ABSTRACT

Larvae of the caddisfly *Glossosoma intermedium* (Trichoptera: Glossosomatidae) are highly abundant, keystone herbivores in many Midwestern streams. *Glossosoma* are highly efficient grazers of periphyton (the algal film covering the streambed) and are often found in extremely high densities (approx. 10,000 individuals/m^2 or more). These herbivorous insects are considered keystone herbivores because they strongly regulate the periphyton community, and competitively displace other grazing macroinvertebrates. Larvae construct cases from sand and pea gravel. They rebuild these cases after every molt through the pupal stage until they metamorphose into terrestrial adults. Larvae cause interference competition while grazing the substrate, dislodging smaller, sessile macroinvertebrates. The combination of high densities, grazing efficiency, and the mechanical disturbance of the periphyton layer by the cases, limits available periphyton resources for grazing macroinvertebrates, including *Glossosoma* itself. This leads to density dependent size regulation in *Glossosoma*.

It has been observed in the field and through preliminary laboratory studies that *Glossosoma* larvae mount the cases of other larvae. It is hypothesized that the larvae are foraging for periphyton on the cases of others. It is unclear whether this behavior is enhanced by the reduction of available resources on channel substrates. Our research will test whether this mounting behavior is correlated with the amount of periphyton resources available on channel substrates.

Glossosoma intermedium larvae will be collected from two local streams, separated by size, and held under controlled conditions. Time-lapse photography will be used to record behavioral patterns on different substrate tiles (i.e., varying periphyton concentrations) in artificial streams. Behavior patterns will be analyzed and the relationship between mounting (case grazing) and resource availability will be assessed. Chlorophyll *a* concentration, an index of algal biomass, will be analyzed from foraging tiles and larval cases for each trial.

NARRATIVE

Background – This study is part of an ongoing research program directed by Dr. Roger J. Haro to address the effect of natural and anthropogenic mechanisms on the structure and function of riverine food webs. My research, concerning the feeding behaviors of *Glossosoma intermedium* (Glossosomatidae: Trichoptera) in its larval form, will act as a pilot study for future related experimentation by Dr. Haro. This research focuses on the relationship between a "keystone herbivore" (*sensu* Lubchenco and Gaines 1981), *Glossosoma intermedium*, and the relative availability of periphyton, the film of algae that covers the streambeds of groundwater-fed, trout streams of southwestern Wisconsin. This algal film is the primary source of nutrition for this insect while in the larval stage, and acts as the principle source of primary productivity in these streams. *Glossosoma larvae* are unchecked by stream predators and capable of drastically reducing the standing crop of periphyton on the streambed. This highly efficient grazing capability plays a definitive role in the grazing food web of southwestern Wisconsin streams.

Other studies have observed periphyton growing in and on the cases of a variety of stream-dwelling macroinvertebrates (Bergey & Resh 1994, Cox & Wagner 1989, Pringle 1985). Case architecture and the nitrogenous wastes excreted by the occupant macroinvertebrate may promote periphyton growth on the case. The significance of this "case-periphyton" as a potential resource for other macroinvertebrate herbivores, however, is not known.

Dr. Haro has observed larvae of *G. intermedium* mounting the cases of other, conspecific larvae. These "riders" remain on the "carrier" larvae for extended periods of time (2 hrs. +) before dismounting. This behavior has been observed in both the laboratory and the field (Haro, unpublished data). We suspect that *G. intermedium* forage on "case-periphyton" to supplement consumption when periphyton levels become limiting on the streambed.

We will conduct a series of laboratory experiments in attempt to gain insight into this grazing behavior. We wish to determine whether this behavior is enhanced by the reduction of periphyton on the substrate. The influence of other environmental factors (current velocity and grazer density) on this behavior will also be assessed. The results

from this pilot study will be used by Dr. Haro to construct future experiments to address several hypotheses. First, under high densities of *G. intermedium*, periphyton growing on the cases of conspecific larvae represent patches of higher quality resource for *G. intermedium* than periphyton patches available on the streambed. Second, during certain times of the year, case-periphyton provides a significant resource supplement to *G. intermedium.* And third, the costs and benefits of case grazing lead to trade-offs in foraging behavior for the carrier and rider larvae, respectively. These hypotheses will be explored by modeling *Glossosoma* foraging behavior as a function of population density, size structure, and periphyton resource distribution through future experimentation.

