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PRELIMINARY RESULTS ON THE SPATIAL DISTRIBUTION OF *BAETIS SPP.* (BAETIDAE, EPHEMEROPTERA) AND ORGANIC MATTER IN THE DRIFT IN THE OBERER SEEBACH

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ABSTRACT

Spatial distribution of drift densities of *Baetis spp.* and particulate organic matter were analysed at two cross sections of a small mountain brook. At low water depth, drift densities of both *Baetis spp.* and POM were higher near the banks, whereas at higher water depth drift densities of *Baetis spp.* were higher at the stream channel, and POM showed no clear distribution pattern. This may be probably an effect of water depth and water velocity dynamics. There seem to be a trend to a negative relationship between *Baetis spp.*, POM drift densities and current velocity, specially in the size classes <1 mm. These size classes were found to show a constant ratio in the same sample. However, *Baetis spp.* size classes >1mm did not exhibit a clear pattern, probably caused by the active movement while being in the drift.

INTRODUCTION

Drift has been and continues to be the subject of a great number of investigations (for literature see Brittain & Eikeland 1988, Waters 1972). Questions around this topic adressed to quantitative contribution of different taxa to drift, diurnal variations of drift density, estimation of drift rates, and loss of abundance or biomass because of drift. Similarly the effects of factors such as discharge, season, light intensity, life cycles of zoobenthos and coexistance of fish to drift patterns have been also investigated. In the same way, studies about macrofauna drift patterns have been also conducted in the Oberer Seebach in Lunz am See (Siegl 1993, Tockner 1990, Waringer 1990, 1991).

The present study examines further the spatial distribution of drift densities of *Baetis spp.* and that of particulate organic matter (POM), that is of importance for the function of drift as a distribution mechanism, at different cross sections in a small mountain brook. Baetidae (Ephemeroptera) are good swimmers (Hefti et al. 1992, Weninger 1968), and therefore they have the potential possibility to influence their movement in the water column while drifting. POM drifts passively, and therefore might be a useful comparison factor in order to obtain some knowledge about the animal behaviour in the drift.

STUDY AREA, MATERIALS AND METHODS

The present investigation was carried out in the "Ritrodat" - area of the Oberer Seebach in Lower Austria. Drift samples were collected at eight sampling sites at two cross-sections (Fig 1.). Four drift samplers (Fig. 2, exact description in Siegl 1993) consisting of a rectangular inflow part (60 cm high and 10 cm wide) and a removable net (100 µm mesh size) were used. At the inner side of the inflow part, there is a recording propeller which is adjustable at variable distances to the bottom, and enables the estimation of current velocity. The sampler has also a sliding front cover, which allowed to take samples from the first 10 cm of the water column above the sediment surface. The samplers were fixed to the sediment surface with iron stakes. In the field, samples were taken first at odd-numbered positions, and then at the even-numbered positions (Fig. 1). Sampling was carried out, as fast as possible, during the night drift peak at about midnight (Siegl 1993). At each sampling point three samples were taken, except on the 21.12.1994, when four samples were collected. An exposure time of 10 min was found to be acceptable in order to get enough individuals of first, and older larval instars of Baetidae as well as enough organic matter.

