BEHAVIORAL RESPONSES OF TWO POPULATIONS OF HYDROPSYCHE MOROSA (TRICHOPTERA: HYDROPSYCHIDAE) TO SUSPENDED SEDIMENT LOADS: ROCK SUBSTRATE

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INTRODUCTION

The transport of suspended and bedload sediment is the leading source of degradation in North American streams today (Waters 1995). Suspended sediment alone is ranked the seventh in stream pollutants (Agency 1990). Clearly, suspended sediment has a major impact on stream organisms. Filter feeding organisms are especially susceptible to suspended sediments (Hynes, 1973). Within North American streams, three orders of filter feeding aquatic larva dominate: Ephemeroptera, Diptera, and Trichoptera (Wallace 1980). Within the order Trichoptera, the hydropsychidae family is the most important, both in terms of numbers and their contribution to the secondary production of streams (Wallace 1980, Wiggins 1996).

Runde (1999) found that *H. morosa* exhibit three behaviors when subjected to suspended leaf particles: no net modification, net removal, or creating a hole in the filtering surface. An increase in net modification was associated with increasing particle size.

The impact of suspended sediment is difficult to measure in the field because of the influence of outside variables, especially bedload sediment. Therefore, I used laboratory artificial streams to observe the effect of suspended sediments of the fifth instar of *Hydropsyche morosa*. Fifth instars were used since differences in net architecture, preferred food, and microhabitat choices are expected among the varying sizes of Trichoptera (Culp 1986, Gore 1990, Reice 1990, Schlosser 1990). In addition, insects from two separate streams with different habitats were collected. Using sequential applications of particles 1-500 μm in diameter, I explored the resulting net tending behaviors of the insects. The objectives of this study were 1) to determine the effects of particle size and load on the net-tending behavioral responses of *H. morosa*, and 2) to compare these effects on insects from different habitats.

MATERIALS AND METHODS

Instar V of *Hydropsyche morosa* larvae were collected from Tenderfoot Creek (Gogebic County, Michigan) and Trout Creek (Vilas County, WI). Chambers were prepared as described by Runde (1999). The bed of each chamber was covered with small pebbles. Five to ten insects were placed in each replicate stream along with water from the corresponding creek. There were three replicates per habitat for each experiment. Insects were fed 20 mg of finely ground Tetra-Flakes every other day throughout the experiment. Water velocity and temperature were held constant at 23 cm/sec and 23°C, respectively.

For each round of experimentation, the insects were given 1-3 days to construct their nets. Once nets had been built, the locations were mapped. Insects which failed to construct nets were removed. Once net mapping was complete, ground leaves were added to each chamber. Every 24 hours, observations were made to determine how the insects responded to the added sediments. Then an additional 0.2 grams of leaves were added each day. Experiments were concluded when all nets were clogged or modified. The leaves were sifted into four different sizes: <64 μm, 64-125μm, 125-250 μm, and 250-500 μm using sieves with 250 μm, 500 μm, 1000 μm, and 2000 μm mesh.

The responses of *H. morosa* larvae to varying particle type, size, and load were observed. Four different net tending behaviors were observed: cleaning without destruction, detachment of one side, cutting of hole in filtering surface, and total removal of net. Complete net clogging and drift were observed as well.

RESULTS

Clay particles (4 μm) did not clog the nets. Some particles clung to the nets temporarily, but were cleaned off by the insects. Like the clay particles, <64 μm leaf particles did not clog the nets. Again, some particles may have clung, but were cleaned off by the insects.

Leaf particles >64 μm clogged nets and caused net modifications by some insects. For leaf particles 64-125 μm, there was a significant difference in net modifying behaviors between Trout Creek and Tenderfoot Creek (two-way ANOVA, load, F=0.89, df=4.29, P=0.489; location, F=14.21, df=1.29, P=0.001; interaction, F=0.89, df=4.29, P=0.439). Most Trout Creek insects modified their nets while no Tenderfoot Creek insects did (Figure 1). For leaf particles 125-250 μm, there was also a significant difference in net modifying behaviors between Trout Creek and Tenderfoot Creek (two-way ANOVA, load, F=0.2, df=4.29, P=.935; location, F=16.2, df=1.29, P<0.001; interaction, F=0.2, df=4.29, P=.935). Again, Trout Creek nets were modified while Tenderfoot Creek nets were not (Figure 2). For leaf particles 250-500 μm, no significant difference was seen between Trout Creek and Tenderfoot Creek (two-way ANOVA, load, F=0.1, df=4.29, P=0.98; location, F=1.6, df=1.29, P=0.22; interaction, F=0.1, df=4.29, P=0.98). Nets from both streams were modified (Figure 3).

