BEHAVIORAL RESPONSES BY HYDROPSYCHE MOROSA (TRICOPTERA: HYDROPSYCHIDAE) TO DEPOSITED SEDIMENTS AND THE EFFECTS OF STARTING MATERIAL ON THESE BEHAVIORS

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INTRODUCTION

Sediment deposition is one of the premier hazards to the biological integrity of stream ecosystems (Cordone 1961, Waters 1995). When deposited sediments occur in a stream community, both direct and indirect problems result. These problems include interference with food acquisition and respiration, resource depletion, smothering of surfaces, and sedimentation of interstitial spaces (Runde1999). In the case of filter-feeding organisms, sediment deposition can destroy habitats, increase predation occurring with drift, and become lethal when organism become embedded. However, the measurement of sediment impacts at the population level has resulted in a confusing array of observations. In the field experiments are virtually impossible and lab experiments need to take into the many factors that may have confounding effects, such as water velocity, particles type, size, and loading rate (Runde1999). Rigorous experiments into the effects of sedimentation at the species-organism level, as well as the differential effects of sediment particle size have been small in number.

Benthic filter-feeders from the genus Hydropsyche are one of many stream organisms that are affected by the deposition of sediments. Using a single sediment addition in which the organisms were instantaneously embedded, the behavioral responses of Hydropsyche morosa were investigated. Also, the effect of the starting bottom substrate in which the organisms make their retreats and spin their nets was investigated. H. morosa from two sites, Tenderfoot Creek in Gogebic County Michigan and Trout Creek in Vilas County Wisconsin, were used in the experiments. In previous lab experiments it was found that there is a difference between Tenderfoot Creek and Trout Creek when the initial substrate is sand (Runde and Geifer, unpublished data). From this information, the objectives of this study were to: 1) Determine the effects of particle size on the behavioral responses of H. morosa; 2) Determine if there is a difference between Tenderfoot Creek and Trout Creek when the initial substrate is vegetable matter; 3) Determine if there is a difference between sand and vegetable substrate for Tenderfoot Creek; and 4) Determine if there is a difference between sand and vegetable matter for Trout Creek.

MATERIALS AND METHODS

Experimental conditions:

In this experiment, the behavioral responses of Instar V of Hydropsyche morosa exposed to sand particles of 125-250, 250-500, 500-1000, and 1000-2000 μm in diameter will be studied along with the effects on starting material used in constructing their nets. These sand particles will be applied in a single 50g load. The H. morosa will be collected from two areas; Tenderfoot Creek in Gogebic County Michigan and Trout Creek in Vilas County Wisconsin. The H. morosa in Tenderfoot creek primarily use vegetable material in constructing their retreats because of an exclusively rocky bottom, with no sand sediment. In contrast, the H. morosa in Trout Creek use sand to construct their retreats because the bottom of this creek is rich in both coarse and fine sediments.

The experiments will be conducted at the University of Notre Dame Environmental Research Center Wet lab in chambers as described by Dr. Runde in Chapter 4 of his dissertation. After collecting from the above-mentioned creeks, five to ten individuals will be placed in each of the six chambers (12 chambers with 125-250 because both sand and vegetable matter will be used for starting materials). This will insure that at least one individual will construct a net. Three chambers will be used for insects collected from Tenderfoot Creek and three chambers will be used for insects collected from Trout Creek. With the 125-250 μm particle experiment three chambers will be given sand as a starting material and three chambers will receive vegetable matter from each respective creek. For the other three experiments, vegetable matter will be used as starting material for all of the chambers from both Trout and Tenderfoot creeks. After 24 hours, the position of all nets will be mapped and only larvae that construct nets will be included in the analysis. Following the mapping, single 50g sediment loads will be added to the chambers, burying the retreats and the nets. This 50g load is equivalent to the loading rate of 16,220 g/m2 and will cover the bottom of the chamber with a 1 cm layer of sediment. There will be four different sizes of particles used, as previously stated.

After 24 hours, the status of the larvae will be checked and categorized into one of the following outcomes: drift-alive, drift-dead, buried-alive, and buried-dead. Buried alive behavior is maintaining contact with a buried retreat, using the anal claws, while extending the thorax and abdomen into the overlying water column. Drift behavior is seen when the insect leaves the retreat altogether and drifts down stream in an attempt to acquire a new retreat location. After the 24-hour period, the drift and buried-alive behaviors for each replicate will be calculated as the proportion of organism exhibiting the behavior.

