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A report on positive phototaxis exhibited by newly emerged bagworm caterpillars (Lepidoptera: Psychidae)

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Abstract

The bagworm, *Thyridopteryx ephemeraeformis* (Haworth) (Lepidoptera: Psychidae) is a polyphagous moth that defoliates ornamental shrubs and trees. It has been reported as an emerging pest in the coastal agroecosystem of Odisha, India. A small experiment demonstrated that bagworm's newly emerged larva (NEL) was positively phototactic under white and UV light. After emerging in the rearing box, the larva was exposed to 3 volts of LED white and UV lights. After which, its phototactic behaviour was observed. Considering this report, light traps can be used to catch this nuisance species, which may now be more manageable. Hanging light sources on infested plant branches may be one technique, and when larvae congregate on that area of the branch, it may be easy to remove and kill them.

Keywords: *Thyridopteryx ephemeraeformis*, bagworm, phototaxis, Psychidae, Lepidoptera

Introduction

The bagworm, *Thyridopteryx ephemeraeformis* (Haworth), is a polyphagous moth that defoliates ornamental shrubs and trees. (Jones and Parks 1928). The adult female of this species has vestigial appendages and mouthparts, small eyes, apterous with no antenna. She spends her entire life upside-down inside the bag constructed by the larva during developmental stages (Kaufmann 1968; Neal 1982). On the other hand, males have wings and are diurnal and get attracted to females with a sex-pheromone scent they emit. Females deposit 1-methyl butyl decanoate in the cocoon at the bottom of their larval sack until they mate (Leonhardt et al. 1983, Klun et al. 1986). After reaching the female bag, the male inseminates the female by pneumatically stretching his abdomen inside her pupal shell, past the length of her body, to reach her caudal genitalia. The female oviposits inside her pupal shell and then falls from the bag. The eggs overwinter, and the larvae emerge in the spring. Young larvae typically make a silk thread and drift away on the breeze. (Jones and Parks 1928). This action is most likely one of the most important ways of distribution in the environment. On the other hand, late instar larvae have been seen to crawl away from their host plant shortly before pupation. Extensive research was done by Kaufmann (1968) on the *T. ephemeraeformis* and observed its biology and behaviour.

Over 50 families of deciduous and evergreen trees and shrubs can be targeted by *T. ephemeraeformis* (also known as the evergreen bagworm, common bagworm, eastern bagworm, and common basket worm) (Rhainds *et al*., 2009) and have been reported as an emerging pest in coastal agroecosystem of Odisha, India (Srivastva and Attri 2004). Still, research on its behaviour and other Psychidae is poorly known (Kaufmann 1968).

Insects use a variety of methods to find their way around. Bees' utilisation of the sun and polarised light for detecting food sources and reorienting to the hive is widely documented. Apart from chemical trails, ants have been observed using the sun for orienting (Romoser 1973). Dung beetles (Smolka *et al*., 2016), aphids (Hajong and Varman 2002) are known to be phototactic as well. However, artificial light at night (ALAN) strongly impacts the insect population (Grubisic *et al*., 2018). Luminosity, exposure time, and wavelengths of light-emitting diodes (LEDs) affect agricultural insects and stored-product insects. Agricultural insects are particularly attracted to green or blue LEDs because of their phototactic tendencies, and they are the most effective entrapment methods for these pesky pests (Park and Lee 2017).

Reports on adult lepidopteran attraction towards light are many (Park and Lee 2017). However, there are only a few observations of positive phototactic movements of lepidopteran caterpillars recorded, which is again used to trap the pest (Rao *et al*., 2016). ALAN was tested in a deciduous forest by Welbers et al. (2017), who used street lamps that emitted various colours of light to modify the lighting conditions. Caterpillar abundance peaked substantially higher in trees illuminated with green or white light than it did in trees illuminated with red light or in the absence of light, according to this study. In addition, male caterpillars exposed to green and white light had lower body mass and pupated quicker than those exposed to red or dark treatments, according to Van Geffen *et al*. (2014). Another research by Gotthard (2000) indicated that the length of the illumination could also influence the abundance of caterpillars because of its effect on the level of predation by predatory insects.

A small experiment confirmed the positive phototactic behaviour of the bag worm *Thyridopteryx ephemeraeformis* (Haworth), which was earlier doubtful by Kaufmann (1968) in his study. He observed that the newly emerged larva of the bagworm emerge out of the bag but did not confirm whether it is a positive phototactic response or not.

