

**Effects of Consumptive and Non-consumptive Predations cues on Caddisfly Detritus
Processing**

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Abstract

The larvae of cased caddisflies (Insecta: Trichoptera: Limnephilidae) occur in pond and stream ecosystems where they feed on detritus (inorganic or organic waste). Limnephilids also use detritus to construct cases around their body that help to protect them from predators, including large invertebrate, salamanders and fish. The focus of this project was on how fish predators affect caddisfly (*Nemotaulis ocellifera*) foraging behavior, hence the rate of detritus processing. I was especially interested in comparing the consumptive effects of fish to non-consumptive olfactory cues from fish. I hypothesized that caddisfly activity, hence detritus processing should be greatest in the absence of fish and lowest in the presence of actively foraging fish that reduce caddisfly numbers (consumptive effects). The degree to which caddisflies use olfactory cues to detect fish predators will be inferred from whether detritus breakdown rates are more similar to those in the consumptive vs. control (no caddisfly) treatments. I found that caddisflies had the highest detritus breakdown rates in the absence of fish and the lowest in treatments with actively foraging fish. Detritus breakdown rates in the non-consumptive (fish cue) treatments were not different from those in the no-predator treatments, suggesting caddisflies do not change behavior in the presence of only olfactory cues. Across all treatments, the amount of chlorophyll (as a measure of algal biomass) was correlated with detritus breakdown, suggesting that detritus processing by caddisflies has dual ecosystem impacts; i.e., both to the conversion of detrital energy to secondary animal production (caddisfly tissue), and the stimulation of primary productivity for herbivores

Introduction

Caddisflies

Caddisflies are important for stream and pond ecosystems because they control detritus break down rates and transfer detritus-bound nutrients (nitrogen and phosphorus) to other organisms and the environment (Klemmer et al. 2012). Caddisflies are detritivores that eat microbes on decaying plant matter. The detritus that caddisflies consume is in the form of leaf litter that has been “microbially conditioned” via fungi (Inkley et al. 2008). These invertebrates are an integral part of the food webs in stream and pond ecosystems. When they expel waste from their bodies, they release nutrients (N and P) for other organisms, such as algae. Algae are also a food source for other invertebrates. Caddisfly detritus-breakdown can also prevent excessive detritus build up in streams and ponds. It has been documented that herbivores consume only a small fraction of the vegetation around these environments and the other fraction becomes detritus (Klemmer et al. 2012). If there are no caddisflies utilizing the detritus in wetlands, it often becomes buried as peat and is taken out of the energy budget in the pond. The same detritus that the caddisflies consume is also used to construct body casings where they develop inside. Multiple caddisfly species live in various wetlands throughout the United States. In the northern wetlands of North America, caddisflies (Trichoptera) from the families *Limnephilidae* and *Phryganeidae* occupy different environmental niches and exist in either permanent or temporary lentic habitats (Wissinger et al. 2006). Caddisfly cases have physiological differences depending on their functions (Wissinger et al. 2006). Research has shown that these cases can be for camouflage, or for protection from predators (Ferry et al. 2012). For example the caddisfly species, *L. externus* create “hedge-hog” shaped body casings out of leaves that provide protection and camouflage against salamander predators (Wissinger et

al. 2006). Caddisfly casings can come in a variety of shapes but not all cases can ensure the best protection. For example, the caddisfly species, *Limnephilus flavastellus*, which can construct body casing out of sticks, had the highest survival rate during an experiment done with other various caddisflies (Ferry et al. 2012). Caddisflies have several predators like salamanders and other invertebrates (Wissinger et al. 2004). Caddisflies are also known to be cannibals. Sometimes during intraspecific competition between species of caddisflies, this drives some species towards cannibalism/intra-guild predation (Wissinger et al. 2004).

Caddisfly-Fish Interactions

Caddisflies are also preyed upon by fish, but there is very little research on the effects of fish-caddisfly interactions and how it affects ecological quality of stream and pond ecosystems. However there are some suggestions that fish can affect the behavior and the abundance of caddisflies. The alewife, found in lakes throughout the United States, is a fish that consumes caddisfly larvae (Demi et al. 2003). During field observations, presence of alewife suppressed caddisfly activity but in the absence of these fish, caddisflies appeared to be more active and there was increase in biomass. Other fish that consume caddisflies are sport fish like trout and centrarchids (bass and sunfish), which consume a wide variety of invertebrates (Pope et al. 2008). When trout-caddisfly interactions occur, this leads to decreased caddisfly biomass and activity, however this decrease varies along different habitats. In large lakes, there is reduced predation pressure compared to small lakes, where caddisfly predation is much stronger.