Sand used in the experiment will be collected from Juday Creek in St. Joseph County Indiana and the vegetable material will be obtained by drying grass in the oven and soaking it in water in order for it to sink to the bottom of the chambers. The sand will be separated into the 125-250, 250-500, 500-1000, and 1000-2000 μm portions using the corresponding sieves. Velocity will be held constant in all experiment at 20-25 cm/sec and temperature will be maintained at room temperature using a 12:12 photoperiod cell.

Statistical Analysis

Since there was no variation in the controls, all test compare populations within the treatments only. With the single addition experiment, percent drift-alive was analyzed across particle size using two-way ANOVA's (particle size x location), and (particle size x starting substrate)

RESULTS

When exposed to single 50g sediment additions the insects either drifted-alive, drifted-dead, were buried-alive, or were buried-dead. Embededness of the retreats and nets was 100%. In figure 1, were vegetable matter was used as the initial substrate, no real difference was found between Tenderfoot Creek and Trout Creek (2 way ANOVA; SED p=.527, LOC p=.305, x p=.715). However, in general an increase in percent drift occurred for decreasing particle size. When comparing initial substrates for Tenderfoot Creek (figure 2) there was a significant difference between vegetable matter and sand (2 way ANOVA; SED p=.46, BOTTOM SUBSTRATE p=.011, x p=.313). However, when comparing initial substrate for Trout Creek (figure 3) no real difference was found (2 way ANOVA; SED p=.155, BOTTOM SUBSTRATE p=.263, x p=.735).

