The Periodicity of Caddisfly (Trichoptera) Drift and the Effect of Predation on that Pattern

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Christine Diana
Dr. Lamberti
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ABSTRACT

This study focused on the relationship between natural caddisfly (Hydropsychid) drift and caddisfly drift in the presence of Decapoda, Ephemeroptera, and Plecoptera predators in Tenderfoot Creek, Michigan. 24-hour drift collections established a natural drift pattern for caddisflies. Enclosure experiments including caddisflies and one of the previously mentioned predators demonstrated a preference of drift at night as opposed to the natural drift occurring in the morning. There was a difference in the drift patterns of Hydropsychids, with more drifting in the enclosure with Decapoda than in the Plectopera enclosure. However, the difference was not significant enough to conclude that these predators have significant effect on caddisfly drift. The enclosures showed a wide range of drift patterns, often having no caddisflies drifting at all. When the larvae did drift, however, the time coincided with the highest amount of drift in the control suggesting that the drift was not caused by the presence of that predator.

INTRODUCTION

Net-spinning caddisflies (Trichoptera: Hydropsychidae) are aquatic for the majority of their lifetime, contributing to the complexity and dynamics of stream ecosystems. They contribute to the food chain by directly or indirectly providing food for larger predators (McCafferty, 1981). Caddisflies may be found in large numbers on rocky substrates and are subject to drift in the water column. Allan (1978) described caddisfly drift as a behavioral way to avoid predators and increase feeding opportunities. Hydropsychids avoid predation by drifting (Allan, 1995) or retreating into their nets (Wiggins, 1978).

Since caddisflies are aquatic for most of their life, they are prone to enter the drift of the stream in order to move to another location. The exact reason larvae enter the drift is under some debate. Some studies suggest drift is a product of surplus animals in the benthos, making invertebrates available to higher trophic levels. However, others find drift to be a behavioral way to avoid predators and increase foraging opportunities. A study by Snodgrass (1993) showed the presence of crayfish increased the number of caddisfly larvae in the drift substantially. There was no relationship between a specific time of day and the likelihood of drift, suggesting the reason for drift was endogenous.

An important variable concerning caddisfly drift and community structure is the presence of predators. Koetsier (1989) described how the presence of predators negatively affected both the biomass and density of caddisfly communities. Studies concerning caddisfly drift due to predation will help in further understanding reasons for drift. Determining which predators are more likely to stimulate drift will help classify drift patterns in given streams. Such insights might lead to the comprehension of some pattern of drift due to various predators and environmental pressures.

I studies the effect of various predators - the crayfish (Decapoda) *Orconectes propinquus*, the hellgrammite (Megaloptera) *Corydalus cornuta*, the stonefly (Plecoptera) *Acroneuria* sp. - on the drift of Hydropsychid caddisflies. I first established the natural pattern of caddisfly drift in Tenderfoot Creek, Michigan. I then did drift experiments by enclosing caddisflies in an in-situ chamber, exposing them to predators, and observing their drift pattern. The, by comparing the drift associated with each predator to the natural pattern, I discerned which predator had the largest effect on caddisfly drift.

MATERIALS AND METHODS

Site Description:

The site for these experiments was a 3-meter long riffle area in Tenderfoot Creek, Michigan. Organisms used as predators were collected from the surrounding 30 meters of the creek, where the depth of the stream riffle ranged from 0.02m to 0.36m. The current velocity directly upstream from the collecting apparatus was 0.23m/s. The temperature of the stream ranged from 18-21°C. The streambed was composed of small cobble directly in the riffle, with larger rocks found closer to the bank. Macroyphytes were found in patches, mostly attached to the hard bottom near the larger rocks.