Significance– The fates of primary production in streams (i.e., consumption by grazers, entrainment in detrital pools, export, and senescence) are not well defined in terms of their relative magnitudes or impact on ecosystem function. However, the importance of primary producers to nutrient cycling, consumer energetics, and faunal composition in running waters (Allan 1995) has fostered an increasing research interest in grazer-periphyton interactions. In other ecosystems, the grazing behavior of a single herbivorous species can have profound consequences for ecosystem structure and function. Examples include: (1) sea urchin and kelp dynamics off the North American Atlantic coast (Elner and Vadas 1990), (2) zooplankton and phytoplankton dynamics in temperate lakes (Carpenter et al. 1987), and (3) lemming and moss relationships in the tundra (Oksanen 1983).

Colleagues studying a sister species of *G. intermedium*, *G. nigrior*, in Michigan streams have demonstrated that these insects play a central role in structuring entire stream food webs, from algae to trout (Kohler & Wiley 1997, Hinz 2000). Here in Wisconsin, Dr. Haro and his students have shown that *G. intermedium* larvae may play a similar role, but are also constrained by the impacts of non-point source sediment pollution. This research will help broaden our understanding of how *G. intermedium* maintains such high densities in the face of very limited food resources and substantial habitat degradation. Additionally, models generated through this research will be used to synthesize results of field and laboratory experiments, generate further hypotheses, and set priorities for future research examining the impacts of non-point source pollution on stream food webs.

Methodology— Periphyton resources and grazing demands are greatest during summer time. *Glossosoma* larvae will be collected from two local streams and will be kept in one of three artificial flumes under controlled conditions. A series of behavioral experiments will be conducted in the laboratory to quantify foraging decisions made by *G. intermedium* under different levels of periphyton availability and grazer density. In artificial flumes, larvae will be allowed to graze on tiles supporting varying levels of periphyton. I will record foraging behavior using time-lapse video equipment. I predict that case-mounting behavior will be more frequent when larvae forage on tiles lacking periphyton. Cases will be randomly sampled from the population of *Glossosoma* and will be analyzed for chlorophyll *a* concentration, an index of algal standing crop, and for differences in algal community structure.

I will be involved in collecting *Glossosoma* from the field, conducting the behavioral experiments in the artificial flumes, analyzing the time-lapse videotapes, and determining chlorophyll *a* concentrations from the cases and forging tiles. My involvement will begin in May of 2000 and will continue for no less than ten weeks. However, it is estimated that I will be involved through the following school year. I am currently a junior here at UW-L and am expected to graduate in December of 2001. Our results will be presented next spring in the Undergraduate Research Symposium and, hopefully, at the annual meeting of the North American Benthological Society to be held here in La Crosse in June 2001. I will receive a summer undergraduate research fellowship (a stipend) for financial support during this study.

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BUDGET PLAN

Item	Quantity	Total
Gas – 45 mi round trip x 8 trips (needed for collecting specimens & foraging tiles)	$0.19 per mi	$68.40
Videotapes – Best Buy (Sony, 8hr, high quality VHS)	6.99/3 tapes (need 5)	$34.95
Fisher Catalog Listings:		
Reagent grade methanol (60 chlorophyll analyses)	4 l jug @ $54.40ea. item # A412-4	$54.40
Standard polystyrene plastic cuvettes	500 pack* @ $76.00ea. item # 14-385-985	$76.00
Whatman 41 4.7cm filter	$12.30/pack (need two) item # 09-85OH	$24.60
Whirlpacks 6oz	500 pack* @ $45.00ea. item # 01-812-SA	$45.00
Shell vials ¼ dram (needed for holding larvae after chlorophyll analyses)	144 pack @ $13.50ea. (need two) item # 03-399-30A	$27.00
Shell vial ½ dram (needed for holding cases after chlorophyll analyses)	144 pack @ 15.50ea. (need two) item # 03-399-30B	$31.00
Hip Waders	1 pair @ $35.00	$35.00
Total for all expenses:		$396.35

* These items represent the minimum size which can be purchased.

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