Pumpkinseed sunfish

Pumpkinseed sunfish (*Lepomis gibbosus*) are primarily bottom feeders that eat gastropods (Wimberger 1994). Research has shown that

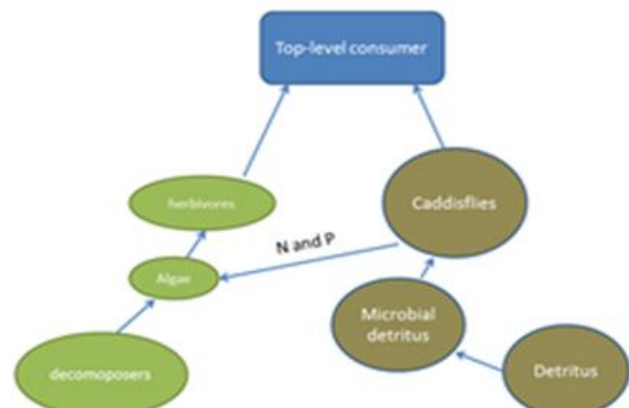


Figure 1: Simplified food web illustrating algae (green pathways) and detritus (brown pathway).

Pumpkinseeds also consume soft-bodied invertebrates (Mittelbach et al. 1991). In a previous study, 18 pumpkinseed sunfish's intestines had contained remnants from organisms from species like *Tricoptera* and *Diptera* (Kleef et al. 2007). The proposed research was significant because it produced useful data on fish predators that are usually molluscivores and contributed to what the predator-prey interaction does to the caddisfly activity (Wimberger et al. 1994).

Detritus-algae interactions

In food webs for aquatic ecosystems, algae are an important resource for herbivorous organisms. There is preliminary evidence that detritus-bound nutrients can stimulate algal growth, even if detritus is part of a different pathway of the food web as a whole (Wissinger unpublished 2013). This link between “brown” (detritus) and “green” (algal) trophic paths has been difficult to demonstrate *in situ* open systems (Vannia 2001, Webster et al. 2009, Klemmer et al. 2012), but there is recent evidence for this phenomenon from microcosm experiments on detritus processing by caddisflies (Thorton & Wissinger unpublished 2013; Fig. 1). The algae pathway is controlled by a dynamic equilibrium between the top-down effects of herbivores but because of the assumption that detritus-bound nutrients released by caddisflies also support algae, the collapse of the brown pathway could potentially disrupt the green pathway as well (Thorton & Wissinger unpublished 2013).

The purpose of this experiment was to determine whether predatory fish inhibited caddisfly activity/foraging. Measuring the detritus breakdown among various treatments determined when caddisflies were most and least active. Detrital breakdown also reflected positive and negative relationships between caddisfly foraging and other ecosystem processes such as algae growth.

Methodology

Study Site & Study Species

For this experiment, study sites were located inside of the Steffee biology hall. The study species was caddisfly instar larvae, *Nemotaulius ocellifera*, one of several species found in Bousson research reserve owned by Allegheny College (Inkley et al. 2008). This species of caddisflies develops during the fall and their diets are composed primarily of detrital leaf litter. Twenty tanks were used and each tank contained 10 caddisflies (220 were used).

Fish species for experiments

The fish species that I used were pumpkinseed sunfish (*Lepomis gibbosus*). Twelve juvenile pumpkinseed sunfish (ranging from 6-9cm) were collected from a fish tank located in the Steffee biology hall. The fish were then divided up into various treatments (consumptive, non-consumptive & control). After the experiment was completed, the fish were returned to the tank in Steffee biology hall.



Fig. 2: Pumpkinseed Sunfish.

Preparing Detritus

For preparing the detrital food source for the caddisflies, I emulated the methods from Inkley et al. (2008). The leaves were collected from red maple trees (*Acer rubrum*), around the Allegheny College campus. Red maple leaves have a high abundance in wetlands and in caddisfly diets (Inkley et al. 2008). After collecting leaves ($400\text{g} \pm 0.5\text{g}$), they were dried at a room temperature of 23°C . I placed the leaves into 20 plastic containers and covered the top with 1mm window screening (20g of leaves/container). The containers were then taken to Bousson research reserve and were placed into south marsh for bacteria incubation. The leaves incubated

in the marsh for a week and were then taken back to Steffee where 20g of leaves were placed into 20 tanks for the duration of the experiment.