Experiment 1: Establishing the Natural Drift Pattern of Hydropsychids

Four drift nets were placed in the described riffle area of the creek on 6 June 2000. The collection bottles were checked at 15:00, 18:00, 21:00, 0:00, 6:00, 9:00, and 12:00. The samples were placed in 70% ethanol and taken back to the laboratory. Every sample was then sorted for Hydropsychids and other aquatic insects. These organisms were identified, counted, and placed in small vials. The data were then analyzed to see if there was a change in the natural drift pattern over the day for Hydropsychids, and if that pattern matched the natural drift pattern of any other organism.

Experiment 2: The Effect of *Orconectes propinquus*, *Corydalus cornuta*, and *Acroneuria* sp. on the Drift of Hydropsychids

Four cylindrical enclosures (11.4cm in diameter, 42cm long) were assembled (Figure 1). Lab matting (mesh size= 1.75mm) was attached to both ends with hose clamps and duct tape. This deflected the movement of large particles and deterred organisms from entering or leaving the enclosure, but allowed for the movement of Hydropsychids into the tapered collection net on the downstream end. The tapered net was attached to the apparatus with a hose clamp and the open end was clamped to a plastic bottle. Water flowed freely through the apparatus. The enclosures were filled with rocky substrate containing natural Hydropsychid communities on the upstream end and algae covered cobble on the downstream portion. One enclosure received two *Orconectes propinquus*, another five *Corydalus cornuta*, and a third five *Acroneuria* sp. A fourth apparatus was left as a control and lacked predators.

The enclosures were placed in the described riffle area on 28 June 2000 and were checked at 15:00, 18:00, 21:00, 0:00, 6:00, 9:00, and 12:00. The experiment was repeated on 1 July 2000 and 20 July 2000. Upon termination of the experiment, the rocks placed in the enclosures were removed and placed in a pan of water where the remaining Hydropsychids were isolated and counted. All drift samples were placed in 70% ethanol and taken back to the laboratory. They were then sorted for drifting Hydropsychids. Data were segregated by time of day to determine diel pattern of caddisfly drift for each treatment. These were then compared to the natural drift pattern to determine if any shifts occurred in timing or magnitude of drift.

Finally, data was gathered together and percent drift was calculated, along with the standard deviations. For each time period, the mean was found for both the number of drifting caddisflies and the number of remaning ones still in the enclosure. The mean number of drifting caddisflies was then divided into the mean number of remaining caddisflies in each enclosure to get the percent of Hydropsychids that drifted. A standard deviation program was then run on the percent drifting number of caddisflies (Table 1). Finally, all the mean percent drift calculations for each time were compiled and mean percent drift was calculated for each predator. A Krusal-Wallis test was run on these results.

RESULTS

Experiment 1: Establishing the Natural Drift Pattern of Hydropsychids

The natural drift samples contained a wide variety of matter including organic debris, tadpoles, and invertebrates. The most common invertebrates were Trichoptera

(Hydropsychidae) and Ephemeroptera. Less common drifting invertebrates were Anisoptera, Zygoptera, and Plecoptera.

The natural drift pattern of the most common invertebrates was not similar among species (Figure 2). For example, the peak of Hydropsychid drift occurred at 9:00 and the peak of Ephemeroptera drift occurred at 15:00. The natural drift pattern for Hydropsychids had a low at 15:00 and a peak at 9:00.

Experiment 2: The Effect of *Orconectes propinquus*, *Corydalus cornuta*, and *Acroneuria* sp. on the Drift of Hydropsychids

Mean percent drift calculated (Figure 3) for the enclosure with Decapoda showed 50% of the Hydropsychids drifted, as compared to 38% drifting in the control. Enclosures with Plecoptera and Megaloptera showed similar drift patterns, with 22% and 25% drifting, respectively. A Kruskal-Wallis test indicated there is no statistical difference in the drift of Hydropsychids in the control or any of the predator enclosures ($p=0.2857$).