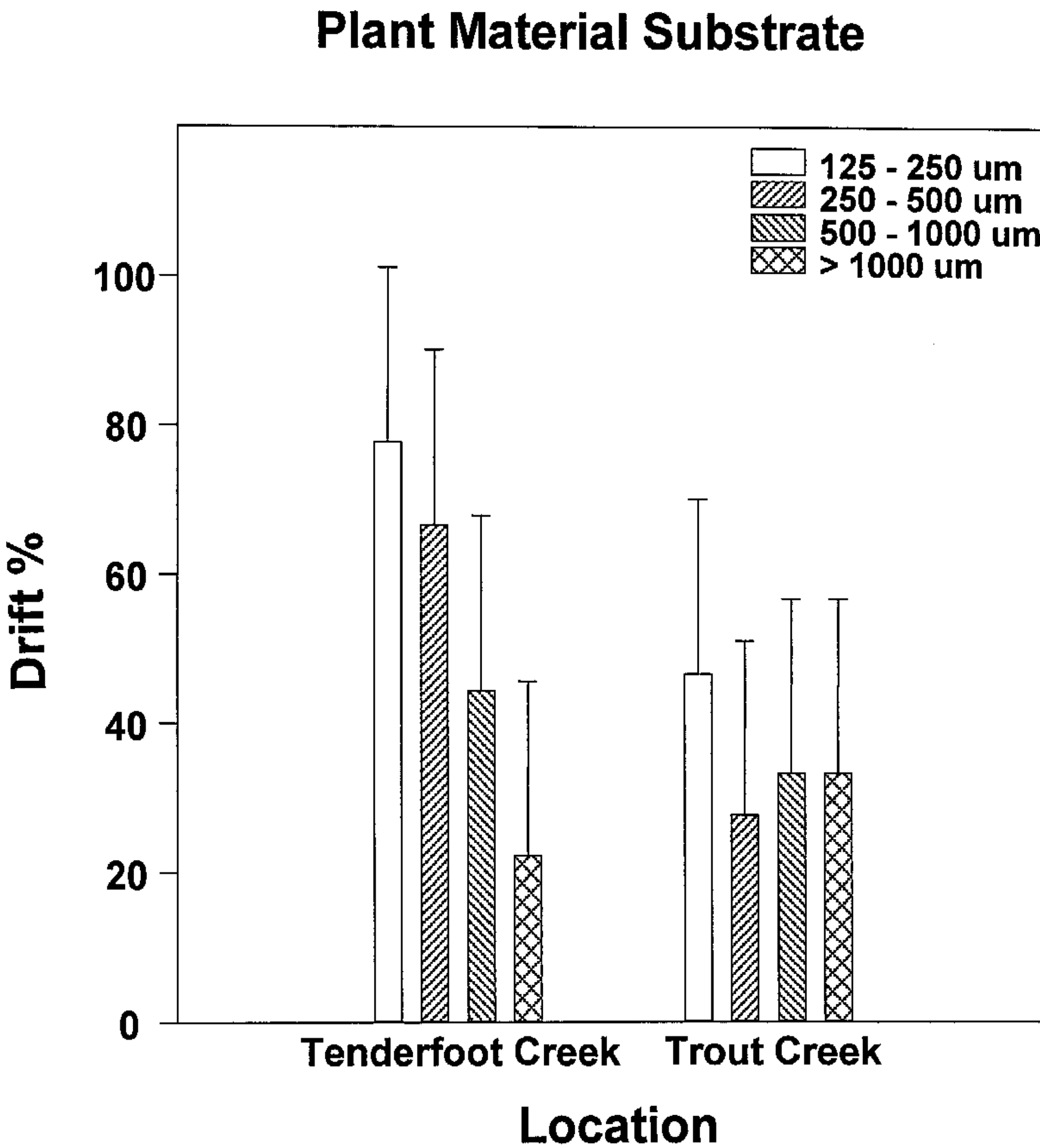

Figure 1.

When comparing Tenderfoot Creek and Trout Creek, no significant difference is seen when the initial substrate is plant substrate.

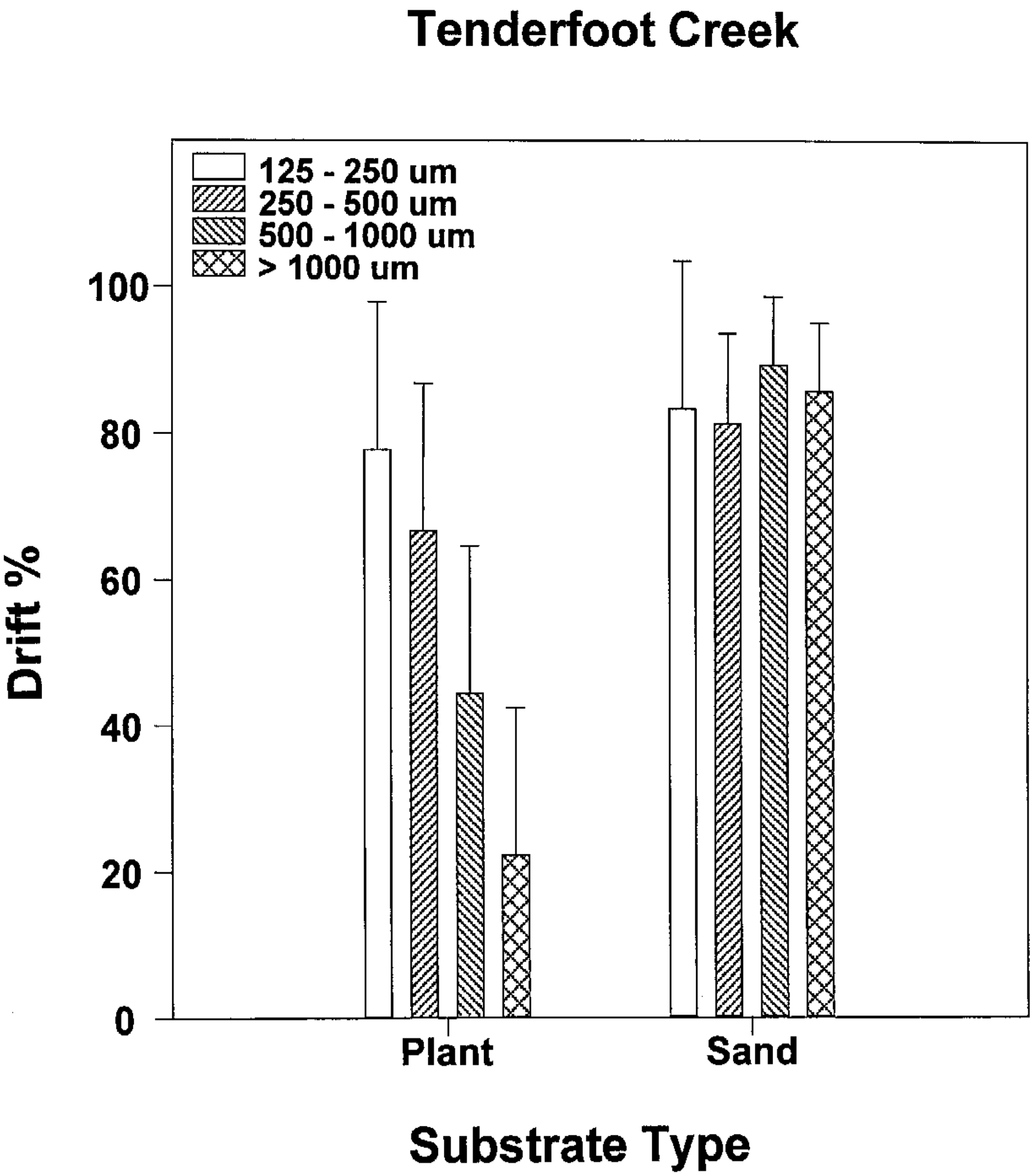

Figure 2.