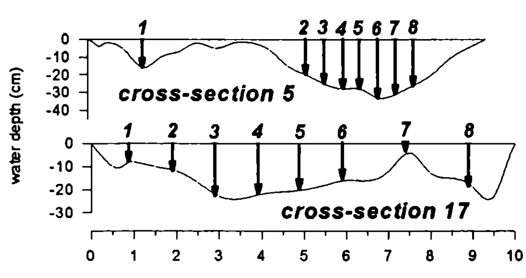
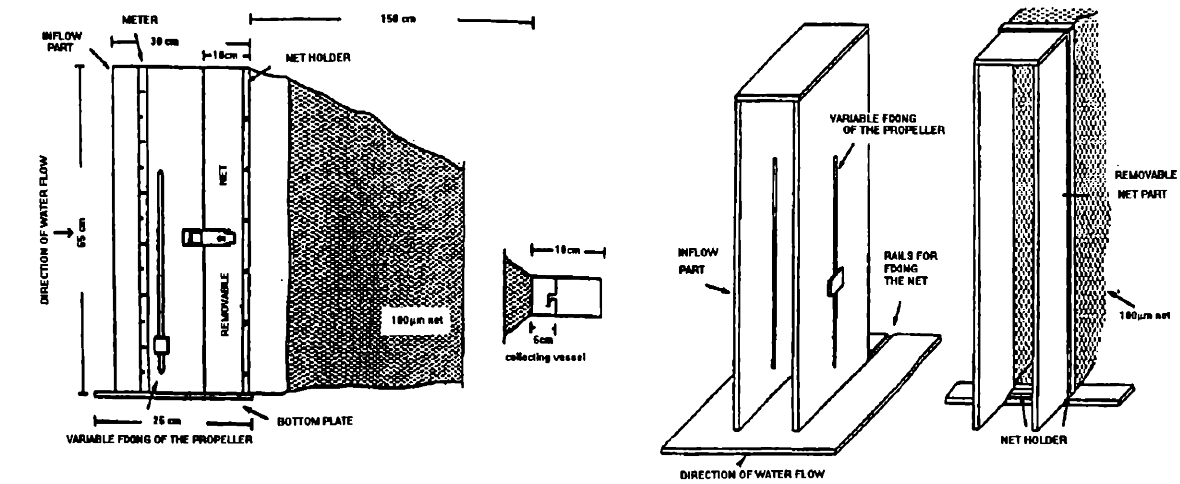


Fig. 1: The two cross-sections, where samples were taken (22. 3. 1995, water level 110 cm); above: cross section under the measurement-bridge (position 5 in the permanent Ritrodat-grid), below: cross-section at the downstram end of the Ritrodat-area (cuts position 17 of the permanent Ritrodat-grid). Arrows show the positions of the drift samplers.



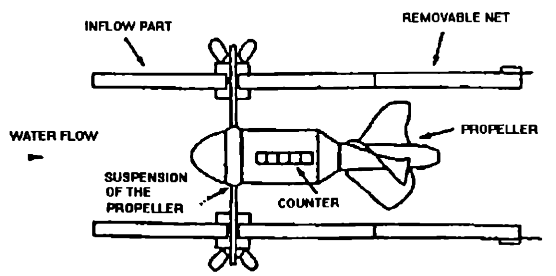


Fig. 2: Drift sampler (side view, oblique view and mounting of the propeller); the inflow part is closed with an upwards moveable frontcover (after Siegl 1993).

A pilot survey was made to examine vertical and horizontal patterns of drift. Two sites (4 & 6) at cross-section 5 were sampled the 28.11.1994 (water level 120 cm), and another set of samples were taken at four sites (2, 4, 6, & 8) the 21.12.1994 (water level 104 cm). Due to the low water depth, additional sampling of the 10 cm layer above the sediment surface was possible only on two sites (4 & 6).

Because the organism drift densities change rapidly specially at night, the process of taking samples from both the 10 cm layer above the sediment surface and the whole water depth requires double time, on the following date only the total water depth was sampled.

The first sampling date with a complete set of eight sites was carried out on the 27.3.1995 on cross-section 17 at the experimental reach (water level 124 cm).

In all occasions, the samples were fixed with formaline. The invertebrates were sorted and counted, and the Baetidae identified to species, accordingly to Müller-Liebenau (1969). Their length and maturity class was also noted. After counts were made, the dry weight of the organic matter of two size classes (< and > 1 mm) was estimated using a LECO-250 balance.

RESULTS AND DISCUSSION

PROPORTIONS OF *BAETIS*-SPECIES

Three *Baetis*-species were found in the samples of the three dates, from which on the 27.3.1995, 92 % of the drift density was due to non-determinable (Müller-Liebenau 1969) larvae of maturity class I ("*Baetis* indet."). *Baetis muticus* LINNE made up with 7 % the main bulk of the older larval stages, followed by *Baetis alpinus* PICTET with 1 %. *Baetis rhodani* PICTET occurred only with few individuals in all the samples.

In November 1994 and December 1994 the proportions were similar as described above, but the first instar larvae were more dominant.