Mean percent drift calculated (Figure 4) show the peaks in Hydropsychid drift in the enclosure with Decapoda were at 9:00 and 18:00. The highest drift for the Megaloptera treatment and the control was at 21:00. Finally, Hydropsychids drifted most at 0:00 in the Plecoptera treatment. So while the natural drift pattern was in the morning, all of the predator and control drift patterns showed a preference for drifting at night.

DISCUSSION

The presence of any of the three predators - Decapoda, Plecoptera, Megaloptera - did not have any statistical effect on Hydropsychid caddisfly drift. Furthermore, the natural pattern of Hydropsychid drift was variable, with the natural pattern having the most drift at 9:00 and the control having the most drift at 21:00. Therefore, there did not appear to be an established drift pattern of Hydropsychids in Tenderfoot Creek, and comparing drift of Hydropsychids in the enclosures to natural drift did not yield conclusive results.

The enclosure with Megaloptera showed a wide range of drift patterns. Often there were no drifting Hydropsychids at all. But when larvae did drift, the time coincided with the highest amount of drift in the control suggesting drift was not caused by the presence of the predator. The enclosure with Plecoptera seemed to follow the same general pattern, with its highest peak of drift still being close to the control. The only possible difference from the control was found in the enclosures containing Decapods. There were two periods of peak drift that occurred during the sampling time, which did not correlate with any other observed pattern. Also, the largest number of drifting Hydropsychids was found in the Decapod enclosure, suggesting they were forced to drift and it was not simply their natural pattern. However, these results were not statistically significant.

There were many factors that may have led to these results other than the predators themselves. During the study there were large amounts of rainfall at sporadic times. Therefore, the flow of the river changed many times, which may have affected the natural pattern of drift from one experimental run to the next. It was hard to get reproducible data since the environmental factors varied from time to time (i.e. flow, temperature).

There were also problems concerning the predators themselves. One such problem was the uncontrollable drift of Plecoptera and Megaloptera when inside the enclosures. The Decapods were kept in the enclosure by a mesh net that was large enough to let drifting Hydropsychids pass through but not the Decapods. However, this method was not successful in the other enclosures due to the closer sizes of Hydropsychids to Plecotpera and Megaloptera. One reason the crayfish may have posed such a risk, possibly causing an increase in drift, is the fact they can tear apart the protective net of the Hydropsychid, becoming a very effective threat. However, the remaining predators may have simply passed by the nets, unable to get the Hydropsychids in their retreats. Damage was observed on the nets in the crayfish enclosures, while there was little evidence of tampering with the nets in the other enclosures.

A major problem occurred in the actual sampling of the Hydropsychid drift. Taking samples every three hours does not reveal the accurate time of actual drift. Also, there were times (for example from midnight to 6:00) when no samples were taken. This influenced the number of Hydropsychids found in the next sample collection. It was impossible to say exactly when the peak drift was during the six hour period when samples were not taken, it can only be stated that the peak occurred in that period. This caused unusually large numbers of Hydropsychids in the samples taken at 6:00 and influenced the graphs showing peak drift.

Further studies could involve a similar experiment where the environmental factors do not come into play quite as much. Reducing variation might make it easier to rule out drift for other reasons than predation. One could take rocks, clean them of all other organisms, and place Hydropsychids on them to establish a community. Then, using an enclosure placed in constant flow - say in a laboratory setting - place predators of exactly the same size and consistently check the drift every few hours for a 24-hour period. The reason this was not done in this experiment was the desire for a natural setting. The laboratory experiment might show how Hydropsychids drift under ideal conditions that may never be achieved in an actual stream. So while these results may not have proved the hypothesis that predators have a major effect on Hydropsychid drift, it is possible that there is some effect. Further studies based on this knowledge could be performed for Hydropsychids in tenderfoot Creek.

