Jurnal Perlindungan Tanaman Indonesia, Vol. 23, No. 1, 2019: 1–5
DOI: 10.22146/jpti.27012
Available online at http://jurnal.ugm.ac.id/jpti
ISSN 1410-1637 (print), ISSN 2548-4788 (online)

Research Article

Biology and Reproductive Behaviour of *Apanteles taragamae* Viereck (Hymenoptera: Braconidae), a Larval Parasitoid of *Diaphania indica* Saunders (Lepidoptera: Crambidae)

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Received August 4, 2017; revised January 8, 2018; accepted August 3, 2018

ABSTRACT

Apanteles taragamae (Hymenoptera: Braconidae) is a larval parasitoid of *Diaphania indica* (Saunders) (Lepidoptera: Crambidae), a minor pest of Cucurbitaceae crop. The aim of this study was to determine the behavior and biology of *A. taragamae*. The study was conducted under laboratory conditions by exposing 930 larvae of *D. indica* to be parasitized by 11 adult female parasitoid of *A. taragamae* (1 day old), which have been mated 24 hours prior to expose. Each female was exposed to 15 larvae/day until they died. The parameters used to measure the biology of *A. taragamae* were fecundity, longevity, and parasitism. Results showed that the longevity of adult females was 5.64 days, the parasitism was 96%, the number of egg laid was 76.40/day, the total number of eggs laid was 611.18, and potential fecundity was 752.73 egg.

Keywords: behaviour, biological control, fecundity, host-parasitoid interaction, life cycle, longevity

INTRODUCTION

Diaphania indica Saunders (Lepidoptera: Crambidae) is a minor cucurbit pest (Ganehiarachchi, 1997). *D. indica* is also reported to attack the Leguminoceae and Malvaceae family (Macleod, 2005). The level of damage caused by *D. indica* can reach 80−100% in bittergourd plants (Thamrin & Asikin, 2003). Vanisree *et al*. (2005) reported that *D. indica* larvae cause damage to plants at the beginning of flowering. The highest attack of *D. indica* in cucumber plants occurs in the generative stage or early flower formation.

Parasitoids associated with *D. indica* are *Tricholobus* sp., *Xanthopimpla* sp., *A. taragamae*, *A. claviatus*, and *Elasmus* sp. (Fitriyana, 2015; Lizmah, 2015). According to Ulina (2017) *A. taragamae* is the most dominant parasitoid parasitizing *D. indica*. Nurkomar (2017) stated that *A. taragamae*'s parasitization of *D. indica* reached 69% in the field. *A. taragamae* is a gregarious endoparasitoid (Peter & David, 1991). Peter dan David (1992) stated that *A. taragamae* adult characterized with small body size (2.89 mm) and black color. *A. taragamae* widely spread in Japan, China, India, Sri Lanka, Thailand, the Philippines and Indonesia (Austin & Dangerfield, 1992).

Previous research on *A. taragamae* related with the hosts range (Dannon *et al*., 2012), biology in *Maruca vitrata* (Lepidoptera: Pyralidae) (Dannon *et al*., 2011) and *D. indica* (Lepidoptera: Pyralidae) as well (Peter & David, 1992), the effect of volatile compound on the adult behavior (Dannon *et al*., 2010b), functional responses and life cycle parameters (Dannon *et al*., 2010a), mass rearing (Mohan & Sathiamma, 2007), hyperparasitoid (Peter & David, 1991), and the relationship of body length to fecundity (Nurkomar, 2017).

Information on the biology and behavior of parasitoid are important to assess. In this regard, the role of *A. taragamae* to suppress the population of *D. indica* in the field, the basic studies about mass rearing and the role of *A. taragamae* as the natural enemy of *D. indica* in the field, especially its biology and behavior are important to be studied. Hence the objective of this research is to study the biology and life cycle of *D indica*.

