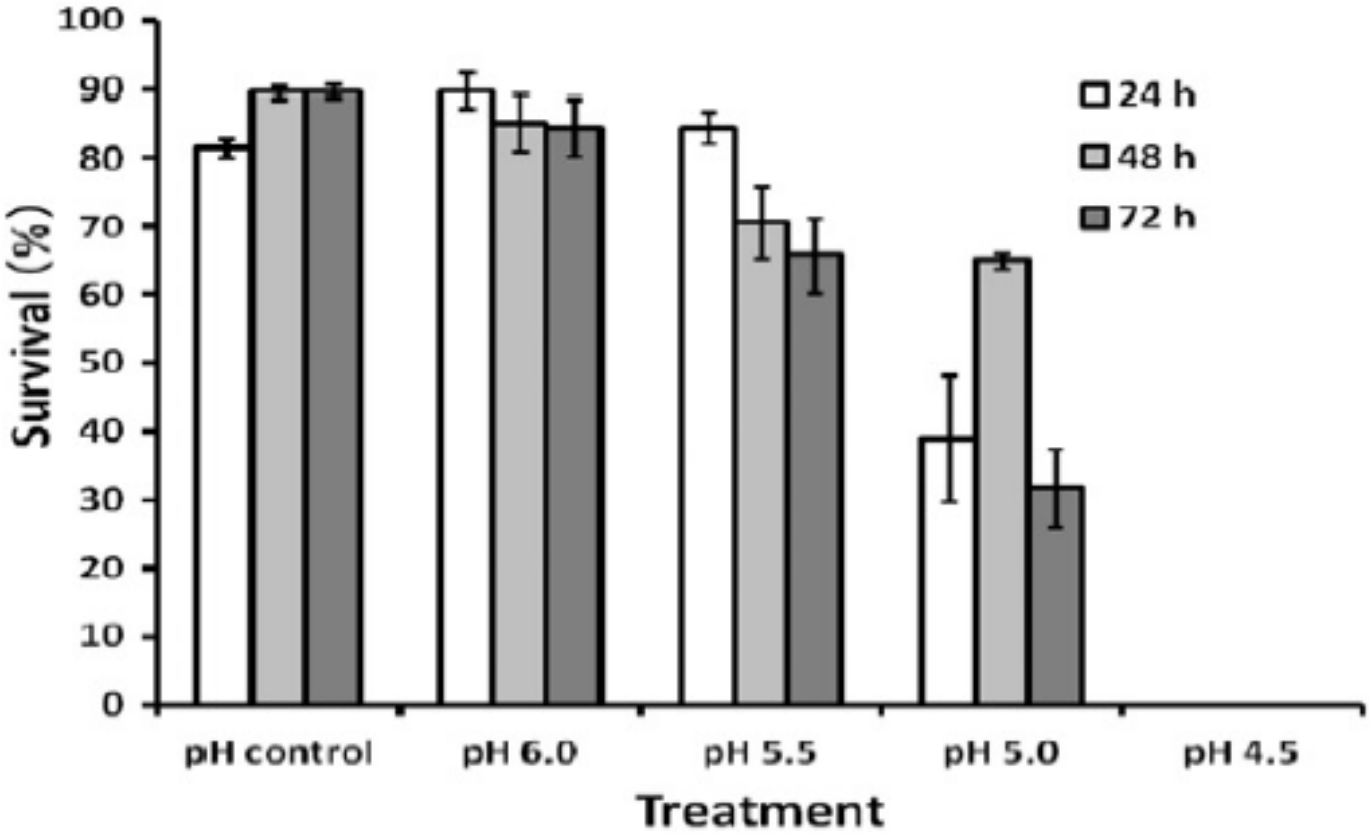


Figure 1. Mean ± S.E. survival of *M. margaritifera* glochidia larvae in different pH levels in a 72 h experiment. In pH 4.5 all glochidia were dead at 24 h time point.