When looking at the effects of initial substrate, Tenderfoot Creek insects drifted less in their natural, plant matter habitat.

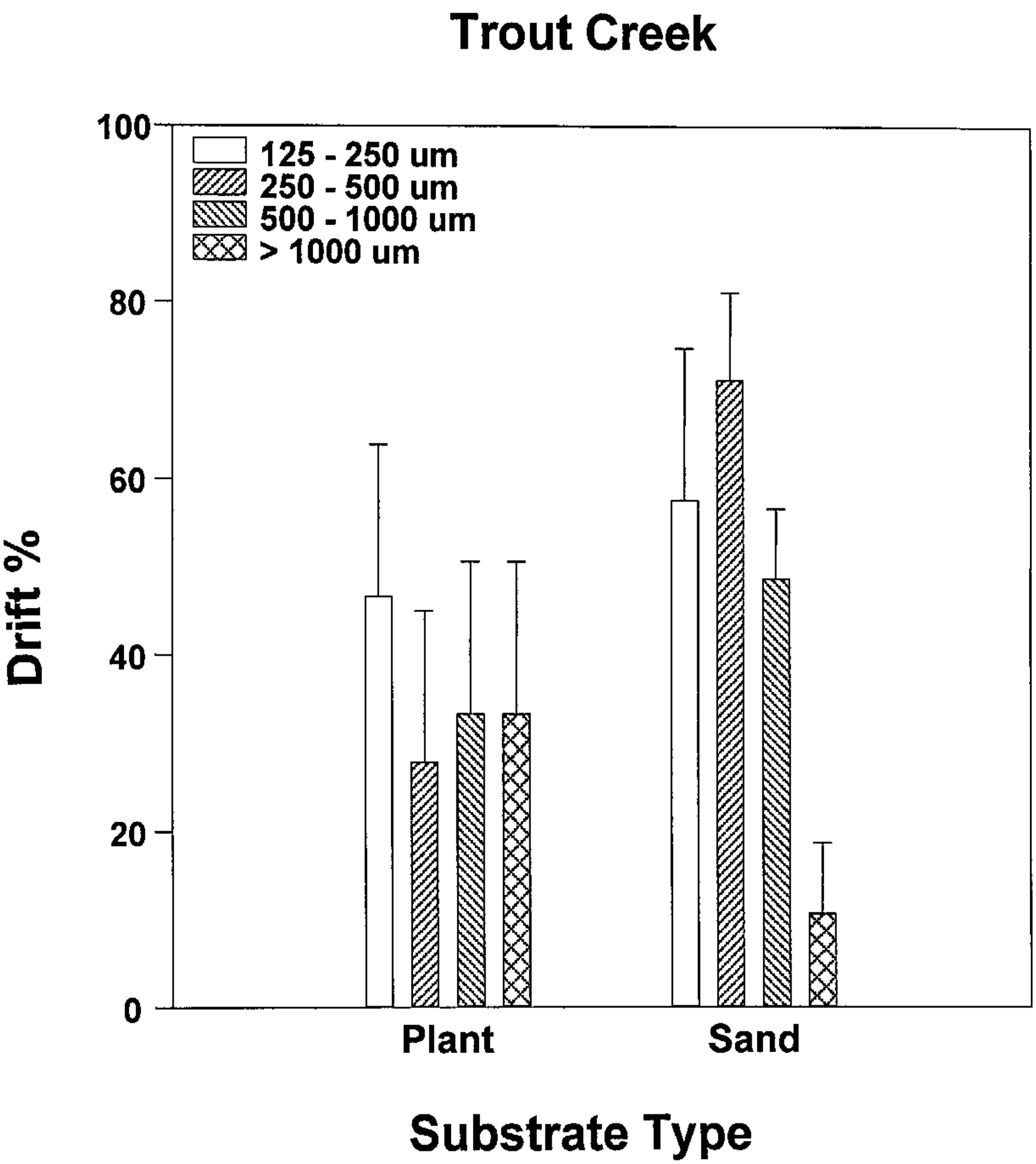

Figure 3.

