INTRODUCING THE ENDPOINT DRIFT OF INVERTEBRATES IN MESOCOSM STUDIES

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Fig. 1: Indoor stream system of the Federal Environment Agency, Germany

Fig. 2: *Gammarus roeseli* and *G. pulex*

Introduction

Downstream drift of macroinvertebrates has often been reported from field observations (Svedsen et al. 2004). Drift allows macroinvertebrates to escape from unfavourable physical, chemical and biological conditions and to colonise new habitats. It can be induced by natural factors such as photoperiod, rapid changes in temperature, turbidity, predator pressure or competition as well as by anthropogenic factors such as discharge and pesticide contamination. In ecotoxicological studies, mass drift of macroinvertebrates has often been reported after pesticide contaminations. The monitoring of amphipod drift (*Gammarus)* has been demonstrated a good indicator for assessing the impact of insecticides, especially phyrethroids (Liess 1994, Lauridsen and Friberg 2005). Drift events may result in structural and functional changes of the corresponding stream sections. The sublethal drift effect is likely to have the same consequences for an ecosystem as lethal effects and thus may be used as a sensitive endpoint in risk assessment. Experiments in stream mesocosms were conducted in order to identify the relevant parameters (insecticide/changes in physico-chemical parameters) for drift induction in *Gammarus* spp. and the most suitable methods to detect drift.

Methods

Streams

Length: 106 m run in a circular mode
Water volume: 40 m^3
Light: mean 3500 lx
Nutrient level: mesotrophic
Biology: sand, sediment, macrophytes, wood and invertebrates from an uncontaminated reference stream

Drift

MFB (Multi freshwater biomonitor)

- Flow-through systems with two electrode pairs placed at the chamber walls
- 2 chambers connected with a plexiglass tube and closed with a net (mesh size 1 mm; Fig. 3)
- 7 tubes with a length of 50 cm (4 with a diameter of 5 cm and 3 with 5.5 cm), 4 tubes with a length of 20 cm and diameter of 2 cm

Fig. 3: Tubes exposed into a stream

Drift nets

Black plastic opening of 15 * 7.5 cm (length * width) attached to a white mesh (curtain tissue, 1 mm mesh size) with a length of 140 cm exposed above the sediment surface in flow direction (Fig. 4)

Fig. 4: Drift net exposed into a stream

Experimental design

Experiment 1: Influence of photoperiodicity

1 A)

Detection method: MFB tube
Organism: 1 *G. pulex* per tube
System: 1 stream system
Flow velocity: 0.15
Light: 9:00 to 16:30

1 B)

Detection method: 1 drift net (Fig. 4)
Organisms: *G. roeseli* introduced into streams before start of the experiment
System: 1 stream system
Flow velocity: 0.15
Light: 7:20 to 18:50

Experiment 2: Influence of flow velocity

Detection method: MFB tube
Organism: 1 *G. pulex* per tube
System: 1 stream system
Flow velocity: increase from 0.15 to 0.3 cm/s

Experiment 3: Influence of a neonicotinoid insecticide

Detection method: 1 drift net
Organisms: *G. roeseli* introduced into streams before start of the experiment

3 A: permanent exposure of 10 µg/L
3 B: pulse exposure of 5 h of 10 µg/L

Conclusions

- Increase of flow velocity and the neonicotinoid insecticide induced drift of *G. roeseli*
- Drift seems to be a sensitive endpoint even for short insecticide pulses as they realistically occur in the field after run off or spray drift events
- Both methods, MFB and drift nets, are suitable to detect drift of *Gammarus* spp. in the stream mesocosms
- Pesticide effects may be stronger during night (night application) since macroinvertebrates are more mobile, to a lesser extent hidden under leaves or in the mud and therefore more exposed to the insecticide

Results and discussion

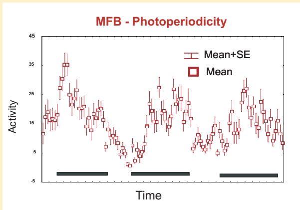

Fig. 5: Diurnal activity of *G. pulex*. Black bars: night time (Exp. 1A)

Experiment 1 A and B: Photoperiodicity

- Diurnal measurements of drift with both, MFB and drift net, indicated increased activity of *G. pulex* (Fig. 5) and *G. roeseli* (Fig. 6) during the nights in the streams. Very low activity was observed during the day.
- Low day activity of the gammarids may be caused by adaption to the presence of fish in the streams, where they originally came from (Macneil et al. 2003). As most stream dwelling fish is a visual predator which hunts by day many prey organisms hide during day to avoid encounter.

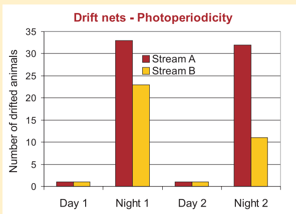

Fig. 6: Diurnal activity of *G. roeseli* (Exp. 1 B)

Experiment 2: Flow velocity

- Increase in flow velocity led to an increased activity of *G. pulex* during day time (Fig. 7) when drift was in general low. Downstream drift behaviour was observed since the animals only stayed in the chambers, which were located downstream (second chamber).
- It remains unclear if the observed drift was caused passively by the increased flow or actively by the animal.

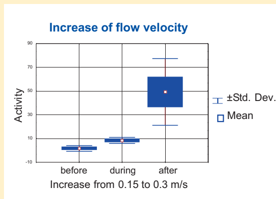

Fig. 7: Activity of *G. pulex* before and after increase of flow velocity (Exp. 2)

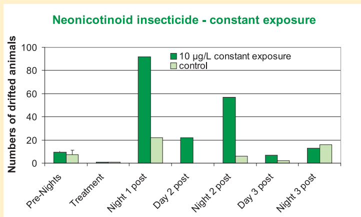

Fig. 8: Diurnal drift of *G. roeseli* before and after constant exposure (Exp. 3A)

Experiment 3 A and B: Insecticide

- Before insecticide application (Fig. 8), night drift was similar in both streams. At the day of application, day drift was very low.
- In the two nights following the insecticide treatment, drift increased considerably in *G. roeseli* in the treated stream, but there was also a slight drift increase in the control stream on the first night.
- The insecticide pulse exposure of 5 h also induced drift of *G. roeseli* but only in the first night after treatment with twofold the amount of animals as compared to the controls (Fig. 9)
- The neonicotinoid insecticide seemed to have induced increased drift behaviour in *G. roeseli* in the stream mesocosms.
- In experiment 3A, drift effects were only of short duration although the insecticide was still present. The reason for the cessation of drift may be a) animals were too weak to drift, b) were dead (some dead animals were observed), c) adaptation to insecticide stress or d) gammarids could not find an uncontaminated place, since the streams were operated in a circular mode.

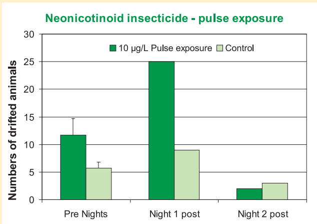

Fig. 9: Drift of *G. roeseli* before and after pulse exposure Exp. 3B)

References

Svedsen, C.R., Quinn, T. and Kolbe, D. 2004. Final Report. Environmental and Safety Division, Seattle, WA, USA. Liess, M. 1994. Verh. Internat verein Limnol 25:2060-2062. Lauridson, R.B and Friberg, N. 2005. Environ Toxicol 20: 513-521. Macneil, C., Dick J.T. A., Hatcher, M.J., Dunn, A.M. 2003. Ecography 26 (4): 467-473.