The bags were collected from the host *Ziziphus jujuba* shrubs from different localities in the agronomy field of Orissa University of

Agriculture and Technology, Bhubaneswar, Odisha (20°15'54.9"N 85°48'25.3"E), in the year 2017. The bags were chosen according to the indications provided by Kaufmann (1968). The matured bag (having the last instar larva) were collected by seeing the moulted head on the outer surface of the bag. This caterpillar moults seven times and becomes an adult (Kaufmann 1968). So the bag whose outer case had around 5-6 moulted head attached were chosen. Total 5-10 bags were collected and kept in a box of size 15cm x 15cm x 15 cm so that after the emergence of the adult winged male, it will find the female bagworm case and try to fertilise it. After copulation, the female bag cases were separated out and each one was kept in a small cylindrical box of 6cm (ht.) x 7cm (dia). Each small box was marked with A (left), B (middle), C (right), D (back) (as shown in figure 1). 3V white and UV LED lights were used to study the behaviour of the newly emerged larva (NEL).

Observations and Discussions

The female, after fertilisation, oviposits eggs inside the pupal case, which is held inside the bag case. After NEL comes out from the bags, it gets scattered all over the box by spinning a thin layer of silk on the inner surface of the box. The NEL move from one place to another by lifting its soft abdomen. Soon after emergence, within minutes, they start to build their bags with the help of the silk formed inside the inner layer of the box. After that, the LEDs were used to study the phototactic response. When the LEDs were switched off, all the larva were found to be scattered evenly all over the box in every marked position, i.e., A, B, C, and D (Fig 1.1). Soon after 'switching on' of the LED at different box positions (Fig 1.2, 1.3, 1.4, 1.5), the 100s of larvae tend to aggregate on the focus point of the light intensity. The shift in the LED's position tends to shift the aggregation of the bagworm larva. Then after the LED were 'switched off' the larvae get evenly scattered in the whole box again (Fig. 1.1; 2. a-f). This result was accurate for both the LED lights white and UV. Welbers et al. (2017) observed the same results by using green or white lights, increasing the caterpillar abundance. Also, UV light does the same Rao et al. (2016).

An opening cut in the bag's midsection prompted a larva's head to travel toward this opening, where it penned its skin and emerged as a pupa. The same results were produced when the posterior end was left open and the new centre aperture was created larger than the posterior one. Because the larvae oriented their heads toward the opening that provided the bag with the most light, these findings suggest they were positively phototropic (Kaufmann 1968).

According to this report, using light traps to catch this nuisance species may now be more manageable. Hanging light sources on infested plant branches may be one technique, and when larvae congregate on that area of the branch, it is easy to remove and kill them all.