DISCUSSION

There was no significant difference in net manipulation with an increase in load. Once the particle size is large enough to clog the mesh of the net, the insects respond by altering the net. Only a relatively small amount of sediment is required for the net to clog. Once the net is clogged, the insects can respond only by cleaning, altering, or abandoning the net.

An increase in particle size increases net manipulation for the Tenderfoot Creek insects after a threshold is passed. When the particles introduced exceed 250 µm, the Tenderfoot Creek insects begin to modify their nets. This may be due to the size of the mesh. Perhaps the nets spun by Tenderfoot Creek insects contain holes approximately 250 µm in width. This would allow for smaller particles to flow through; clogging would occur (and modifications soon thereafter) once the particles exceeded the size of the mesh. Further studies need to be done to test this theory; the size of the mesh is unknown at present. Another possible explanation for the 250 µm threshold is that below 250 µm, the particles are easier to remove from the net. The larger particles harder to grip, heavier, and have a larger surface area, allowing the water pressure to exert a greater force. Once the particles reach 250 µm, it may be easier to modify the net than to attempt to remove the particles.

Trout Creek exhibits the same percent net manipulation for all particle sizes greater than 64 µm. This leads to the same theory as stated above. Perhaps the size of the mesh of Trout Creek insects is around 64 µm. Nets then would become clogged, and hence modified, when the sediments introduced are larger than this proposed mesh size. Again, to test this theory it is necessary to measure the nets.

No net manipulation was observed for Tenderfoot Creek or Trout Creek for clay (4 μm) or leaf particles less than 64 μm in diameter. Again, the particles were most likely smaller than the mesh of the nets from both streams. This allows the particles to flow freely through the net without causing a disturbance. Even if the net became clogged, the particles may be very easy to clean off of the net. Further studies need to be done to determine the exact size of the mesh. Another theory is that the insects are adapted to cleaning off particles of this size in their natural habitat. Again, this theory would have to be tested by determining the mean size of native sediments in each of the streams.

The results indicate a significant difference in the net tending behaviors of the insects in Trout as compared to Tenderfoot Creek, for sediments ranging in size from 64-250 μm. This is most likely due to the difference in mesh sizes between insects in the different streams. The insects in Trout Creek modified their nets when exposed to 64-250 μm sediments, while the insects from Tenderfoot Creek did not modify their nets at all in this particle size range. Trout Creek insects may be exposed to less FPOM, and thus are able to weave tight nets; this is advantageous in that it allows the insects a greater opportunity to collect more food. Tenderfoot Creek, on the other hand, may be higher in FPOM. The insects from Tenderfoot Creek are most likely adapted to a high FPOM load, and therefore weave looser nets. It appears that Tenderfoot Creek insects spin nets with mesh around 250 μm in width, while Trout Creek insects weave nets with mesh less than 64 μm in width. Again, more in-depth studies need to be completed in order to satisfy this hypothesis. Furthermore, Tenderfoot Creek insects were collected from a section of the stream which is much more susceptible to flooding than Trout

Creek. During a flood, mass amounts of sediment are flushed downstream. Natural selection would select for those insects which are able to withstand this increased sediment load. This offers another explanation as to why the insects sampled from Tenderfoot Creek did not modify their nets while those from Trout Creek did.