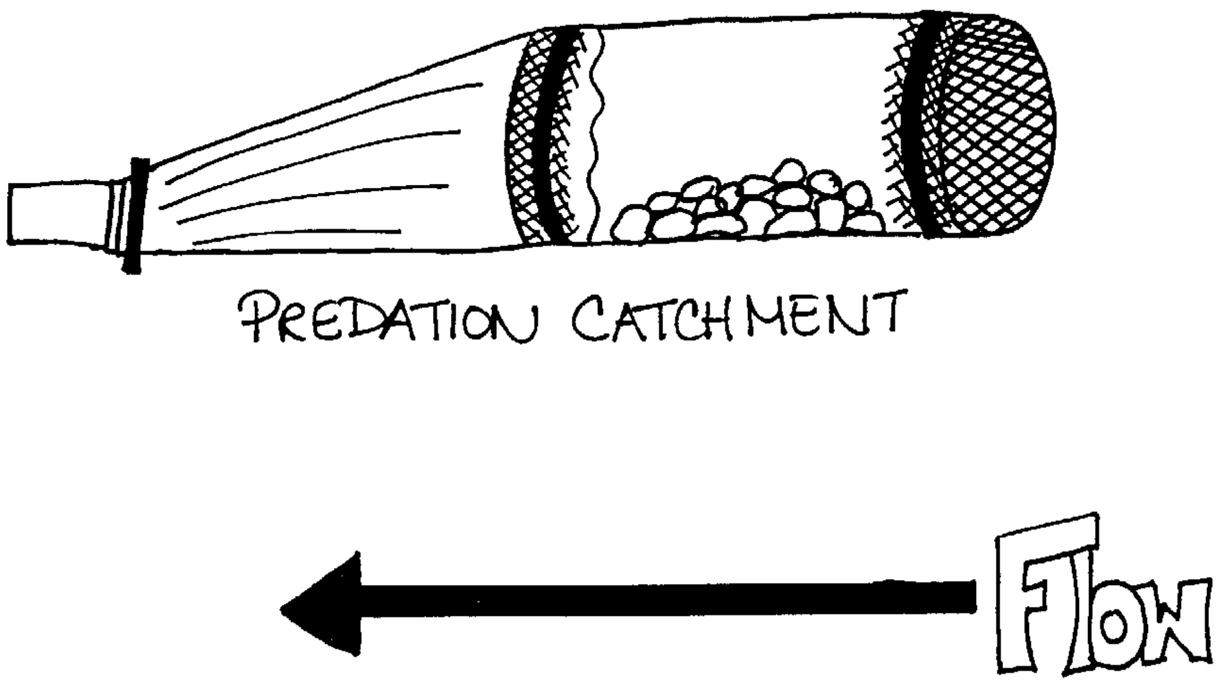


Figure 1: Enclosure for Predation Experiments

Figure 2: Hydropsychid