

## An Introduction to the Black Soldier Fly, *Hermetia illucens*

A mass of wiggling larvae is not what one expects to see in a carefully maintained home compost bin...or is it? Maggots, the larvae of houseflies, *are* pests, but there are other flies that are attracted to decaying organic matter. For the conscientious composter, the surprise guests are likely to be the Black Soldier Fly, *Hermetia illucens*. While it could be mistaken for a wasp, *Hermetia illucens* is not a nuisance and does not bite (DiClaro & Kaufman, 2021). The internet is abuzz with farmers, researchers, and composters talking about this amazing and beneficial insect. In fact, the name Black Soldier Fly is fast becoming a household word (Hauser & Woodley, 2015).

### **Nature's Super Composters**

Black soldier flies (BSF) can break down enormous amounts of organic material. Plus, they multiply quickly. BSF do not spread disease or damage crops, and they outcompete insect pests by consuming their eggs (Holtermans, 2024). While eating waste and getting plump, BSFL are removing toxins from the materials they consume (Liu et al., 2019). In addition, Black Soldier Fly Larvae (BSFL) are full of protein and fats, which make them an excellent feed source for animals, and potentially for humans (Wang & Shelomi,

2017). These are the reasons why black soldier flies are being recruited worldwide to help solve environmental challenges big and small.

With all they have to offer, it is good news that black soldier flies are cosmopolitan. It is believed that they originated in Central America, then began to spread throughout North America in the 1800's (Hauser & Woodley, 2015). They were documented in Europe in the 1920's (Kaya et al., 2021). Traveling along trade routes, it is estimated that they reached their current distribution by the 1960's (Hauser & Woodley, 2015). In current times, BSF are simply transported wherever they are needed (Kaya et al., 2021).

### **Lifecycle and Behaviors**

Black soldier flies are saprophytic, meaning that they “obtain nourishment from the products of organic breakdown and decay” (Merriam-Webster.com, 2024). Accordingly, they have thrived with the large amount of organic waste available in current times. For instance, worldwide each year, over 1000 million tons of food are wasted (UNEP Food Waste Index Report for 2024), and 3.7 million tons of animal feces is produced (Berendes et al., 2018). BSF lay about 500 eggs at a time, in or near moist decaying matter. They are attracted to places where organic material is collected as well as pastures dotted with dung.

BSF are members of the superphylum, Ecdysozoa. “All ectdysozoans grow intermittently by molting- that is, by shedding an exoskeleton or external covering” (Freeman et al., 2017, p 644). The period between molting events is called an instar. BSFL

spend 14 days moving through six instars before entering a pupae stage, after which they become adults (DiClaro & Kaufman, 2021). They do all their voracious eating during the larval period. Just before becoming pupae, they migrate away from the food source to dryer areas. This tendency is used by farmers to harvest them. It is simply a matter of providing a ramp for them to climb, and a bucket for them to drop into at the end of the ramp (Giannetti et al., 2022). Adult black soldier flies may drink, but do not eat; when they fly, they make a loud buzzing sound (DiClaro & Kaufman, 2021).

## **A Growing Market**

Industry has been growing up around black soldier flies. “The global black soldier fly market size was evaluated at \$315 million in 2023 and is slated to hit \$917 million by the end of 2032” (Zion Market Research, 2023). A literature review from 2019 provides insight into why industry finds the black soldier fly so attractive:

*H. illucens* can be applied in environmental ecology and as an effective treatment for organic waste. Due to its broad feeding range, many types of organic waste (such as kitchen waste, livestock excrement, deteriorated fruits and vegetables, crop waste, and food-processing waste) can be converted into proteins, lipids, peptides, amino acids, chitin, vitamins, and polypides. The proteins and amino acids have been used to produce aquaculture feed and feedstuffs with high digestibility. In addition, grease from *H. illucens* digestion has been successfully used as a raw

material for biodiesel with good performance. Furthermore, the antimicrobial peptides and chitin extracted from *H. illucens* have high medicinal value (Liu et al, 2019).

## **Research To Anticipate Disease**

The increasing economic value of BSF is attracting the attention of researchers worldwide as they seek to identify BSF's susceptibility to disease. A study of the BSF mitochondrial genome discovered that there are 52 haplotypes across five continents, yet there is little genetic diversity among commercially employed stocks (Gulliet et al., 2022). The genetic similarity of BSF utilized industrially is cause for concern. A virus could do serious economic damage if it spread through the BSF population. As of the writing of this paper, there are no reports of illness among BSF, and they are considered very resilient (Jensen & Lecocq, 2023). Yet, research has revealed that there are some viruses BSF may be susceptible to, (Walt et al., 2023) and that they have been hit with serious viruses in the past (Pienaar et al., 2022). In addition to viruses, threats from bacteria, fungi and nematodes are being investigated (Jensen & Lecocq, 2023).

## **Environmental Benefits**

It is during the larval stages that the black soldier fly does its environmentally beneficial work. For instance, their gut microbiota can remove dangerous components

from animal manure. Manure from farm animals can contain antibiotic resistant genes (ARGs). When naturally-occurring bacteria are exposed to ARGs, they can gain resistance to antibiotics (Cai et al., 2018; Zhao et al., 2023). A 2018 study examined how BSFL would impact ARG levels in chicken manure. In just twelve days, over 90% of the ARGs were removed (Cai et al., 2018). Another study from 2023 found comparable results with swine manure (Zhao et al., 2023).

As BSFL move through their six instars they generate “frass” a combination of exoskeletons and excretions that make an outstanding fertilizer (Lopes et al., 2022). A 2023 study took a close look at the process of generating compost containing BSFL frass and applying it to the growing of maize. They found it highly effective: a “2 % application had optimal enhancing impacts on the height and weight, root activity, total phosphorus and net photosynthetic rate of maize seedling” (Wu et al., 2023).

Scientists are exploring many other ways that *Hermetia illucens* can benefit the environment. When they are given sewage sludge to eat, they can upcycle the minerals it contains (Seyedalmoosavi et al., 2023). They can process organic leachates, which would otherwise pollute groundwater (Popa & Green, 2012). In contaminated soils they perform entomoremediation, cleaning the soil (Bulak et al., 2018). BSFL can even be used as a milk substitute for young goats, offering a nutritious and cost-effective means of providing extra nutrition (Astuti & Wiryawan, 2022). Researchers continue to shed light on the boundless opportunities for leveraging the powers of *Hermetia illucens*.

## **Taking Care of Our Partner**

The Black Soldier Fly is an excellent partner as humanity works towards solutions to a variety of environmental problems. As interest in BSF grows, the focus is primarily on what they can do. How they are treated is also important. A 2022 literature review found that there is a need for further investigation into the welfare of BSFs subjected to mass farming practices (Barrett et al., 2022). A wasteful and human-centered approach to resources does not serve us well environmentally. With the myriad benefits humanity is gaining from black soldier flies, it is appropriate to consider what is required to provide them with humane treatment. For instance, a 2024 study examined which means of BSFL slaughter was most instantaneous (Barrett et al., 2024). Approaching all of nature's resources with respect, including insects like *Hermetia illucens*, is a positive step into a sustainable future.

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