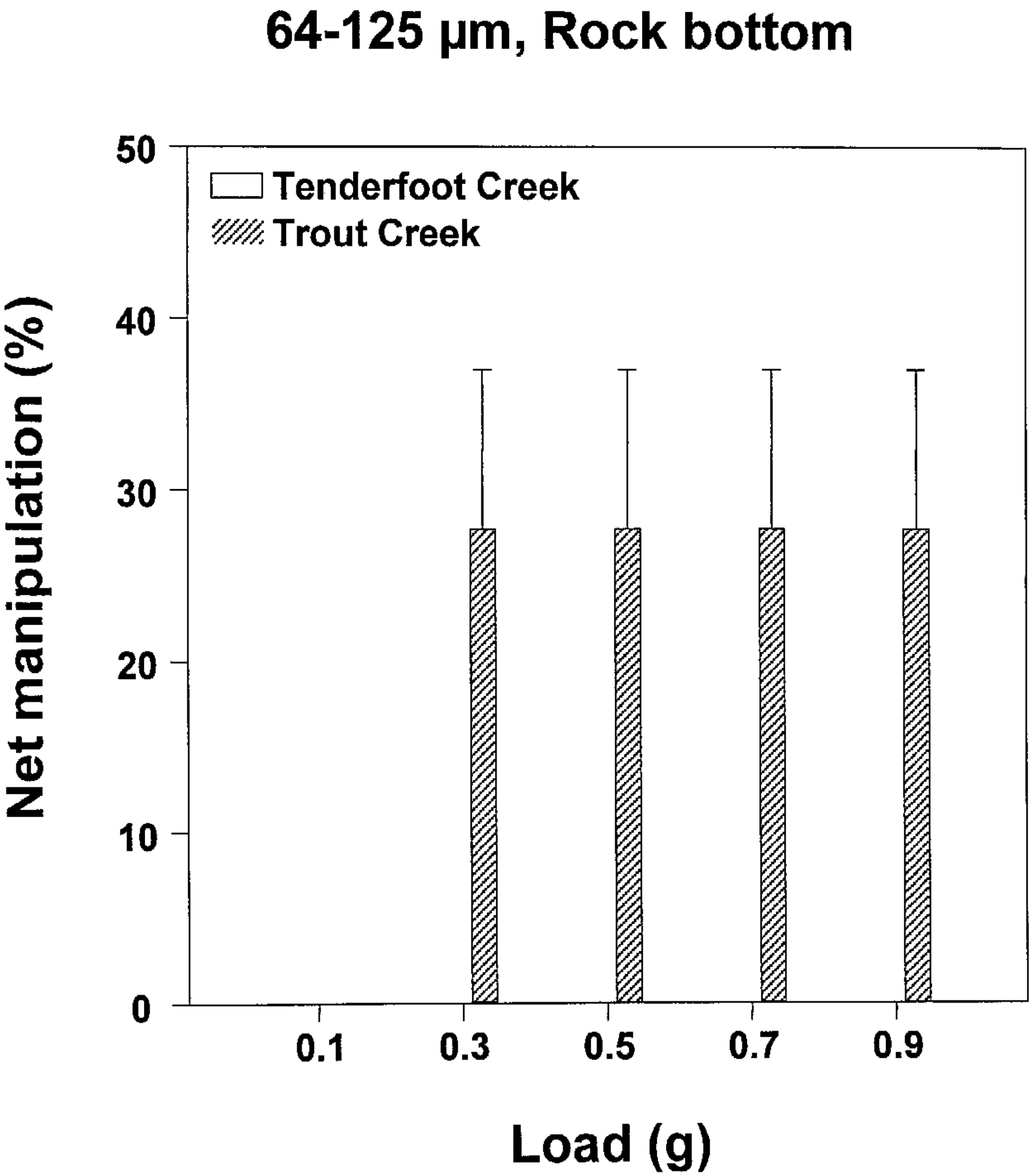

Figure 1.
When leaf particles 64-125 µm are applied, insects from Trout Creek modified their nets while Tenderfoot Creek insects did not.