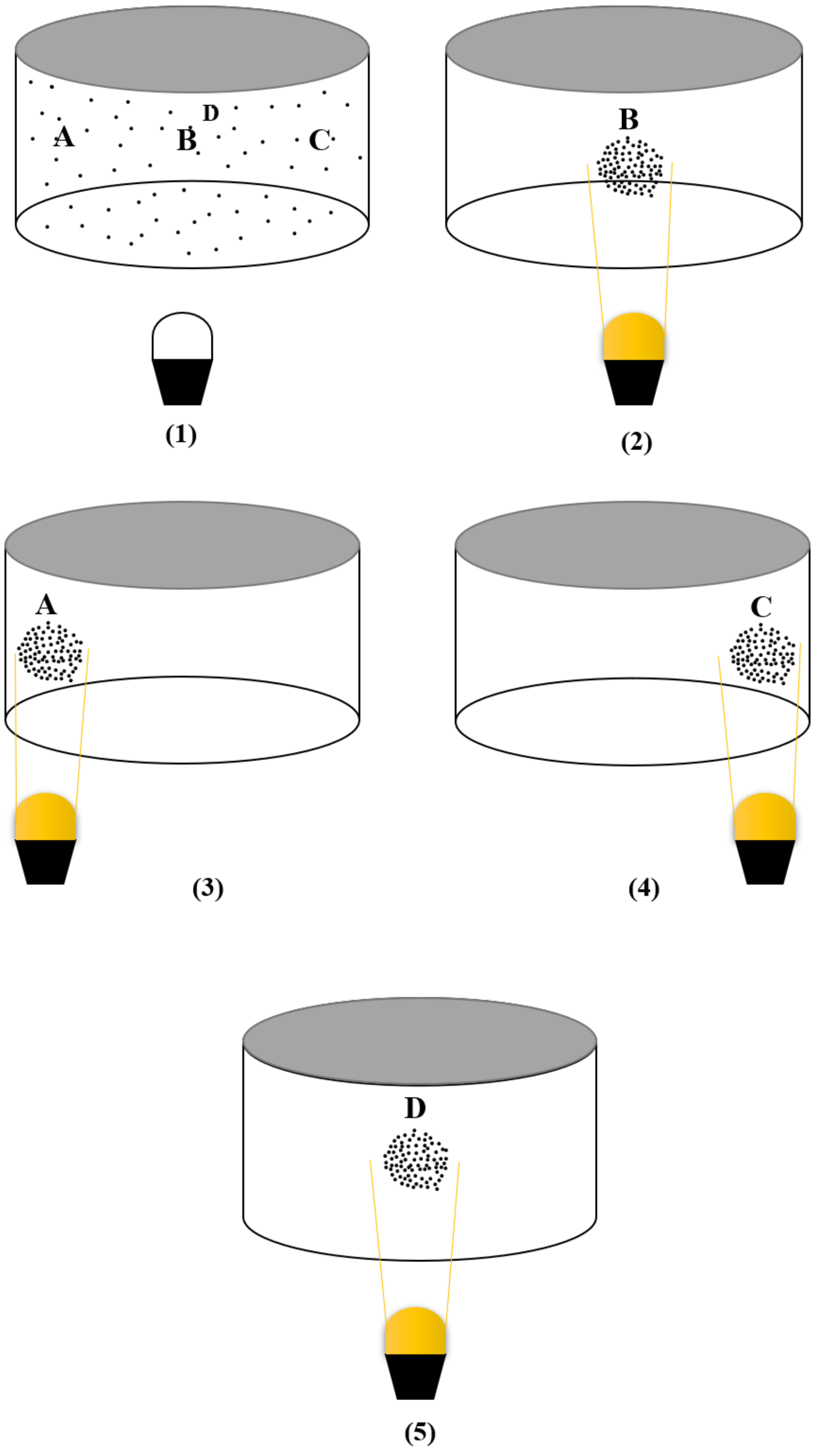

Fig. 1. (1) Evenly scattered bagworm larva when no light intensity was present (2) Aggregation of larva in ‘B’ (3) Relocation to ‘A’ (4) Again relocation to ‘C’ (5) Again aggregation of the larva after placing the light on the back of the box in ‘D’ position