These results differed to that of Siegl (1993), who using the same method found that *Baetis rhodani*, and *Baetis alpinus* had a 38 % and 13 % respectively in the drift in the same sampling area in March 1993. Moreover, 49 % of the drift density was due to individuals of the first maturity class ("*Baetis* indet."), and he also found few individuals of *Baetis muticus*. The difference to the present findings may be due to known shifts of the benthic species-ratio in the surface sediment (Townsend 1989), that may have an effect on drift patterns.

DRIFT DENSITIES

Drift densities in November and December were low (Tab. 1).The mean drift density of *Baetis spp.* in cross-section 17 was 13.1 (±95% CL 1.8) ind., and that of POM was 0.07 (±95% CL 0.01) g dry weight /m³ in March 1995.
In contrast, Waringer (1991) working on the same sampling position reported lower drift densities (24h-average: 1.7 ind./m³ [total fauna] and 0.01 g POM/m³) in March 1989. This difference is probably caused by a different drift sampler type with a smaller opening (50.3 cm³/net), a larger mesh size (200 µm) and longer exposition times.
Beside the fact, that the present data are nocturnal drift densities, which are higher in many invertebrate groups due to diurnal rhythms (Siegl 1993, Waringer 1990), the first instar *Baetis* larvae dominated the drift density. These size classes can only be caught quantitatively with a fine net. Using smaller mesh sizes such as 40 µm, even much higher drift densities have been recorded including meiobenthic taxa and small first instars of chironomids (Tumwesigye 1995, Schmid-Araya, pers. comm.). The exposure time may also influence the drift densities. Tumwesigye (1995), using the same sampler but with a 40 µm mesh net, noticed increasing variation of drift densities with decreasing exposure time. He found that 10 minutes are long enough for a low coefficient of drift density variation, and short enough to avoid clogging with organic material.
Apart from these methodological differences, it is plausible that temporal differences on benthic abundances occur in the sediment. Siegl (1993), found a nocturnal drift density of 0.9 ind. *Baetis spp.*/m³ in March 1993 using the same drift method. However, drift density can also be influenced by a number of other factors such as life history traits of each species, activity and behaviour, competition phenomena, light intensity and water velocity (Elliott 1970).

VERTICAL DISTRIBUTION

At cross-section 5 directly above the sediment, drift densities were higher than in the water column in November and Dezember 1994 (Tab. 1). Despite the fact that there was lower discharge near the stream bed, drift densities of organisms and organic matter were greater close to the sediment surface than in the whole water column (Tab. 1).

Tab. 1: Results from the sampling dates 28.11. and 21.12.1994 ("below" = 10 cm layer above the sediment surface, "above" = layer from 10 cm above the sediment to the water surface). The numbers are arithmetic means (n=6), the values from the "above-stratum" were calculated considering the vertical differences in water velocity. Percentages refer to drift rate of the different strata (in g/s and ind./s).

	28. 11. 1994	**21.12.1994**
Water depth (m)	0.28	0.16
Discharge (m³/s)	0.023	0.009
Drift density *Baetis spp.* total (ind./m³)	3.87	9.23
Drift density *Baetis spp.* below (ind./m³)	4.13	
Drift density *Baetis spp.* above (ind./m³)	3.67	
Drift density POM total (g/m³)	0.029	0.019
Drift density POM below (g/m³)	0.042	0.035
Drift density POM above (g/m³)	0.024	0.012
Discharge above (%)	73.1	68.6
Discharge below (%)	26.8	31.3
Baetis spp. above (%)	55.5	
Baetis spp. below (%)	44.4	
POM above (%)	60.2	42.5
POM below (%)	39.7	57.4

Similar to the present study Weninger (1968) reported increase of drift near the sediment surface. Elliott (1979), established a random depth distribution of drift, while Waringer (1991, 1992) found no significant differences in vertical net positions neither for invertebrates nor for POM, but his drift sampler were not directly positioned above the sediment surface.

HORIZONTAL DISTRIBUTION

The drift densities of both *Baetis spp.* and organic matter were substantially higher near the banks than in the mid channel of the brook in December 1994 (Fig. 3). Point 6 (Fig. 1) evidenced significant differences in drift densities with all other sampling positions (ANOVA, $p < 0.05$).

