UNDERSTANDING THE REPRODUCTION OF *HERMETIA ILLUCENS* UNDER VARIOUS CONDITIONS

Insect Genetic IMProvement, IMPlementation, IMPact

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ABSTRACT

The aim of this review is to examine in detail the reproductive behavior of the Black Soldier Fly (BSF) under different conditions.

BSF *Hermetia illucens* (L.) (Diptera: Stratiomyidae), which inhabits tropical, subtropical, and warm temperate regions, has emerged as a promising option for industries such as food, feed, fertilizer, and biofuel. This fly, which can be easily reared on various waste materials, is considered an alternative protein source due to its richness in protein and fat. It is easy to rear, and compared to many other insect species, BSF grows rapidly. However, the most critical processes in mass-rearing BSF involve obtaining large amounts of organic matter, ensuring consistent larval production, and producing eggs efficiently in both quantity and quality to maintain a stable progeny.

BSF reproduction consists of two stages: mating and egg-laying. In tropical regions, BSF mates continuously under natural conditions, while in warm temperate regions, it mates a few times per year. Two days after mating, females become ready to lay eggs, triggered by the release of volatile organic compounds from decaying organic matter. Eggs are deposited in dry crevices near a moist food source. Studies in the literature have examined BSF reproduction in natural habitats, using semi-artificial (greenhouse regulated by sunlight) and artificial breeding methods (i.e., rooms regulated by artificial light). Both mating and egg-laying are influenced by environmental conditions such as light, humidity, and temperature. Seasonal changes, particularly the intensity of sunlight, affect the number of mating events. Additionally, the sex ratio and population density impact BSF reproduction.

In conclusion, environmental and biological factors influence BSF reproduction and must be optimized. It can be suggested that stimulating BSF with temperatures above 26°C and optimal light intensity could enhance reproductive and egg-laying efficiency.

Keywords: Insect rearing, Climate effects on livestock, Design of breeding programmes, Growth and development

1. INTRODUCTION

1.1. Black Soldier Fly

Like all other insects, BSF belongs to the Diptera, which are Arthropoda. It is widely found in tropical and warmer climates, especially between latitudes 40°N and 45°S. The BSF goes through five different developmental phases during its roughly 45-day life cycle: egg, larvae, prepupae, pupae, and adult [1,2]. Life cycle of BSF is shown in Figure 1. The industrial applications BSF include producing sustainable fertilizers, animal feed, pet food, fish feed, human food products, and raw materials for cosmetics and bioplastics, offering eco-friendly solutions for waste management and resource recycling (Figure 2)