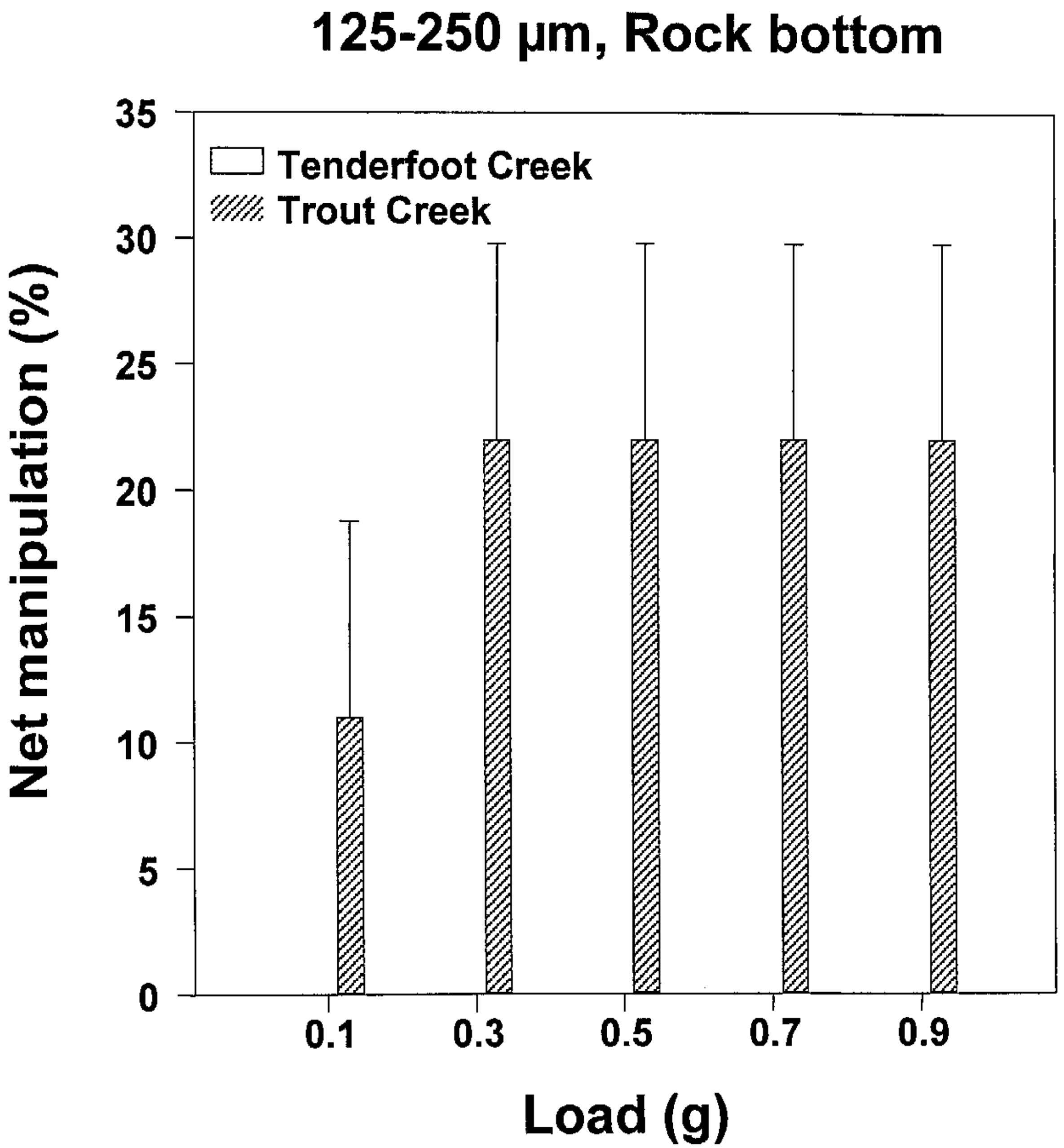

Figure 2.
When leaf particles 125-250 µm are applied, insects from Trout Creek modified their nets while Tenderfoot Creek insects did not.