Conflicts of Interests

The authors have no conflict of interest

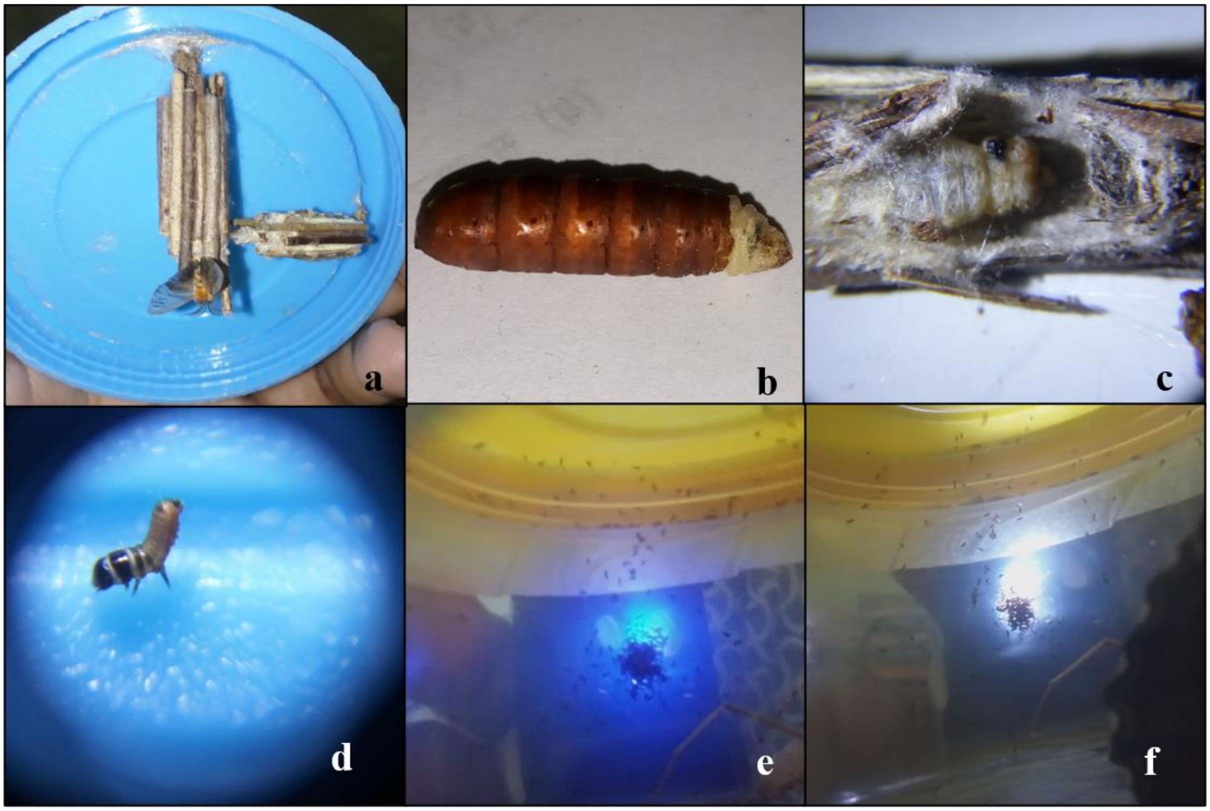

Fig. 2. **(a)** Mating of *Thyridopteryx ephemeraeformis*; (**b)** Adult female with the pupal case attached; (**c)** Adult female inside the bag without the pupal case; (**d)** Newly emerged larva (NEL) moving with its raised abdomen; **(e)** Aggregation of NEL under UV light; (**f)** Aggregation of NEL under white light

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Parasite on Asian rice gall midge - *Orseolia oryzae* (Wood-Mason) in light trap collection

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Adult rice gall midge, *Orseolia oryzae* (Wood mason) (Diptera: Cecidomyiidae) insects were collected from light traps during September 2021and brought to the laboratory. On observation it was found that many insects were dead. While observing the dead adults under a microscope, a peculiar structure was observed to be attached to the female adult on the ventral side. Further microscopic examination revealed that an organism was attached to the intersegmental area between the thorax and abdomen and was feeding on the adult gall fly (Fig1**).** We were not sure where and how the parasite had attacked the adult insect. It had devoured only the gall midge insect tissues but not the eggs which were in the abdomen. Two days after feeding it had detached itself from the host tissues. Since it was feeding from outside we presume it be an external parasite.

The parasite was observed to possess an oval shaped body having projections on the dorsal surface (Fig 2). On the ventral surface it had a longitudinal groove running from one end to another end (Fig 3) and possessed a mouth.

This is the first report. Perusal of available literature could not throw light on the external parasites of gall midge.

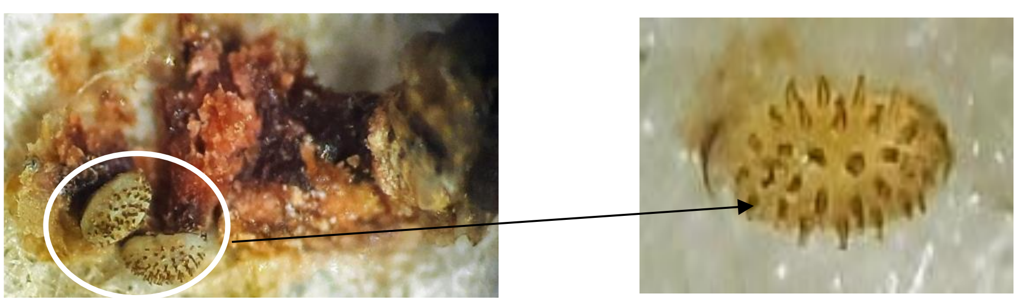

Fig. 1: Parasites feeding on the gall midge adult **Fig. 2: Dorsal view of the parasite.**

Fig. 3: Ventral view of the parasite

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