Impact of iron (Fe) on survival of FPM glochidia

- Clear effect even with the lowest concentration 0.5 mg/L
- In the highest concentration 2.0 mg/L none survived for 48 h

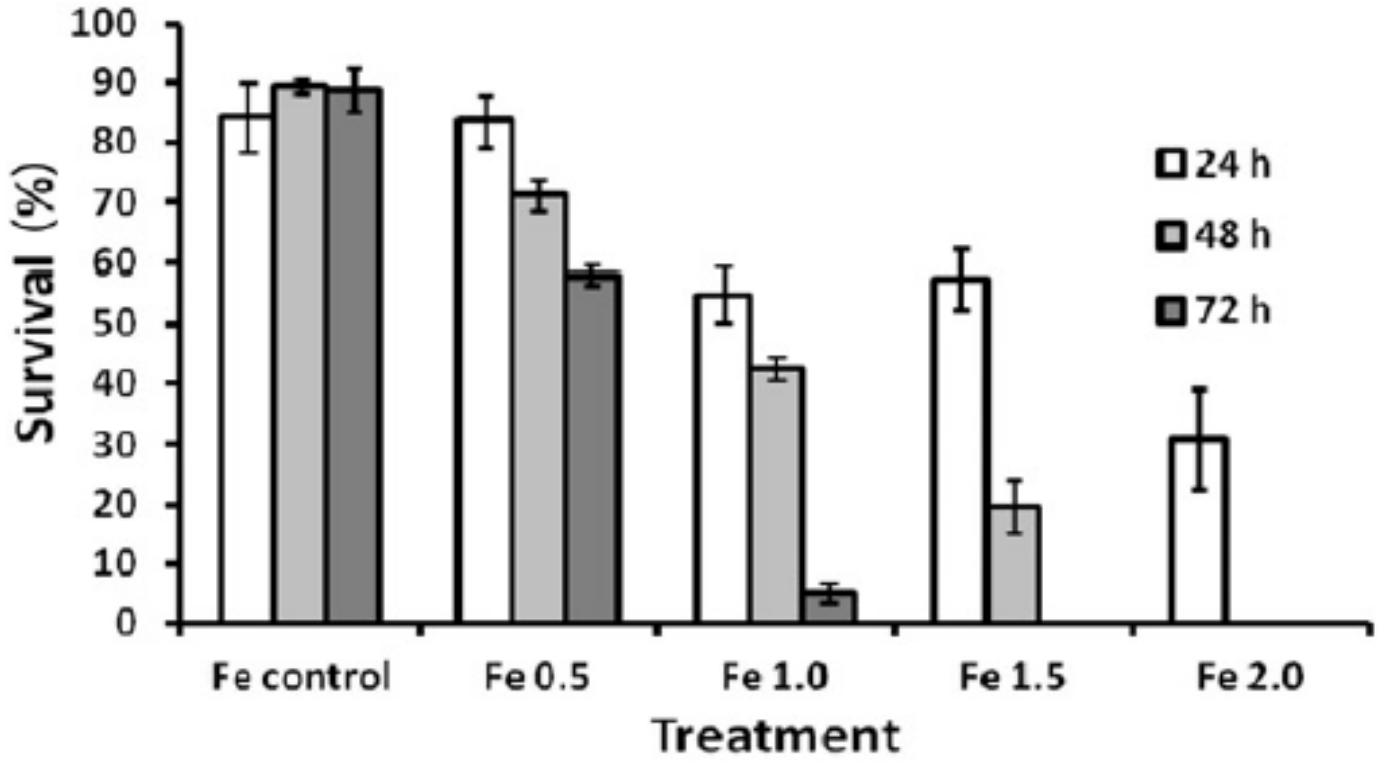


Figure 2. Mean ± S.E. survival of *M. margaritifera* glochidia larvae in different Fe concentrations in a 72 h experiment. In concentrations of Fe 1.5 mg L^{-1} and Fe 2.0 mg L^{-1} all glochidia died within 72 and 48 h, respectively.