Habitat/Treatment Design

Ten-gallon tanks were used for the caddisflies habitats. Before beginning the experimental, I sterilized each tank using chlorine and rinsing them down with water. Using a meter stick I filled each tank so that the water level came past 15 cm. The water was collected from south marsh in Bousson research reserve. I used a series of air splitters and air stones to aerate the water in each tank. Within the experiment I conducted 4 different treatments.

Table 1: Various experiments used in my experiment and the number of tanks (replications) used for each one treatment.

Consumptive Fish Treatment	Non-consumptive Fish Treatment	No Fish/Dead Treatment	Control
5 replications	5 replications	5 replications	5 replications
(caddisflies included)	(caddisflies included)	(caddisflies included)	

There were 5 replications of each treatment (Table 1).

Consumptive Fish Treatment

For the consumptive experiment I used 5 of the 20 tanks to place fish and caddisflies in the same environment. The fish were able to freely swim around the tank and interact with caddisflies. To make sure that the fish were healthy, each tank was given a pinch of *Tetramin* fish flakes each day. This would ensure that the fish would have enough food for the entire experiment month just in case they happened to consume all of the caddisflies.

Non-consumptive fish treatment

Instead of letting the fish roam free in this treatment, each fish was placed into a mini guppy breeder container. The breeder was suspended in the ten-gallon tank for the duration of the experiment. Each fish was fed a pinch of *Tetramin* fish flakes each day during the

experiment. Periodically I cleaned out the guppy breeders when they became unsanitary for the fish.

Essences of dead caddisfly (EDC) treatment

For this experiment there were no fish used. Using some of my extra caddisflies (20 to be exact), I dissected the insects and placed them into 5 tanks. This method was done in an experiment using gastropods where dead conspecifics (snail pieces) induced a crawl-out response in *Physella virgata* (Covich et al. 1994). During the first week of my experiment I placed 2 mutilated caddisflies into each tank. Then during the third week I repeated the same methods and added 2 more caddisflies to each tank. This determined if shredded caddisflies will induce a negative effect in caddisfly foraging.

Caddisfly activity Control experiment

For my caddisfly control I used 5 tanks that did not contain fish or caddisflies. Twenty grams of microbial treated detritus was placed into each of the tanks along with an unglazed tile (26 cm² area) to grow algae. As the experiment went on, the detritus broke down due to the bacteria growing on the leaves.

N+P Control experiment

In order to compare algal quantification with fish and caddisflies vs. just fish, I used two tanks where I just had pumpkinseed sunfish and no detritus. An unglazed tile (26 cm² area) was placed into each control tank. The fish in the control experiments were fed the same amount of food as the fish in the 20 other tanks. After the experiment month, the tiles were collected and placed into labeled zip-lock bags.

Behavioral & Survivors Statistics

“Caddisfly activity” was represented by the amount of detrital mass loss at the end of the experiment. After the experiment was over, the detritus from each tank was collected and placed into a 14g pie tin. The detritus was placed into an oven at 60°F for a week. After a week the detritus was weighed via OHAUS balance scale. To measure the caddisfly activity we used this equation:

$$\text{Caddisfly Activity (mass loss)} = (\text{detritus}_i - \text{detritus}_f)$$

Initially the mass of the detritus in each treatment was 20 g (detritus_i), so we subtracted the remaining detrital mass (detritus_f) of each sample to get the caddisfly activity. The remaining detrital mass was also recorded for data analysis as well. After tearing down each experiment, I collected the remaining caddisflies and recorded how many were still alive using a Microsoft excel document.

Algal quantification

To collect quantitative data for algae, I emulated the methods done in Klemmer et al. (2012). Within each of the experimental tanks, unglazed tiles (26 cm² area) were placed into the habitat. The tiles were observed each day for any visual indications of algae growing topically. At the end of the experiment the tiles were collected and placed into zip-lock bags and stored into a freezer at -18°C. After a day of storage, 50 ml of 90-100% (200 proof) ethanol was added to each bag. This lysed the algal cells, releasing the chlorophyll- α . The ethanol also turned algae into phaeophytin (dead algae). The solution was moved to whirl packs to be homogenized and afterwards they were moved to test tubes for the fluorometer to measure total chlorophyll- a per unit area.

