UBC Social, Ecological Economic Development Studies (SEEDS) Student Report

Black Soldier Fly: Phase 1 Accomplishments, Challenges and Hopes

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The objective of Phase One (10 May- 22 July 2010) is to establish a stable colony of Black Soldier Flies, with a combination of both lab and field work.

My Understanding of Black Soldier Flies

Black Soldier Flies, or *Hermetia illucens,* are not only a widespread and common member of the *Stratiomyidae* family, but are well known mostly for their unique attributes that give them the ability to reduce organic residue. Studying this ability is the key focus of this Directed Studies project. But it does not stop there. Black Soldier Flies are also commonly used in manure management (where they not only reduce the amount of manure, but also control and reduce local house fly populations), used as live pet food for reptiles, amphibians, and fish, and even forensic entomology.

Appearance.

The eggs of *H. illucens* are oval shaped and about 1 mm in length. They are pale yellow or creamy white in colour.

Larvae are a dull whitish or beige colour, with chewing mouthparts on their small projecting heads. Larvae can reach approximately 27 mm in length and 6 mm in length. Female larvae tend to exceed male larvae in size by approximately one-third.

Pupa are a dark coffee bean brown, and slightly smaller than larvae. They are non-moving, but respond to touch.

Black soldier fly adults are often described as mimics of organ pipe mud daubers, due to their close appearance in size and colour. Black soldier flies are often described as 'wasp-like' due to their narrow waspish waist, but important differences between soldier flies and wasps include wasps have four wings while BSF have only two and BSF lack a stinger. They range from 15-20 mm in length, with females tending to be larger than males. The antennae of BSF adults are elongated and have three segments; the ends of their legs have a unique white colouration that is visible in the above photo.

Black Soldier Flies and Composting

Utilizing BSF to reduce organic residue, and thus reduce the amount of material that needs to be composted (which has an associated cost) is the main objective of this entire project. Because of this, I decided to take a few moments to outline exactly why BSF are so ideal at reducing foodstuff.

Why are BSF so ideal for composting?

- ***BSF larvae can consume large amounts of compost straight away.***

Their large, powerful mouthparts allow BSF larvae to shred and devour fresh organic material immediately (without a need for pre-decomposition). Thus odor is greatly reduced since there is no need to allow large amounts of waste material to sit around, ferment (and stink!) before BSF can get in to do their job. Experts have estimated that BSF larvae can reduce food and waste materials by ~75%. Other estimates range as high as 95%. BSF larvae target mainly the protein and fat (not cellulose) within the waste material, and even have the ability to improve the organic waste in to a rich fertilizer (which presumably could be sold or used on a farm). BSF larvae can also be easily and economically transported to wherever they are needed.

- ***Adult BSF are not associated with disease transmission.***

Adults do not have functional mouthparts and therefore do not feed or bite. They dislike entering enclosed spaces and have a short life span of only 5-8 days. Therefore, even when raising hundreds of thousands of BSF, one need not worry about disease transmission (or them invading your house).

- ***The presence of BSF reduces the populations of pest flies in the area.***

As BSF larvae ingest manure, they churn it, causing the manure becomes more liquefied. Thus making the manure to become less suitable for pest flies to lay their eggs in, as well as the development of pest

fly larvae. Therefore BSF naturally control pest fly (e.g. the house fly) populations which *are* vectors for diseases transmission. So while getting rid of your food and wastes, you get the added bonus of reducing the amount of pesky flies in your area, on top of lowering the chances of disease transmission!

- ***BSF larvae can extend their life stage under conditions of stress.***

A typical BSF larval stage lasts approximately 2 weeks. But under conditions of stress, BSF larvae are able to extend this stage. This is significant because the larval stage is the only feeding stage in the life cycle, which means BSF larvae are the ones consuming the waste material. Their natural ability to extend this life stage means that a lesser number of BSF larvae can be used to consume a larger amount of organic material.

- ***BSF larvae not only reduce the amount of compost present but also the amount of nitrogen within the compost.***

It is estimated that BSF larvae can reduce the total [N] in the waste material by 62%. This is significant since excess, untreated Nitrogen is a common contaminant of water supplies. Also, by reducing the amount of manure present in an area, BSF larvae presumably also reduce methane formation (which is 23x more potent than carbon as a greenhouse gas) and off-gassing. Big industries may wish to use them to earn carbon sequestration credits. This would be something very interesting for someone to research that could potentially yield great economic benefits as well as (perhaps more importantly) benefit our planet Earth.