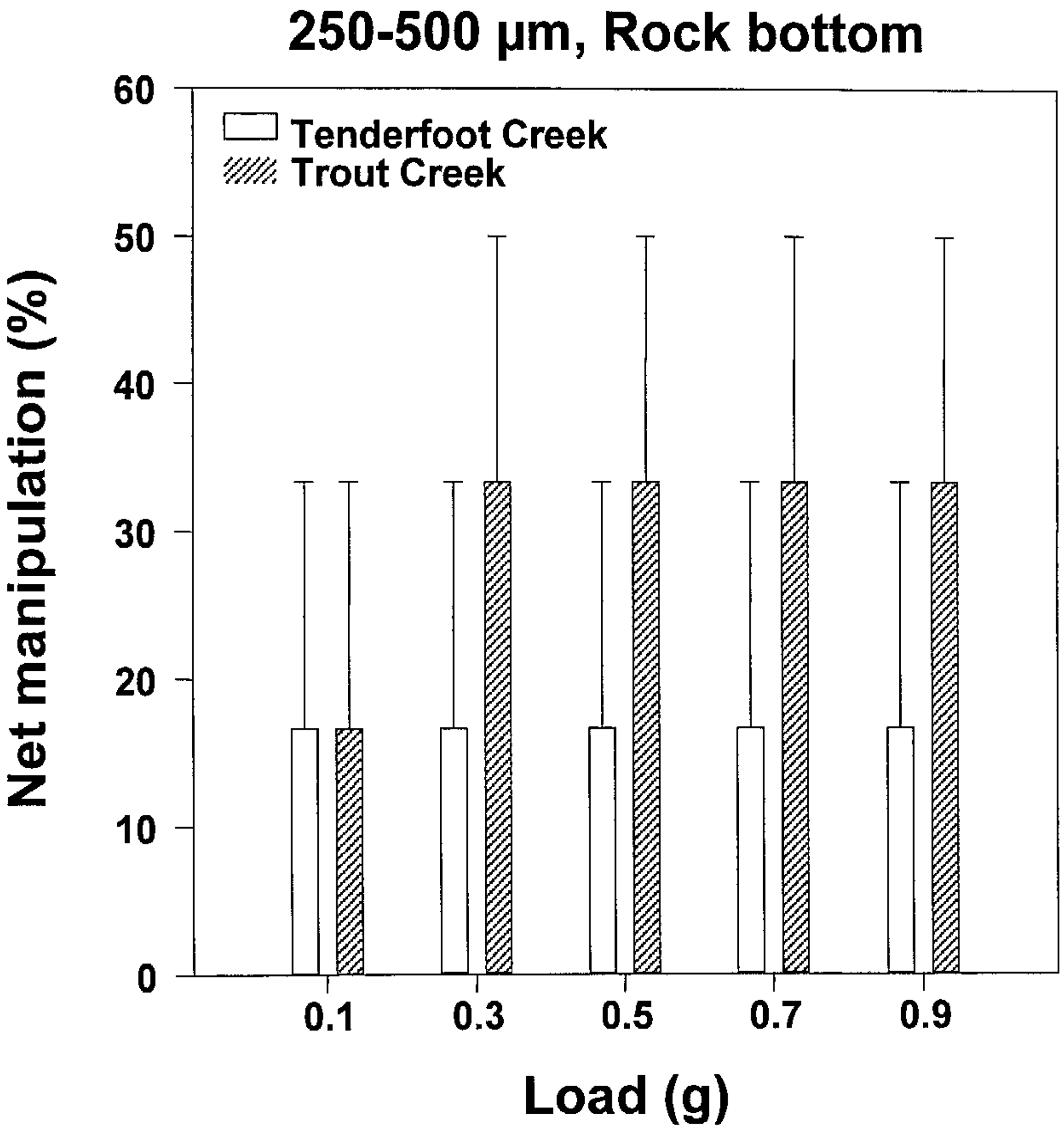

Figure 3.
When leaf particles 250-500 µm are applied, insects from both Trout Creek and Tenderfoot Creek modified their nets. There is no significant difference in percent modified between the insects from the two streams.

LITERATURE CITED

Culp, J. M., F. J. Wrona, and R. W. Davies. 1986. Response of stream benthos and drift to fine sediment deposition versus transport. Canadian Journal of Zoology 64:1345-1351.

Gore, J. A., J. R. Kelly, and J. D. Yount. 1990. Application of ecological theory to determining recovery potential of disturbed lotic ecosystems: research needs and priorities. Environmental Management 14:755-762.

Hynes, H. B. N. 1973. The effects of sediment on the biota in running water. In: Proceedings of Hydrology Symposium held at University of Alberta, Edmonton, May 8 and 9, 1973. Canada Department of Environment, Ottawa, Canada. 9:653-663.

Reice, S. R., R. C. Wissmar, and R. J. Naiman. 1990. Disturbance regimes, resilience, and recovery of animal communities and habitats in lotic ecosystems. Environmental Management 14:647-659.

Schlosser, I. J. 1990. Environmental variation, life history attributes, and community patterns in stream fishes: implications for environmental management and resource assessment. Environmental Management 14:621-628.

Wallace, J. B. and R. W. Merrit. 1980. Filter-feeding ecology of aquatic insects. Annual Review of Entomology 25:103-132.

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

Wiggins, G. B. 1996. Larvae of the North American caddisfly genera (Trichoptera). University of Toronto Press, Toronto.