Fluorometer measuring

Before using the fluorometer, the machine was warmed up for 10-15 minutes and the algae samples were placed in a room that had dim light. While the machine was starting, 3ml of the algae solution was taken from each of the samples and placed into 12mm test tubes with rubber caps. After the fluorometer was ready, the machine was calibrated to read chlorophyll-*a* (Chla-A). The algae solution was measured twice because the ethanol that was used to release the chlorophyll- α had turned the algae into phaeophytin. Phaeophytin was excluded from this experiment. In order to record just the chlorophyll- α measurement, test tubes were placed in the machine to measure the initial fluorescence of chlorophyll-a and phaeophytin (RFU_i). After recording the initial fluorescence, test tubes were removed and 0.1N of hydrochloric acid (HCl) was added to each test tube, turning the rest of the solution into phaeophytin. Test tubes were placed back into the fluorometer to measure “after fluorescence” (RFU_f) of just phaeophytin. The total chlorophyll- α per unit area was obtained by subtracting the “after fluorescence” from the “initial fluorescence”:

$$\text{Chla (mg/units of area, e.g., m}^2\text{)} = R * (\text{fluorescence initial} - \text{fluorescence after}) * (\text{extract volume of the sample} / \text{area of sample m}^2) * (\text{total volume} / \text{subsample volume}) * (1/\text{dilution factor})$$

Statistical Analysis

With the data collected from the total number of caddisfly survivors (caddisfly density change), caddisfly activity (mass loss) and algal growth, I used StatView program to run one-way ANOVA tests on different variables. The first test was observing the differences in detrital mass loss among the various treatments to determine if caddisfly activity is significantly different or not. After recording the results from the variation tables I ran a similar test using the caddisfly survivors to see if the treatments affected caddisfly densities. For determining the relationship between survivors and mass loss I used a simple regression. This determined

whether the number of survivors in each treatment ultimately contributed to the results of the detritus breakdown.

For the algae statistical analysis I also ran one-way *ANOVA* test where I observed the relationship between treatments and the amount of chlorophyll- α (mg/cm²) produced. Data was also recorded using regressions for the relationships for mass loss, survivors and remaining detritus.

Results

Detritus mass loss

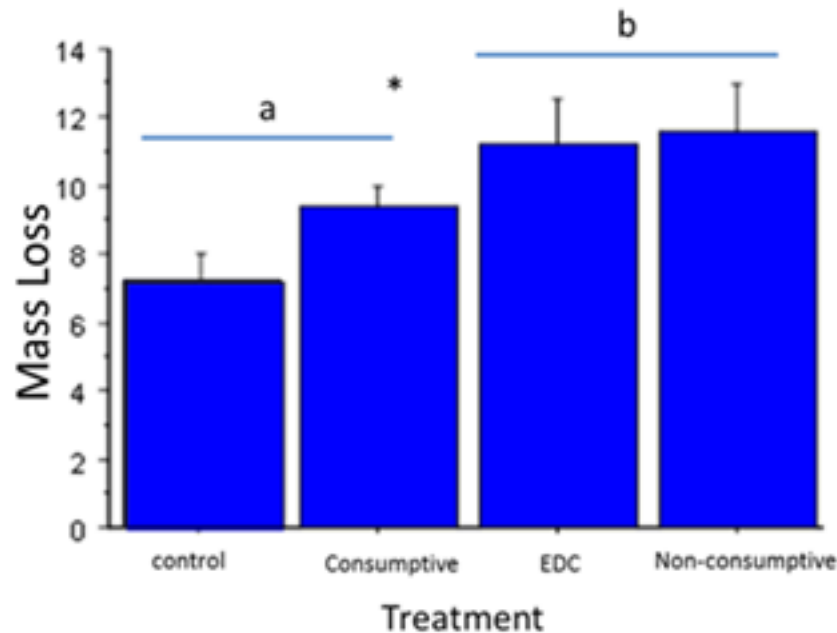


Fig. 3: Mean ($\pm$ S.E) mass loss across all caddisflyfy treatments. In this and subsequent Figures, Control= no fish; Consumptive=actively foraging fish; EDC=essence of dying caddisflies; and Non-consumptive=caged fish. The overall analysis was significant ($F_{3,16}= 3.435$; $P=0.0423$), and bars above means connected treatment that do not differ based on post-hoc multiple comparisons test ($P > 0.05$).

I used a one-way *ANOVA* for comparing the treatments with mass loss. Detrital mass loss in the control and consumptive experiments was lower compared to the essence of dead caddisflies (EDC) and non-consumptive experiments (Fig. 3). However there seemed to be no relationship between the control vs. consumptive (Fig. 3).

Survivor ANOVA analysis

Caddisfly survival varied among treatments ($F_{2,12}=9.612$; $P=0.032$) and was lowest in the consumptive treatment, intermediate in the EDC and highest in the non- consumptive treatment (individual mean differences based on post-hoc multiple comparisons test; $P < 0.05$; Fig. 4).