When comparing initial substrate from Trout Creek, no significant difference was seen.

DISCUSSION

In this experiment, H. morosa was exposed to a single sediment addition in which the organisms were completely embedded. The morphology of the substratum, the position of the retreat, and the transported sediment load determine the degree of embededness in the stream itself (Runde, 1999). In my experiments, each organism constructed their nets at the bottom of the chamber, making each organism equally susceptible to burial. When looking at the results, four common trends were seen between location, particle size, and starting bottom substrate.

In a similar experiment, (Runde, 1999) found the H. sparna, from a sandy substrate stream, showed similar results as the H. morosa from Trout Creek. When the bottom substrate was initially sand, as particle size increased, the drift decreased. When individuals were buried under small particles, the oxygen level in the interstitial spaces was low, causing the individuals to drift. As the sand particle size increased, elevated flow through the sediment provided the necessary oxygen to remain buried-alive.

When looking at figure 3, it can be seen that Trout Creek insects respond similarly to burial regardless of the initial substrate. This suggests that there is no difference between sand and vegetable substrates for individuals from Trout Creek. The tendency to drift for these individuals was rather low for each of the initial substrates. There are a variety of factors that may responsible for this result. One possible reason could be that the predation in Trout Creek is greater than that of Tenderfoot Creek. Regardless of initial substrate, evolutionarily, the Trout Creek individuals are more adapted to being buried-alive because of the increased predation that would result from drifting. Also, the energy required to construct nets and retreats from sand substrate could be higher than that of vegetable substrate, which in turn could decrease the frequency of drift for Trout Creek individuals. The sandy sediments of Trout Creek could cause these individuals to be adapted to any kind of particle size and have adaptations of cleaning and repairing nets, which would make them less likely to drift. Also, the fact that the Trout Creek insects where collected at a lake outlet could make them less likely to drift because of the stability they are able to create with their retreats.

The third trend that was noted was the Tenderfoot Creek insects withstood burial better when the constructed their nets out of vegetable matter. When looking at Figure 2, it can be seen that when sand is used as the initial substrate, the Tenderfoot Creek insects drift at the same rate, regardless of the size of the particles. However, when vegetable matter is used as the initial substrate, a pattern similar to the sand bottoms for H. morosa in Trout and for H. sparna, in experiments by Runde, is seen. As the size of the particles increased, the drift decreased. This could be due to the fact that the Tenderfoot insects are not accustomed to burial and sand particles because of the primarily rocky bottom with no sediments. When they were given sand substrate to construct their nets, they may have been of weaker structure and resulted in the insects to drift regardless of the size of the particles. However, with their natural vegetable substrate as starting material, they could maintain contact with their retreats and obtain oxygen when larger particles were used. Maybe a possible evolutionary structural difference in the anal claw of the two sites exists. It would seem logical that sand would be harder to maintain contact with then vegetable matter and thus the Trout Creek individuals are able to maintain their buried-alive behavior in sand and vegetable matter, whereas the Tenderfoot individuals find it to hard to maintain contact with their retreat in foreign substrates.

Finally when comparing Trout Creek with Tenderfoot Creek with vegetable matter as the initial substrate, (Figure 1), no statistical difference exists between the two sites. Based on the previous discussion, this is not expected. The likely reason for this may be due to low replications. Further research would be necessary to increase replication and thus decrease variability and reduce error bars. Another reason, although unlikely, is that no real difference exists.

The deposition of sediments is an important factor in stream ecology. In this experiment, in can be seen that there are a variety of factors that influence the decision to drift; physical, evolutionary, and ecological. It can also be seen that different streams are affected by sediment deposition in different ways. In general, as particle size increases, organisms drift decreases. However, the initial substrate in which the organisms build their retreats and nets can cause fluctuations in the decision to drift.

Literature Cited

Cordone, A.J., and D.W. Kelly. 1961. The influence of inorganic sediment on the aquatic life of streams. California Fish and Game 47: 189-228.

Geifer, M and J.M. Runde. 1999. unpublished data.

Runde, J.M. 1999. Hydrodynamic and Behavioral Responses to Sediment Transport by Hydropsyche Sparna (Trichoptera: Hydropsychidae). Doctoral Thesis. University of Notre Dame Department of Biological Sciences.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7.