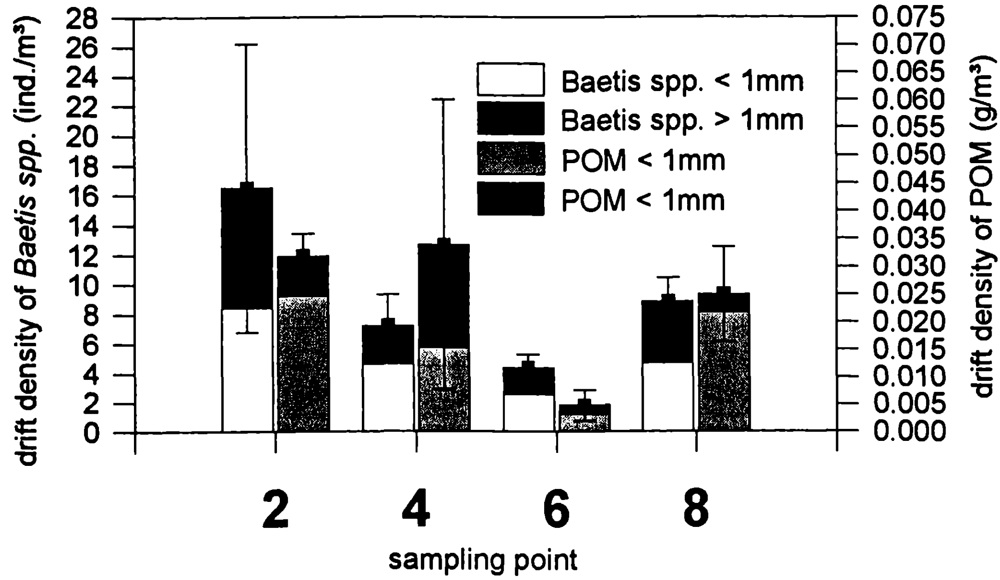


Fig. 3: Drift densities in cross-section 5 on the 21.12.1994; vertical lines are standard deviations for total drift densities.

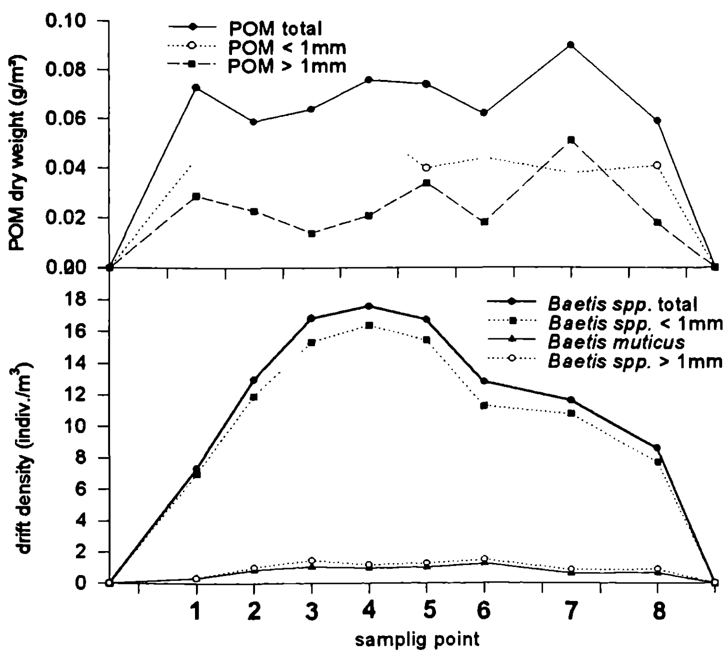


Fig. 4. The distribution of drift densities at cross-section 17 on the 27. 3. 1995. Significant differences were found between the sites 3, 4, 5 and 1, 8 in all size classes of Baetidae (ANOVA, $p < 0.05$).
Comparing the near-bank region (sites 1, 2 together and 7, 8 together) with the mid-stream region (sites 3, 4, 5 together) differences could be found among these two regions. In contrast, the size classes of POM showed no significant differences in distribution of drift densities (ANOVA, $p > 0.05$) along the cross-section.

Fig. 4: Drift densities in cross-section 17 on the 27.3.1995.