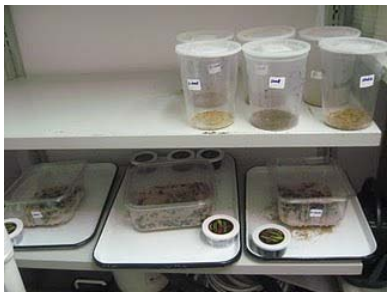
- ***BSF Larvae can also be used as pet food.***

BSF larvae are quite nutritious; their bodies contain 42% protein and 35% fat, including essential amino acids and fatty acids. This makes them a great food source for birds, reptiles, amphibians, fish and livestock. The high calcium content of the larvae is said to prevent or halt metabolic bone disease.

Methodology and Problems Faced

Our first shipment of BSF larvae arrived on 28 May 2010. By the 4th of June, we had a 100% mortality. First I will discuss our methodology, and next how we changed our methodology due the issues that we faced.

Our first shipment of BSF larvae consisted of 900 total larvae, with 300 each of extra-small, small, and medium sized larvae. The larvae were sorted by size, in to three separate yogurt containers, along with their food. Next, after a failed dumpster diving excursion, I obtained 3 plastic containers from Nancy (from the insect room), which I prepared by cutting five 1cm by 1cm holes in to the bottom of each. I next covered the holes with a medium-fine mesh and sliced a green Styrofoam block in to cubes that would lift the plastic containers off the ground for the purpose of ventilation. Problem #1 occurred when I discovered BSF are extremely adept escape artists, and that I would have to replace the medium mesh with an extremely fine mesh. Luckily, I made this discovery before any BSF larvae were transferred. Below is a photo of the set-up within the insect collection room on the 2nd floor of LSF. The larvae stayed within the yogurt containers in the insect collection room, with a temperature of 23C, and humidity of 48%. A more ideal temperature would be 28C; a more ideal humidity would be greater than 75%.



The 900 BSF larvae were transferred from the yogurt containers (on the top shelf) to the larger plastic containers (on the bottom shelf) on the 1st of June. These plastic containers were placed inside Growth Chamber #4 on the ground level of LSF. The temperature on the Growth Chamber was set at 27C (with a range of 10C), and the humidity was set at 75%. Four large pans of water were placed in the Growth Chamber to increase the humidity. At this point, I was aware that there seemed to be an issue with the humidity gauge but was hoping the four pans of water would suffice.

The BSF were on a combination diet of the Phoenix Worms BSF food, as well as 2 tablespoons of coffee grounds (from the LSF lounge) per day.

When I checked the BSF just a day later, the news was not good. Only one-third of the extra-small maggots had survived and those that had survived were quite sluggish. The medium-sized maggots fared the best, with seemingly no mortalities, while approximately fifty percent of the small maggots survived. The conditions of the Growth Chamber were kept the same.

Upon checking the BSF larvae on 4 June, it was apparent that we had a 100% mortality. It was then discovered that controlling humidity within the growth chamber is very difficult, and somewhat

unreliable. A humidity of greater than 50% is vital for BSF survival; the gauge inside the Growth Chamber read 33%, which is fatal.

While our first attempt at yielding BSF larvae was unsuccessful, it was not in vain. Important changes were made to our experimental set-up. First, the larvae were to be kept in the insect collection room, as the inability for the Growth Chamber to maintain a high level of humidity was too large of a risk to take. Next, we ordered only medium-sized larvae, as the smaller larvae seemed to be more fragile than the mediums. Also, BSF are photophobic, so from now on, their container will be covered. While in the Growth Chamber during our first attempt, they were exposed to full light, and this very likely contributed to their demise. We also arranged for UBC Farm to donate chicken feed, which is much more balanced and nutritious for BSF than coffee grounds.

To begin our second attempt, Rylo ordered 600 medium-sized BSF larvae. They arrived on 17 June, while I was away at my grandmother's house. Again, these larvae were kept in the insect collection room, which had a temperature of 25C, and a humidity of 48%. They were placed in a single yogurt container, along with a wet paper towel for increased humidity. The yogurt container was placed within a cardboard box, which further shielded the young BSF maggots from the dim light of the room.

This time, the experiment progressed much more nicely- the maggots seemed much more active than the previous order, and were consuming the chicken feed (thus maturing and darkening much faster) much more rapidly than the coffee grounds. A small issue that we initially encountered was that the dry chicken feed seemed to significantly decrease the humidity of the yogurt container; this was easily fixed by soaking the chicken feed before feeding it to the BSF larvae.

Then a much larger issue was encountered. The biopod, which was supposed to have arrived the same day as the maggots (17 June) was stuck at customs at the US/Canada border for over three weeks. With our maggots maturing so quickly, it was essential to have the biopod so mature maggots could crawl off in to a collection bucket, where they would be rewarded with drier, more ideal conditions.