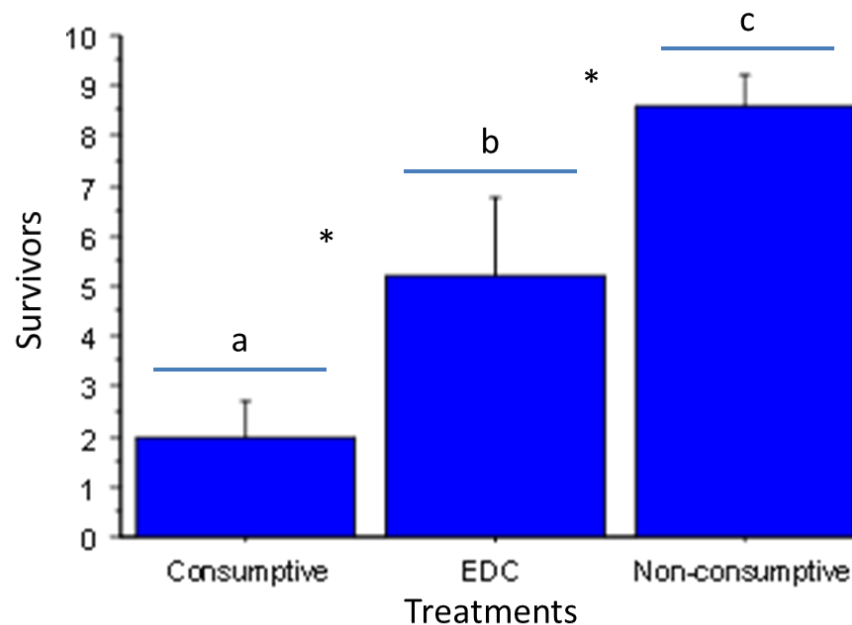


Fig. 4: Mean ($\pm$ S.E) total number of survivors in various treatments. Data suggest there is a positive relationship among each of the treatments based off post-hoc multiple comparisons test ($P < 0.05$).

There were no relationships between treatments.

Mass loss vs. survivors

At first glance it appeared that the detritus mass loss increased as the number of caddisfly survivors increased. However there was no statistical relationship between mass loss and survivors ($F_{1,13}=3.291$; $P=0.092$; Fig. 5)

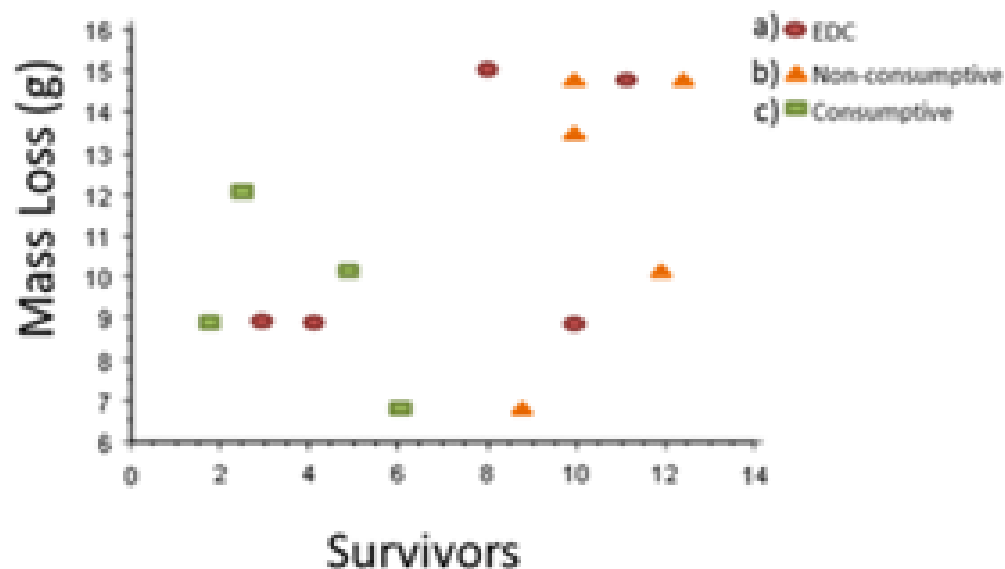


Fig. 5: mass loss as a fraction of the number of survivors at the end of the experiment; a) represents essence of dead caddisflies, b) represents the non-consumptive and c) represents the consumptive experiment.

Chlorophyll- α results

A one-way ANOVA was used to determine the results for the chlorophyll- α levels in each treatment. There was more chlorophyll- α (mg/cm²) production in the non-consumptive and EDC vs. the consumptive and control experiment (Fig. 6).