Impact of aluminium (Al) on survival of FPM glochidia

- Significant effect even with the lowest concentration 0.25 mg/L after 72 h
- In the highest concentration 1.0 mg/L almost none survived for 72 h

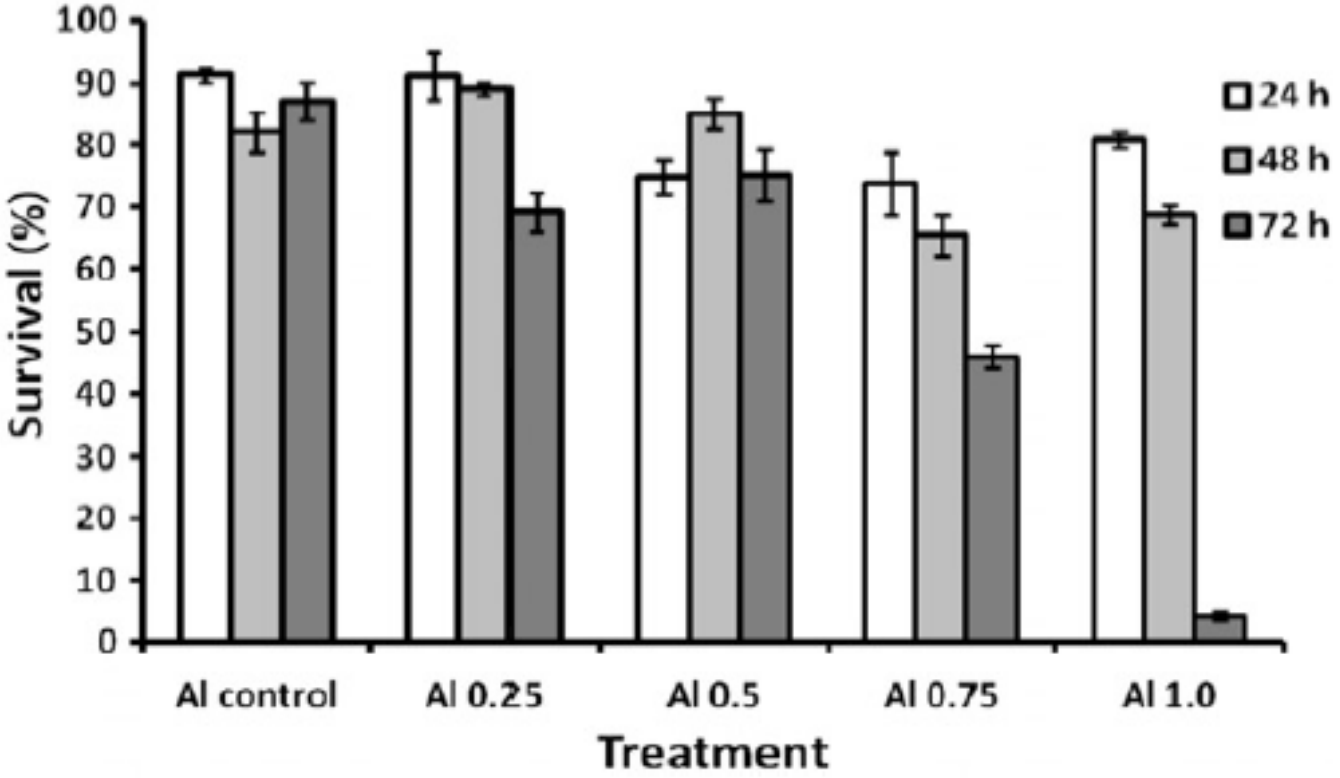


Figure 3. Mean ± S.E. survival of *M. margaritifera* glochidia larvae in different Al concentrations in a 72 h experiment.

Impact of combined aluminium and iron on survival of FPM glochidia

- Significant effect already with the lowest concentrations
- In the highest concentrations, almost all died within 48 h