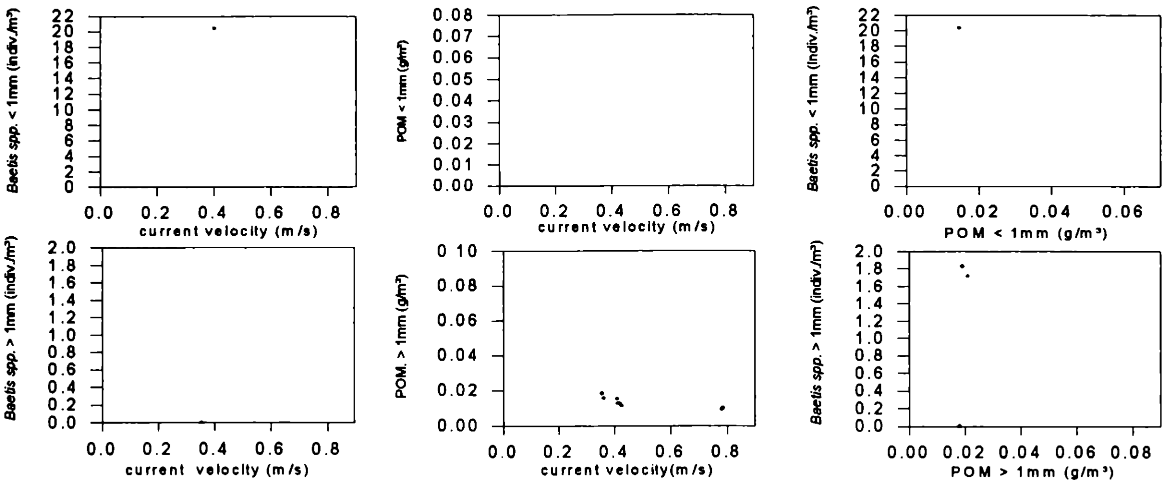


Fig. 5: Relationship of drift densities to current velocity and Baetis-drift density to POM-drift density (data from the 27.3.1995).

Studying the horizontal distribution of drift in a river cross-section, Elliott (1970) and Waringer (1992) did not find significant differences between different sites across the stream. Higher drift densities near the bank have been recorded by Ciborowsky (1987) and also Weninger (1968) found higher *Baetis* drift near the banks.

In the present study an increase of drift density of both *Baetis spp.* and POM were found near the bank in December 1994. Further, drift densities of *Baetis spp.* were higher in the mid-stream area, while organic matter showed no clear distribution pattern in March 1994. At the first date, the water level was very low and exhibited decreasing tendency. Such a situation may increase drift density in the bank-near regions, probably because of invertebrate escape mechanisms from areas which are drying up (Elliott, 1967). The drift distribution on the second date could be due to a period of high water levels (constant tendency). At higher water velocity the active movement of animals may be reduced in favour of the passive transport, which shows a vector to the mid-stream area, related to the distribution of water velocity in this cross-section. Nevertheless, this trend is not shown in the distribution of POM.

RELATIONSHIP BETWEEN DRIFT AND WATER VELOCITY

Comparing drift densities with water velocities (measured in the sampler) (Fig. 5), a negative, although not significant ($p > 0.05$). relation showed, especially for the size class < 1 mm, *Baetis*- and POM-drift densities where positively related (Fig. 5), indicating that POM < 1mm and *Baetis spp.* < 1 mm had a similar drift pattern. A different pattern for the size class > 1 mm, may be caused by active movement of older instars while drifting.

Waringer (1991, 1992) did not detect any influence of discharge on drift densities. Tockner (1990) stated, only when discharge exceeds "bankfull" at a spate event, drift density should increase. Decrease of drift density of *Baetis sp.* with increasing current velocity has been reported by Brittain & Eikeland (1988). They argued that the reason for this pattern could be escape movements of *Baetis sp.* into the sediments. Weninger (1968) reported also higher drift of small *Baetis* instars at lower current velocity. In December 1994 the drift densities of small sized *Baetis* although lower, showed a similar relationship to current velocity in the Oberer Seebach. The influence of water level and discharge could be overlayed by the factor of seasonal differences and life-cycles, Schmid-Araya (pers. comm.) found in the Ritrodat-area an increase in drift density when water level decreased.

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