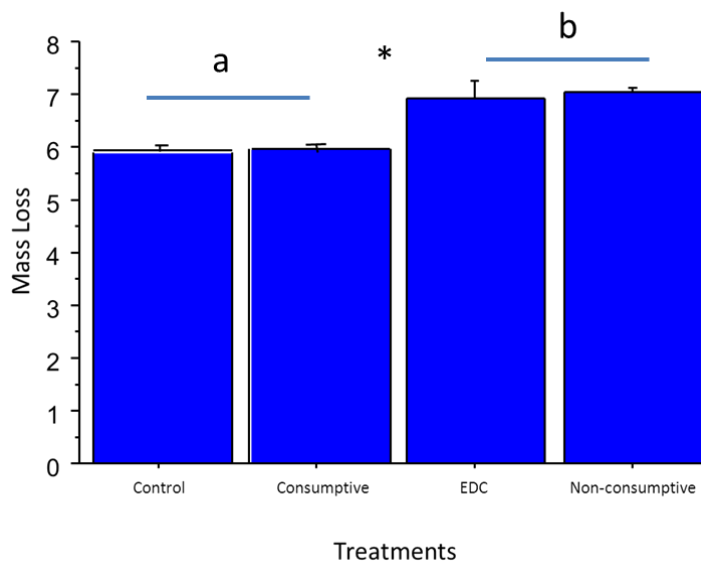


Fig. 6: Mean ($\pm$ S.E) chlorophyll- α production among consumptive and non-consumptive treatments. Overall analysis was significant ($F_{3,15}=8.119$; $P=0.002$) based on post-hoc multiple comparisons test ($P > 0.05$).

Chlorophyll- α vs. survivors

The trend suggested, as the caddisflies survivors increased the chlorophyll- α (mg/cm²) increased and there was a positive relationship between the survivors and chlorophyll- α ($F_{1,13}=12.12$; $P=0.004$; Fig.8).

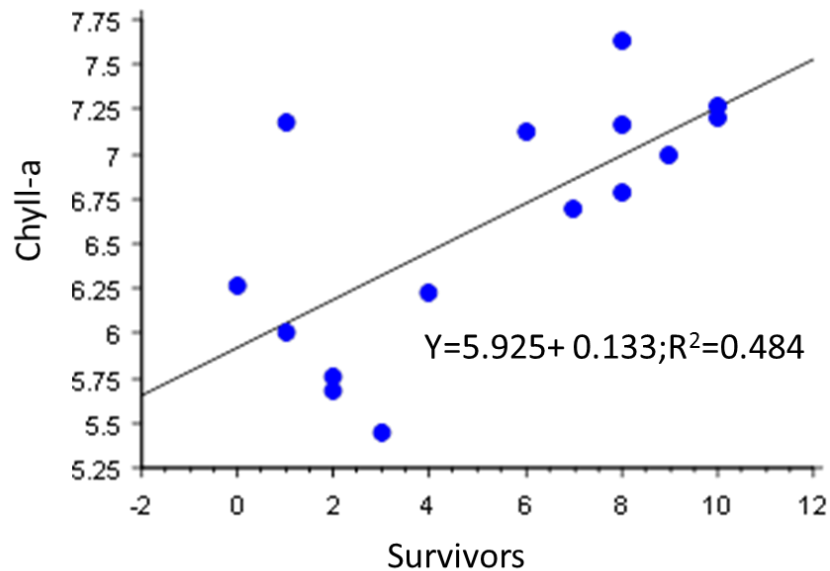


Fig. 7: Regression showing a positive relationship between chlorophyll- α and caddisfly survivors.

Chlorophyll- α vs. mass loss

At first glance, it appears that chlorophyll- α (mg/cm²) increased as the detrital mass loss increased and there was a positive relationship between chlorophyll- α and mass loss ($F_{1,17}=5.833$; $P=0.027$; Fig.9).

