Techniques for collecting black soldier fly eggs year-round for use as a promising feed material for fish culture

In rural areas of Laos, fish culture development is strongly encouraged for stabilizing food self-sufficiency as well as animal protein supply. However, feed cost occupies a large portion of total cost in fish culture operations and needs to be reduced. The black soldier fly (BSF, *Hermetia illucens*) is distributed over Laos, and its larvae (Fig. 1) could be a promising feed material for fish culture because of its high protein content. By using the larvae, the feed cost for fish culture is expected to be largely reduced because they can be reared with food residues and livestock manure. Although people in Laos commonly consume a wide range of insects as food, BSF is not included, which means that it has exploitable potential. This study, therefore, aimed at the development of a year-round egg collection technique that can be applied by small-scale farmers. The following findings were obtained:

1. The larvae of BSF contain considerable nutrients (e.g., protein and fat) (Table 1) and are valuable as feed material for fish culture.
2. BSF adults are attracted to outdoor oviposition traps throughout the year; however, the oviposition incidence has large fluctuations, thus periods with scarce oviposition were observed during seasonal occurrence (Fig. 2).
3. Although some reports mentioned that around 1,000 newly-emerged BSF adults must be released in a large net cage (about 2 m on all sides) to obtain fertilized eggs of BSF, it was also observed that oviposition can occur in a smaller-scale system, with 100 adults in a small net cage (27 cm on all sides) as performed in the present study (Fig. 1).
4. Although previous reports mentioned that sunlight and/or a large incandescent lamp, in addition to the large cage, were necessary for oviposition of BSF, the oviposition was observed using other smaller illuminants, e.g., a 40W fluorescent light or a 20W LED light, like in the present study (Table 2). The pre-oviposition periods were 4–5 days, and the oviposition periods lasted approximately 7 days under artificial lights and about 9 days under sunlight/artificial light. The fertilization rates under the latter were relatively higher.
5. Stable production of BSF larvae that is low-cost and space-saving became more feasible with application of the above-mentioned system.

In addition to the above findings, the following observations were noted:

1. Fruit rinds (e.g., water melon) are efficient as attractants, resulting to an influx of incoming BSF adults to the oviposition traps.
2. It is necessary to clarify the number of ovoposition events/ mating frequency of BSF adults during its lifetime to improve the collection of fertilized eggs.
3. The mechanism of enhancing egg fertilization under the sunlight should be studied.
4. This system is applicable not only in Laos but also in other areas / countries.

Fig. 1. A female BSF (upper left), larvae (upper right) and adult BSF in a rearing and egg collection cage made of polyethylene (lower photo)

Table 1. Crude protein, crude fat, and ash contents (% dry weight) in black soldier fly (BSF) larvae and in general commercial feed for fish culture in Lao PDR

Constituent	Content (%)	
	BSF	Fish feed*
Crude protein	67.1	32.0
Crude fat	6.9	4.0
Ash	6.5	–
Others	19.5	74.0

*manufactured by Centago, Thailand

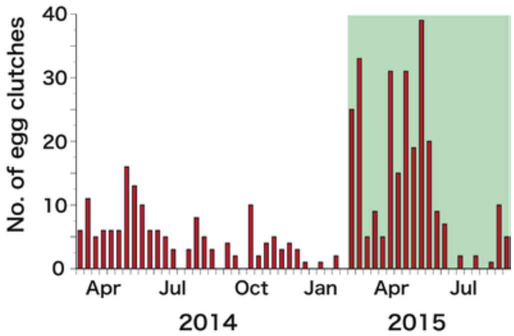

Fig. 2. The number of egg clutches collected at outdoor traps in Laos. (The part shaded in green showed a marked improvement.)

Table 2. Life-history parameters of adult *Hermetia illucens* under different light sources

Life-history parameter	Supplemental light source (mean ± SE)		
	LED lamp only	LED lamp + 2 h sunlight[1)]	
Pre-oviposition period (days)	4.6 ± 0.3	4.4 ± 0.3	
Oviposition period (days)	7.6 ± 0.8	9.4 ± 0.8	
No. of clutches/female	0.43 ± 0.04	0.39 ± 0.04	
No. of hatched clutches/female	0.05 ± 0.03	0.15 ± 0.03	*
Hatchability (%)[2)]	11.2±9.1	39.5±6.3	*
No. of eggs/female	289.0 ± 27.0	240.2 ± 31.6	
No. of hatched eggs/female	43.7 ± 35.8	84.4 ± 19.0	
Male longevity (days)	12.8 ± 0.2	14.1 ± 0.3	*
Female longevity (days)	12.3 ± 0.2	12.7 ± 0.2	

*Difference was significant between light sources (ANOVA, $p<0.05$)

1) Exposed to sunlight between 1000 and 1200 for the first 15 days after emergence as adults (14 out of 15 days had clear weather).

2) Number of hatched clutches/total number of clutches