vs Ephemeroptera Drift

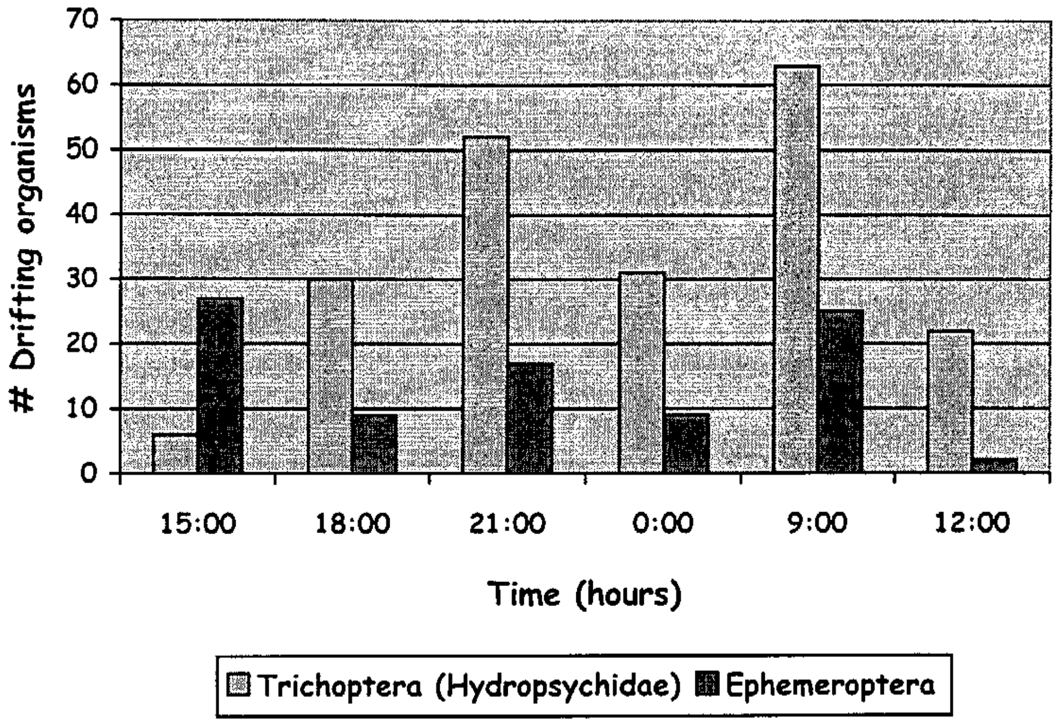
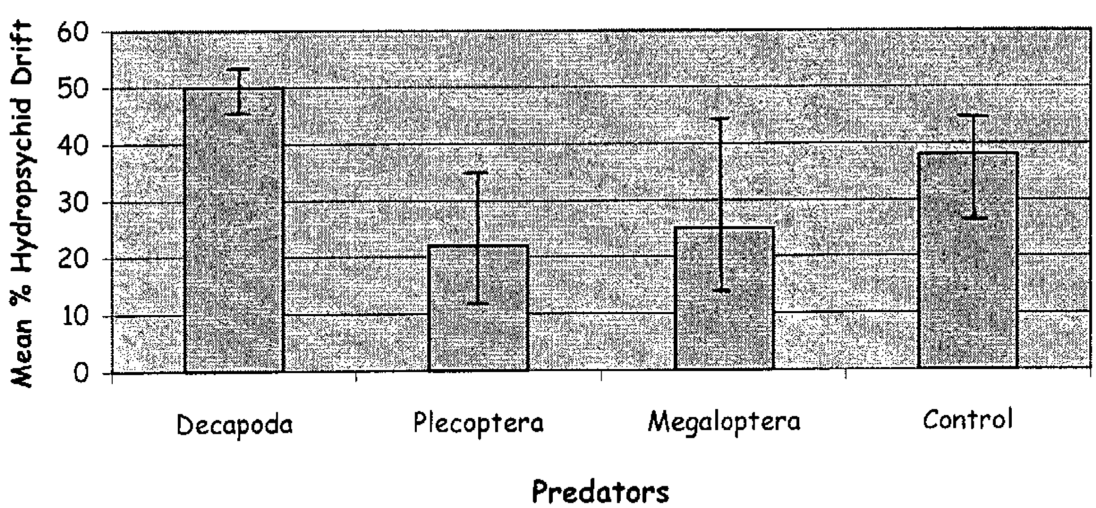