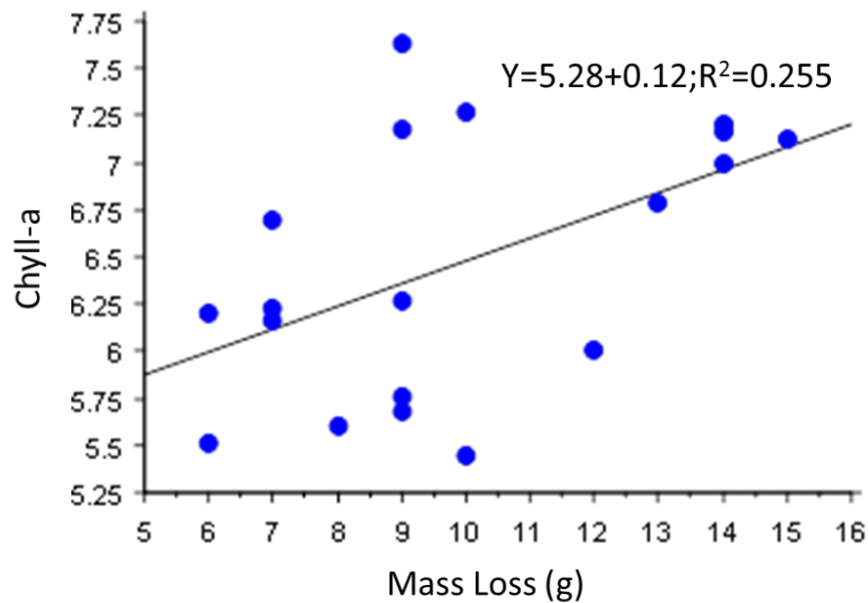


Fig. 8: Regression representing the relationship between detritus mass loss and chlorophyll-*a*.

Discussion

Treatment effects on caddisfly activity (mass loss)

When comparing the mass loss among the different treatments in my experiment, I observed that detritus breakdown was lowest in the consumptive & control treatments (Fig. 3). For the control I did not expect detritus breakdown to be any higher than the rest of my treatments considering the fact that there were no caddisflies within my control tanks. Within the consumptive experiment, fish were able to roam around the tank and consume caddisflies. This result is consistent with a previous study in which increased caddisfly density caused an increase in the detritus breakdown and less detritus breakdown occurred when caddisfly density decreased (Klemmer et al. 2012). So the rate of detritus breakdown decreased as the number of caddisflies decreased. Even though consumptive and control experiments had the lowest amounts of mass loss, there was no relationship among the two treatments (Fig. 3). This means that the caddisfly activity was unaffected by the olfactory cues or consumption by fish. This outcome was also

observed in a previous study where there was no detectable effects on invertebrate activity when the prey was exposed to caged/cage-less salamander predators (Greig and Wissinger 2013). However these invertebrates lived in a temporary habitat while my caddisflyflies came from a permanent habitat.

Treatment effects on survivability of caddisflies

Pumpkinseed sunfish mainly consume insects, crustaceans and gastropods (Carlander, 1977), so it is perhaps not surprising that caddisflies had the highest mortality in the consumptive experiment. However, it is a bit surprising given the size of the caddisfly cases relative to the fish I used in this experiment (Fig. 10).



Fig. 9: Comparison between a caddisfly casing and the fish used in my consumptive experiment. The case is composed of organic material, primarily detritus.

The high rate of mortality in the fish treatment suggested that the cases of *Nemotaulius ocellifera* are not completely effective at eliminating fish predation. Material used in caddisfly case construction is divided into two categories: organic and mineral (Otto et al. 1980). Mineral cases offer more protection because they are made of harder material (rocks and twigs), however they

take more time and energy to make (Otto et al. 1980). Since my caddisflies only had detritus in their habitats, they could only make organic cases, which did not reduce predation. However in a previous study, looking at variations in morphology of caddisfly cases, organic cases provided camouflage against predators, which lowered predation rates (Otto et al. 1980). Since there were survivors from my consumptive treatment, the organic cases may have provided camouflage against the fish.

The non-consumptive experiment had more survivors than the consumptive and the EDC experiments, however there seemed to be a decrease in caddisflies in some of my non-consumptive replications (Appendix A). In the beginning of my experiment I placed 10 caddisflies into each tank. When I collected the caddisflies, on average, there were eight survivors. This meant that on average, two of the caddisflies died from natural mortality. This also led me to believe that there may have been cannibalism involved. Intraspecific competition and cannibalism can reduce victim growth, survival and population size (Wissinger et al. 2010). However this can also cause the remaining caddisflies to develop faster because there are more resources available. One example of cannibalism would be in dragonfly larvae, where the oldest stage of larvae was stronger than the earlier stages (Wissinger et al. 2010).

Survivability vs. mass loss

The regression plot of survivors and mass loss showed no relationship between the two variables (Fig. 5). This could be a result of the caddisflies being subjected to both predators and natural mortality. When there are limitations on intraspecific resources, this could induce agonistic behavior among the caddisflies (Klemmer et al. 2012). This would explain why the EDC treatment also displayed low numbers of survivors.