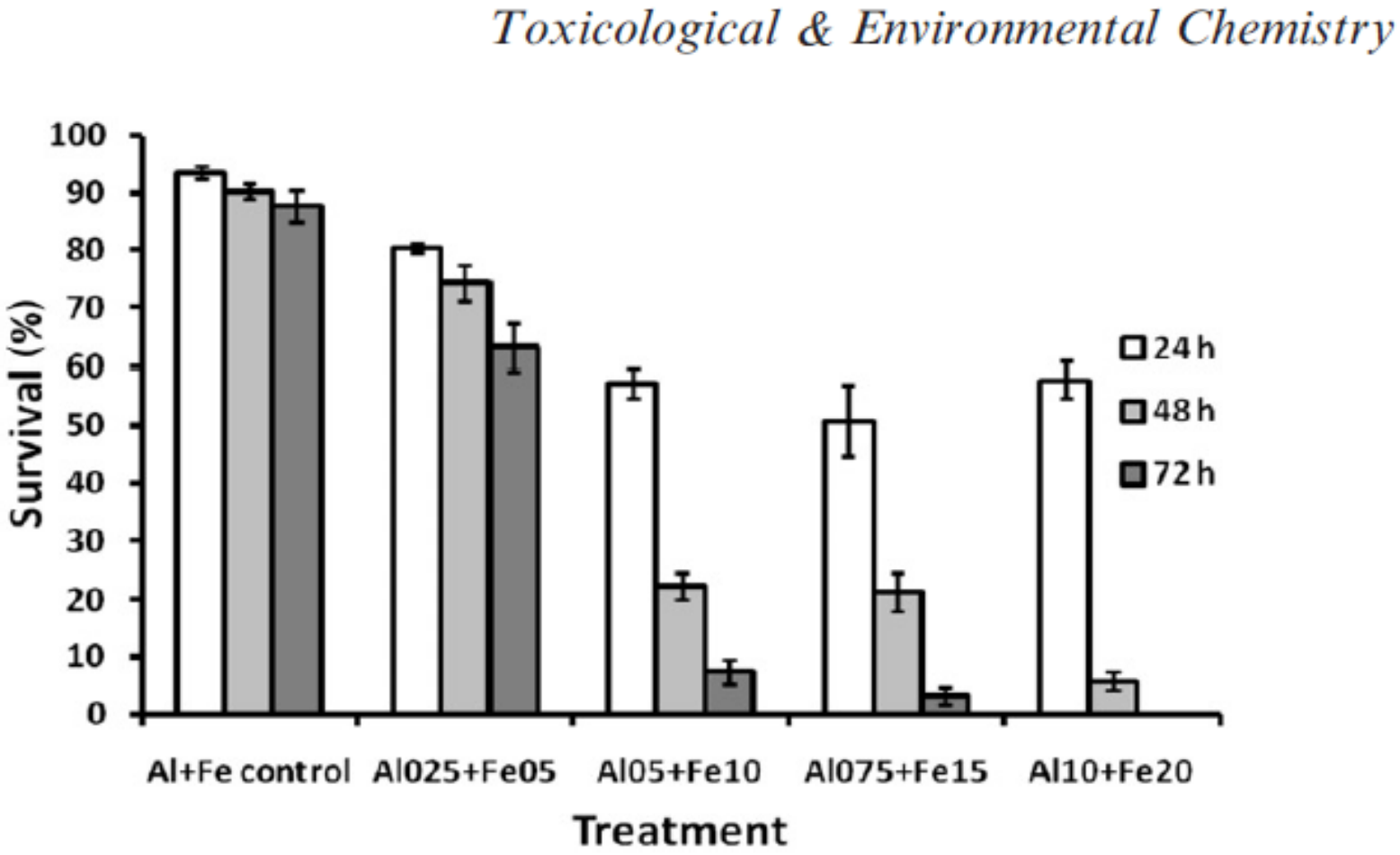


Figure 4. Mean ± S.E. survival of *M. margaritifera* glochidia larvae in different concentrations of combined Al and Fe in a 72 h experiment. All glochidia died in concentration of Al 1.0 mg L^{-1} + Fe 2.0 mg L^{-1}