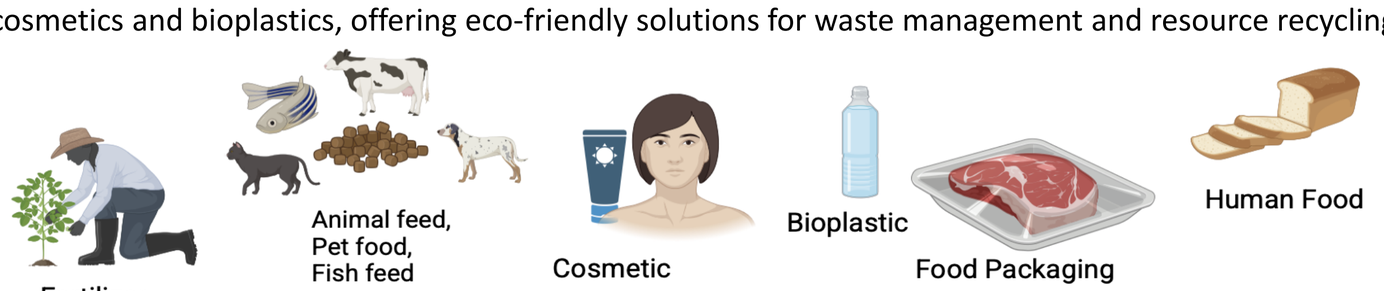

Figure 2. Industrial application of BSF

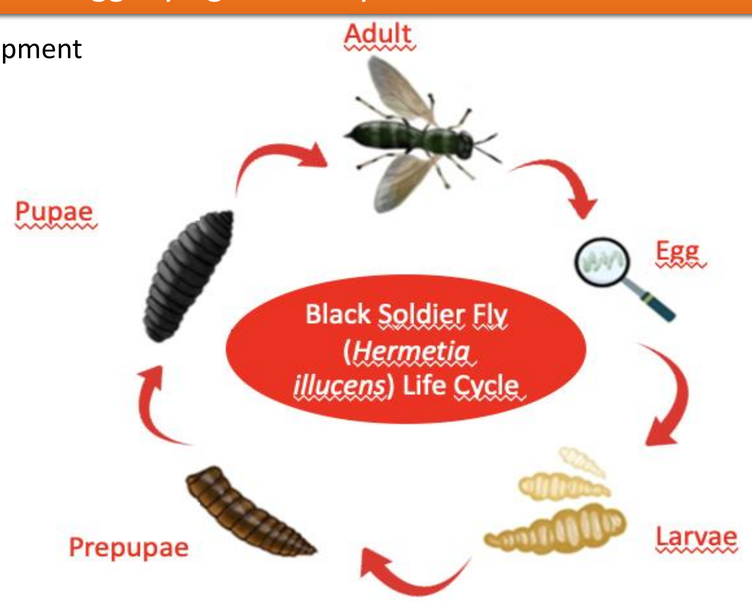

Figure 1. Life cycle of BSF [1,2]

1.2. BSF Reproduction

Mating and **oviposition** are the two stages of H. *illucens* reproduction (Figure 3). Female BSF lay their eggs in spots that are dry and dark after mating. In order to provide hatchlings with easy access to food, the free-roaming BSF prefers to lay its eggs in the cracks of decomposing organic materials. Like other insects, BSF use their smell capabilities to guide their egg-laying. It takes about 20-30 min for female BSF to oviposit, and they prefer dry environments over humid ones. For egg laying, a moisture content range of 60–70% is ideal. When reproducing in captivity, a female BSF reaches this area with the part of her body that lays eggs and starts laying them in a cluster. 300–1000 eggs, each weighing roughly 0.03 mg, make up an egg cluster. After oviposition, fertilized eggs usually hatch four days later [1,3]. The factors effecting on reproduction rate of BSF is given in Table 1.

Table 1. The variables influencing the pace of BSF reproduction

Category	Factor	Impact on Reproduction
🌿 Environmental Factors	Light Intensity	Affects mating events; seasonal variations impact frequency.
	Humidity	Optimal levels enhance egg-laying; affects egg and larva survival.
	Temperature	Influences mating behavior and egg development.
🌿 Biological Factors	Sex Ratio	Balanced ratios improve mating efficiency; skewed ratios reduce it.
	Population Density	Overcrowding reduces efficiency; optimal density improves behavior.
🌿 Seasonal Changes	Sunlight Intensity	Seasonal changes in sunlight directly impact mating frequency.

Four to six days after egg laying, hatching, also known as egg eclosion, is the next most crucial stage of BSF life. **Temperature** of 25- 30°C is necessary for a good hatch. BSF eggs hatched at 16–19°C, although a significant neonatal BSF larval mortality rate was noted. **Relative humidity (RH)** also has an impact on hatching; a RH of greater than 60% is ideal for egg hatching. The egg membrane cannot prevent water loss at low relative humidity (RH < 60%), which causes desiccation and, regrettably, increases mortality. **Light** has an impact on the hatching of the eggs in addition to temperature and relative humidity. When it comes to light sources for BSF raising in captive breeding, LEDs are preferred over fluorescents [4-6].

2. CONCLUSION

In conclusion, the reproduction of BSF is a complex process influenced by both environmental and biological factors that must be carefully optimized to ensure success. Mating and egg-laying are directly affected by abiotic factors such as light intensity, temperature, humidity, and the availability of decaying organic matter, as well as biotic factors like sex ratio, population density, and cage conditions. While BSF can mate continuously in tropical climates, achieving successful reproduction in temperate or artificial settings requires precise control of these factors. Semi-outdoor conditions with full sunlight and temperatures above 26°C have been shown to enhance mating behavior, courtship performance, and egg-laying efficiency. Therefore, tailoring environmental conditions and managing biological parameters are essential for maximizing BSF reproductive performance, making it a key consideration for sustainable BSF farming and industrial applications.