Then came July 7th, a day that was great for more than one reason. First, the pod arrived from customs. Next, when opening the yogurt container, I was greeted by the pleasant sight of two fully formed male adults! In the next few days, I took the adults, as well as a larva and pupa to the LSF Learning Centre to have professional photographs taken. They are present below:



The pod was immediately placed inside of the Growth Chamber, but no BSF larvae were transferred yet. Over the next two weeks, I manually sorted the pupa from the larvae, placing the pupa in a separate container with dry bran and a slightly moist paper towel. Meanwhile, Rylo and I experimented with the Growth Chamber. We set up an aquarium, filled it with water, and added a heater. We believed that this would act as a control for both temperature and humidity, and would allow for relatively steady conditions. But on July 19th, we discovered that the humidity in the Growth Chamber is just too difficult to control- when the temperature is raised (to around 30C), the fan/chiller within the Growth Chamber kicks in, which very quickly brings the humidity down to 33%. We memorably learned that this was fatal for BSF, with our first shipment having complete, 100% mortality. At this point, it was officially decided that the BSF would never be transferred to the Growth Chamber (except perhaps, if it could be manipulated to be used as an overwintering chamber), and would remain in the insect collection room. On the 21st of July, the pod was brought to UBC Farm, and placed in the shade beside the Administrative Building. Our 600 BSF larvae/pupa were immediately transferred in to this pod.

From this time on, there has been almost nothing but tribulation. As of the 27th of July (which I realize is not supposed to be within the scope of this report, but is just too exciting to exclude), we officially have one adult female, and five adult males. They are staying around the area of the pod, and hopefully within the next week, I will be able to report on my blog that I have found eggs!

Here is my logic that I used while calculating the estimated number of hours that I have worked on this project since the end of May: I have checked on the BSF approximately three times per week, and spent about 2.5 hours each time in the lab/insect collection room. This gives an estimate of about sixty hours worked. Adding in a few eight-hour days that I spent creating modifications, the estimate increases to about seventy-six hours worked. With nineteen posts on my blog, and each post taking an average of thirty minutes, this adds an additional nine and one-half hours, for a total of approximately eighty-five and one-half hours.

Future Projects

- **The SUB RECOURSE System:** This fall (2010), Rylo and I will introduce a BSF/worm module to the SUB that will greatly reduce the amount of foodstuff that is put in to the composting machine. With over one million dollars per year in operating costs, right now the composting machine has a hefty price tag. By implementing a BSF/worm module in to the composting system at the SUB, Rylo and I hope to dramatically reduce the amount of organic residue that enters the composting machine, thus extending its life by a great extent, and lowering the overall cost that is spent on composting in the SUB.
- **The Doggie Doo/Rat Trap:** Quite an interesting idea. I have to give Rylo the credit for this one. He had the idea of building a contraption approximately the size of a large garbage can. This contraption would be placed for the large part in parks, as well as dog day cares. One side would have a small opening on top for dog owners to place their pet's excrement. The BSF maggots within the machine would consume the dog waste, thus eliminating the need for companies to haul away the massive amount of waste that dogs create each year. Rylo's friend owns a dog day care, and reportedly said that she pays someone $200/month to haul away dog waste. But the garbage bag full of dog waste sits and festers for one full week before it is even picked up.

  The Rat Trap would be the other side of the machine. There would have to be a way for a wild rat to enter from ground level, and be killed and afterwards consumed by BSF larvae. Rat infestation is becoming a growing issue in places such as the Granville Island area, and this would be a proposed solution.

- **BSF as live food for reptiles, amphibians, birds, and livestock.** With their high calcium content and nutrition levels, BSF larvae are considered to be a very good food option for these animals. Perhaps contracts with the Vancouver Aquarium, local farmers, and the Vancouver Zoo could prove feasible.
- **Disaster Aid.** A small, easy-to-ship box with a culture of BSF larvae could be shipped to a country or city that has just experienced a severe natural disaster. Waste management and water contamination tend to be huge issues during these disasters, as exemplified by Haiti. As stated earlier in this report, BSF can greatly reduce foodstuff as well as manure which would also reduce the potential for water contamination.

The potential for this BSF Directed Studies Project are almost endless. Thus far, I am more than content with the progress that we have made, as a team. With six healthy adults currently at UBC Farm, we are potentially on our way to establishing a stable, sustainable BSF colony. The next step is to implement the RECOURSE system in to the SUB, thus proving the ability of BSF to reduce foodstuff. While officially this Directed Studies course ends at the end of August, it has truly become something that is very important to me, and something that I will stick with until the above projects are realized.