Figure 3: Mean Percent Drift



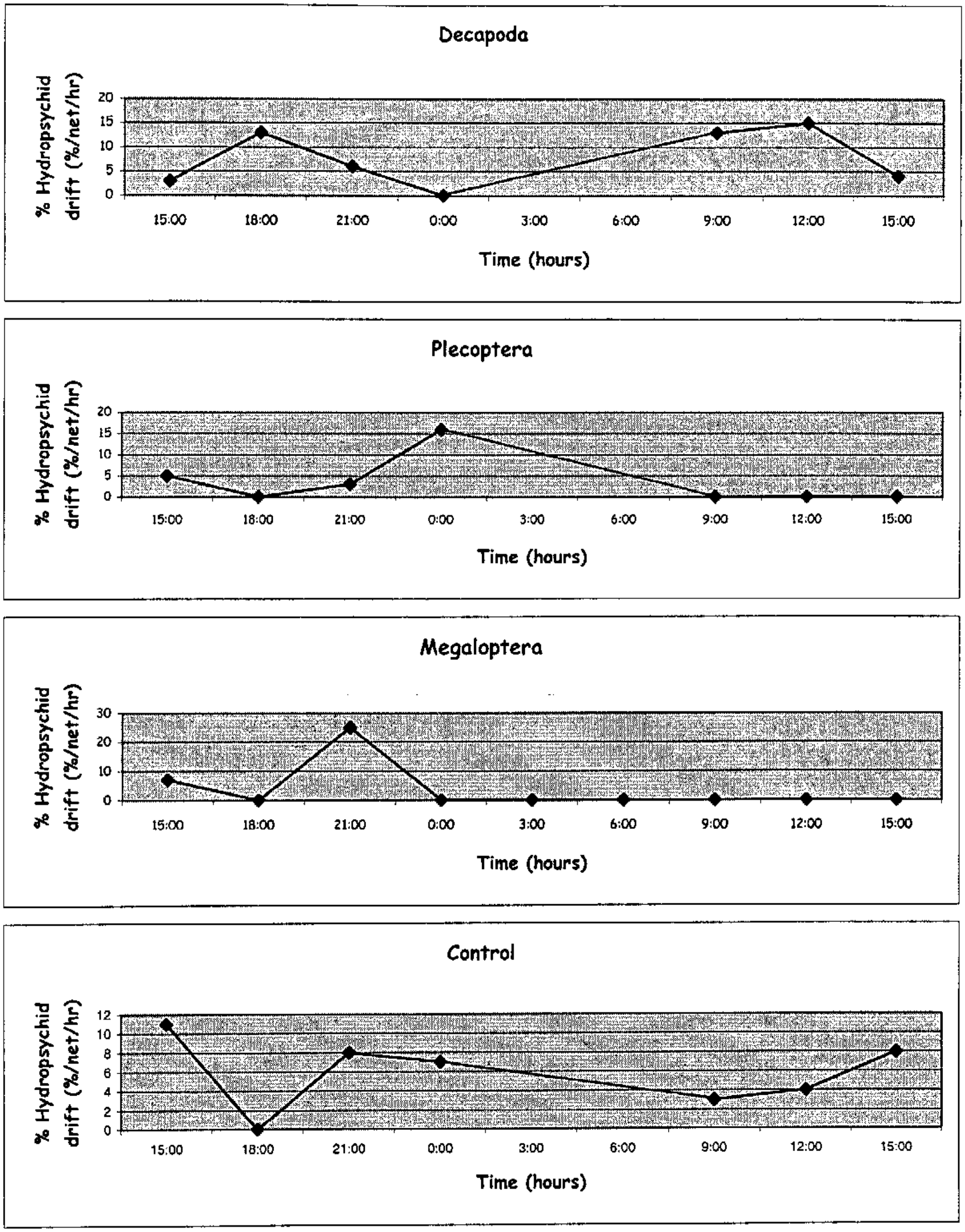


Figure 4: Percent Hydropsychid Drift at Each Time Collection for Each Predator (A-D)

Table 1: Standard Deviations of Mean Percent Drift at Each Time Collection for Each Predator

TIME	DECAPODA	PLECOPTERA	MEGALOPTERA	CONTROL
15:00	0.04811	0.08882	0.11547	0.19245
18:00	0.14597	0	0	0
21:00	0.09623	0.05249	0.25000	0.13323
0:00	0	0.19419	0	0.11547
9:00	0.11547	0	0	0.05774
12:00	0.13229	0	0	0.06415
15:00	0.07217	0	0	0.14434

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