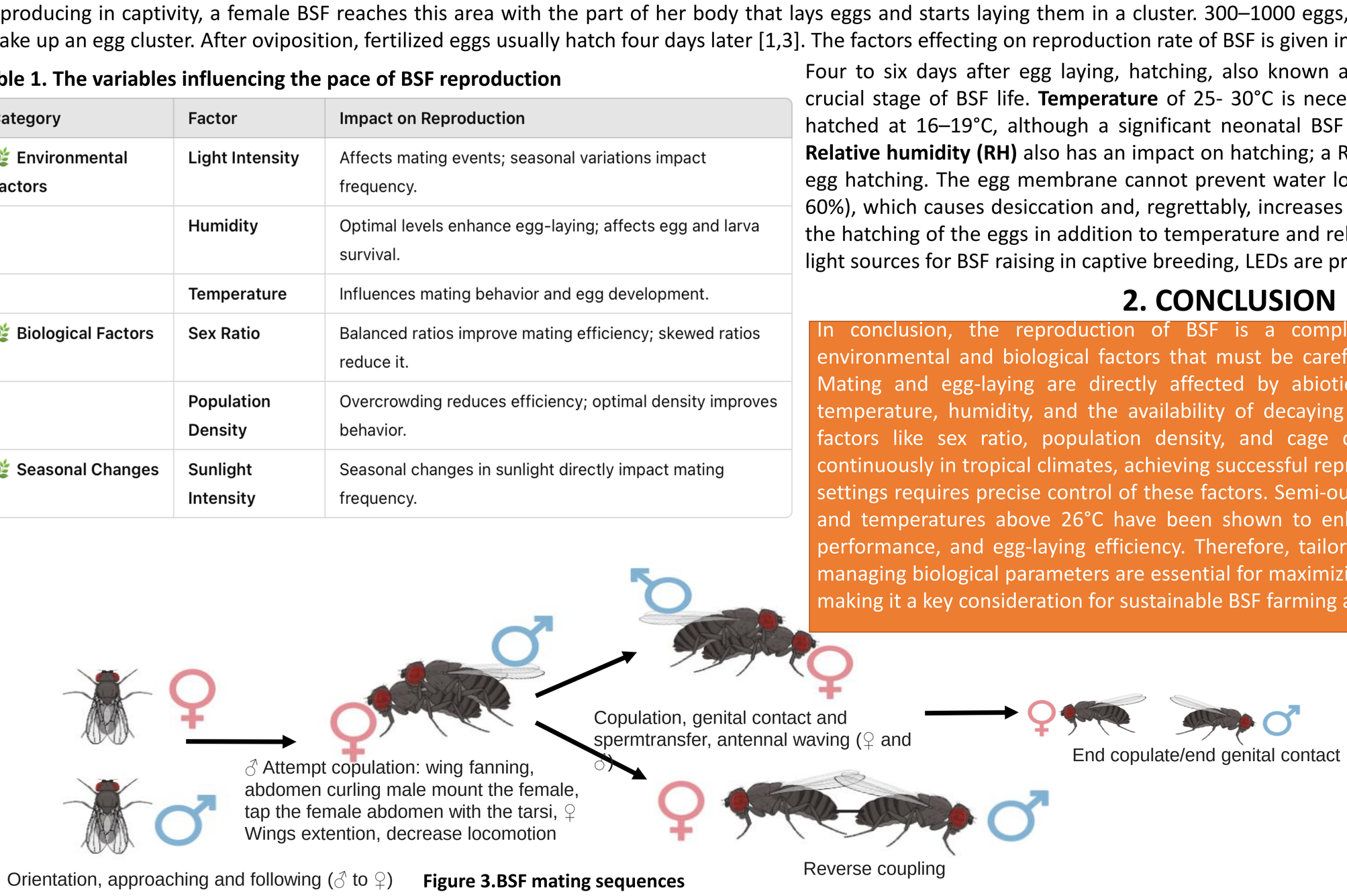

Figure 3.BSF mating sequences

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