Impact of aluminium and iron on survival of FPM glochidia attached to fish

- No effect

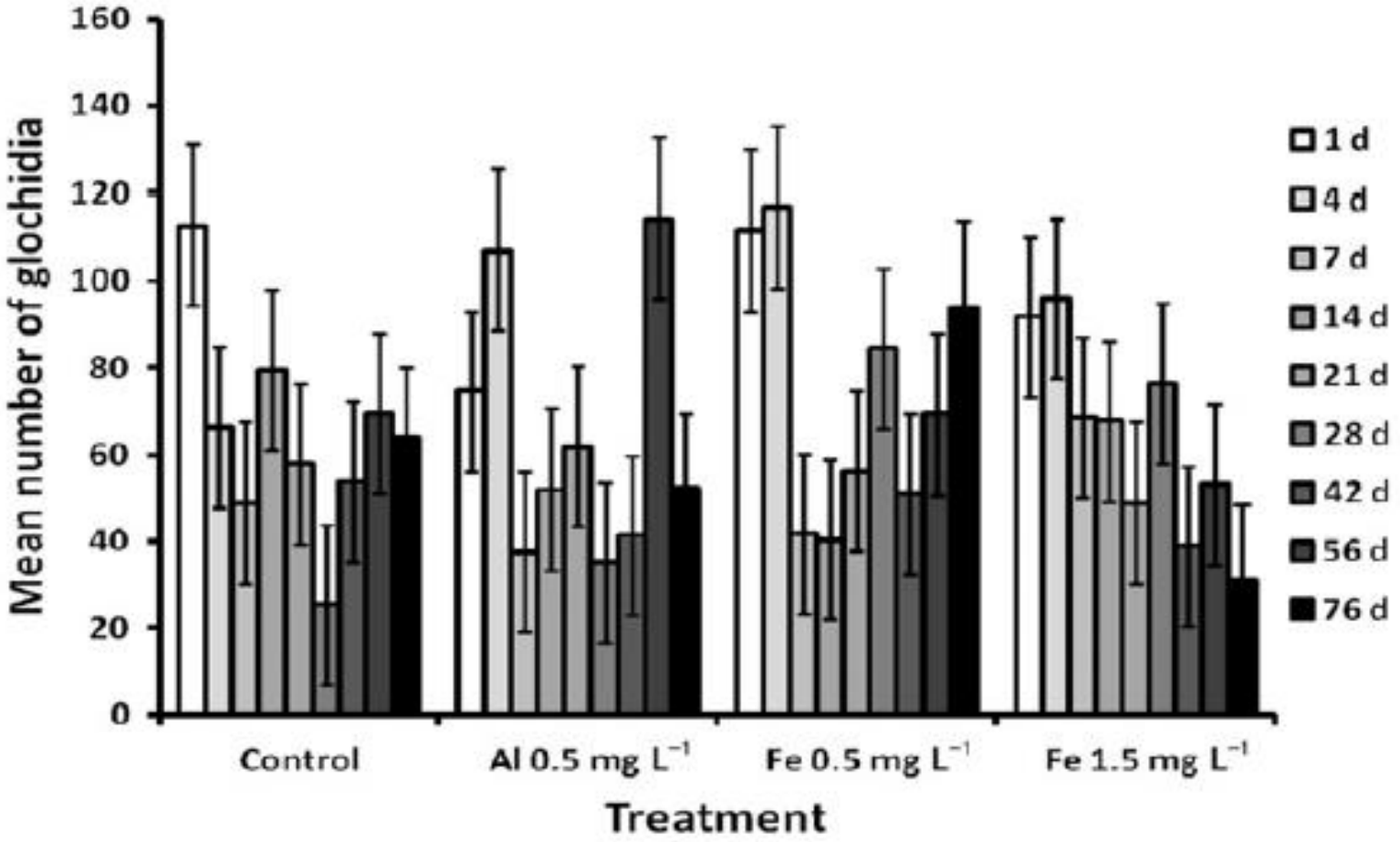


Figure 5. Mean ± S.E. numbers of *M. margaritifera* glochidia attached to the gills of host fish in different concentrations of Al and Fe in a 76 days experiment.