Effects of chlorophyll- α due to treatment

There was less chlorophyll- α (mg/cm²) collected from the consumptive vs. the non-consumptive treatment. The other three factors that contributed to chlorophyll- α production (besides treatments) were caddisfly survivors, mass loss and remaining detritus. There was a positive relationship between chlorophyll- α and caddisflies survivors, where I observed that chlorophyll- α levels increased as more caddisflies survived the experiment (Fig. 8). The same result was observed in Klemmer's study where nitrogen (C:N) and phosphorous (C:P) in unprocessed detritus increased with increasing caddisfly density (Klemmer et al. 2012). Mass loss vs. chlorophyll- α also showed a positive relationship (Fig. 9). Ninety-five percent of caddisfly diets are composed of microbial detritus and as more of this substrate gets broken down, the more nutrients (ammonium; NH_4^+) are released into the water (Klemmer et al. 2012). Within the regression plot for chlorophyll- α and remaining detritus, there was negative relationship, where chlorophyll- α decreased as the remaining detritus increased (Fig. 7).

Effects on caddisflies on ecosystem processes

As found in previous studies (Klemmer et al. 2012, Thornton and Wissinger unpublished 2013), between-treatment differences in the abundance of caddisflies affected detritus processing rates (Fig. 5), nutrient availability (not measured), and hence algal growth (Fig. 7,8).

The experiment that had the most remaining detritus was in the consumptive experiment (Appendix A). Since the consumptive experiments allowed fish to consume caddisflies, there were less survivors which resulted in less detrital breakdown. This would explain why chlorophyll- α levels were lower in the consumptive vs. the non-consumptive experiment. The only caddisflies that survived the experiment could have hidden themselves or grew to a size where the predator fish could not consume the caddisflies (Fig. 10). Stressful environments can

result in trade-offs where the prey species will increase their resistance against biotic reactions instead of their resource use (Greig and Wissinger 2013).

Another factor that may have contributed to the differences in chlorophyll- α was that caddisflies could have consumed the algae. Algae is another important food source for marsh yinsects including caddisflies (Batzner and Wissinger 1996). In previous studies (Klemmer et al. 2012), tiles (6.5cm² area) were placed into cages to keep caddisflies out, but in my experiment the tiles were not in cages. During periods where caddisfly densities are high, this limits the amount of available detrital resources (Klemmer et al. 2012). Therefore the nutrient release associated with detritus processing that stimulates algal productivity is outpaced by the rate at which the caddisflies consumed that same algae. This was an exciting discovery because this could mean that algal growth might have been larger than what was measured at the end of the experiment.

Conclusion

In my study, the data did support my hypothesis that caddisfly detritus processing (measured with detritus mass loss) increased in the absence of predatory fish (non-consumptive treatment). However the multiple comparisons test led me to believe that there was no difference in detritus breakdown among the control and consumptive treatments. This meant that caddisflies are unaffected by both olfactory cues or actively foraging fish. Increased caddisfly foraging also resulted in increased ecosystem processes (algal quantification) because of the release of detritus bound nutrients (N and P). The active fish (consumptive) treatment showed an overall decrease in caddisfly foraging because there was a decrease in caddisfly numbers. However there was no relationship between caddisfly survival and mass loss. Consumptive treatment also resulted in decreased ecosystem processes. The caddisfly species, *Nemotaulis ocellifera*, used organic cases

throughout the whole experiment but if they were to construct mineral casings, then perhaps more caddisflies would have survived. In the future, I suggest using a different caddisfly species, preferably one that construct mineral cases during instar larvae development. This will provide new information on how mineral-cased caddisfly foraging is altered by predatory fish interactions.

Appendix A: Table recording fine grained (D_f), detrital mass loss and total number of survivors in each replication.

Tanks	Treatment	Fine grained (D_f)	Mass Loss	Survivors
1	consumptive	13g	7g	4
2	consumptive	10g	10g	3
3	consumptive	8g	12g	1
4	consumptive	11g	9g	2
4	consumptive	11g	9g	0
6	Non-consumptive	10g	10g	10
7	Non-consumptive	6g	14g	10
8	Non-consumptive	13g	7g	7
9	Non-consumptive	6g	14g	8
10	Non-consumptive	7g	13g	8
11	Dead Caddis ess.	11g	9g	2
12	Dead Caddis ess.	5g	15g	8
13	Dead Caddis ess.	6g	14g	9
14	Dead Caddis ess.	5g	15g	6
15	Dead Caddis ess.	11g	9g	1
16	Control	14g	6g	N/A
17	Control	12g	8g	N/A
18	Control	11g	9g	N/A
19	Control	13g	7g	N/A
20	Control	14g	6g	N/A
21	Control N+P			N/A
22	Control N+P			N/A

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