Impact of aluminium, iron, pH and combined metals on survival of FPM juveniles, River Iijoki and River Ähtävänjoki populations combined

- Statistically significant effect especially in high concentrations of metal combinations and in low pH / 168 h

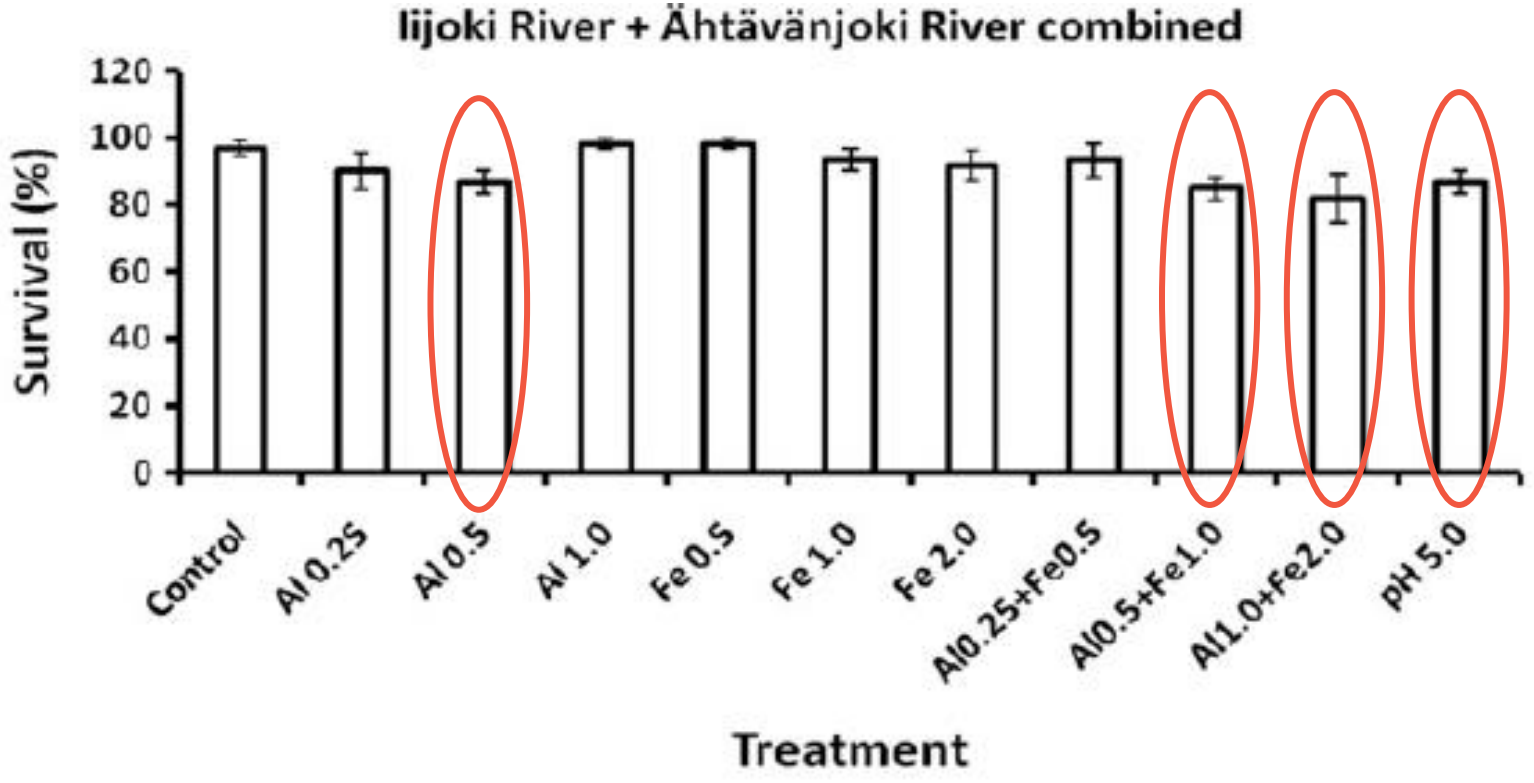


Figure 8. Mean ± S.E. survival of juvenile *M. margaritifera* in different pH levels and Fe and Al concentrations at the end of a 168 h experiment, results for combined data of River Iijoki and River Ähtävänjoki populations.

Thank you!

Photo: Panu Oulasvirta