MATERIALS AND METHODS

Mass Rearing of Diaphania indica

D. indica larvae were collected from cucumber plantation in Bogor Regency. The collected larvae were reared in the laboratory using plastic containers (14 cm × 9 cm × 7 cm) and fresh cucumber leaves as its natural diet were supplied every day until becoming pupae, then pupae were moved in plastic containers (3 cm in diameter, 18 cm in height) until became adults. Adults were fed daily with 20% of honey solution. Male and female adults that emerged were placed in a plastic container (15 cm in diameter, 50 cm in height) to copulate. Adults were reared to produce eggs until they die. The laid eggs were transferred into a plastic tube (9 cm in diameter, 12 cm in height). The three or four days old larvae were used for experiment.

Mass Rearing of Apanteles taragamae

A. taragamae parasitoid was collected from parasitized *D. indica* in cucumber fields. *D. indica* larvae were reared until *A taragamae* pupae emerged from the larvae. *A. taragamae* pupae were put into a tube smeared with 20% of honey solution at the wall. Each tube was labeled indicating the date of pupating and the date of pupae emerged from the larvae. The ratio sex of parasitoid adults emerged was recorded. One day old parasitoid adults were directly exposed to *D. indica*.

Observation of the Number of Eggs, the Longevity of Adult, and Parasitism Rate of A. taragamae

Biological characteristic of *A. taragamae* was carried out through parasitization process by exposing 15 *D. indica* larvae aged 3−4 days to one *A. taragamae* female. Each parasitized larva (larva was considered parasitized when the parasitoid ovipositor pierced the larva) was separated and moved in a labeled plastic cup (3 cm in diameter, 7 cm in height). The parasitization process was done every day until the female adult dies (15 larvae were used every day). The dead female adult was dissected to calculate the number of eggs remaining in the ovary. *D. indica* larvae parasitized were reared by feeding cucumber leaves every day and separated from the dead larvae. Dead larvae were dissected to observe the existing and the number of parasitoid eggs/larvae in the host. Observations were conducted on 11 female parasitoids as replications. The number of eggs produced, the longevity of adults, and the parasitism rate were calculated by the following formula:

$$\text{Parasitism rate} = \frac{\Sigma \text{ parasitized larvae}}{\Sigma \text{ total number of larvae}} \times 100\ \%$$

Box plot was used to analyze the average number of eggs using the R Statistic 3.0 program.

RESULTS AND DISCUSSION

Fecundity, Longevity, and Parasitism of A. taragamae *in* D. indica *Larvae*

Table 1 showed that the number of eggs laid by *A. taragamae* female (611 eggs) was higher than reported by Peter and David (1992), which is 243. The difference in the number of eggs laid by an adult in the host was influenced by the food source of adult and the number of hosts. Parasitoid adults tend to put more eggs when the food and hosts are continuously available. This result was similar to Schmidt (1994) that the number of eggs laid in a host varies depending on the quality and number of hosts.

Potential fecundity is the maximum ability of female parasitoid to produce eggs during their life-time, which includes the number of eggs laid in the host and the number of eggs left in the ovary (Handayani *et al.*, 2004). The potential of fecundity

Table 1. Fecundity, longevity, and the parasitism of *Apanteles taragamae*

Parameter of biology	Mean ± SD	Minimum	Maksimum	n*
Total number of laid eggs	611.18 ± 203.02	191	857	11
Number of remaining eggs in the ovary	141.55 ± 88.36	51	335	11
Potential of fecundity	752.73 ± 258.66	245	1120	11
Number of laid eggs per day	76.40 ± 51.17	17	115	11
Longevity (day)	5.64 ± 1.86	2	8	11
Parasitism (%)	96.04 ± 3.58	87.8	100	11

Remarks: *n= samples of *A. taragamae* female observed (until the adult died)

for *A. taragamae* female was 753 eggs during their lifetime and laid eggs were 76.40 per day (Table 1). Egg production is influenced by food availability, host availability, and ovary size. In this study, *A. taragamae* was reared with a sufficient number of food and hosts. Handayani *et al*. (2004) stated that the total egg production increases with the availability of food or the availability of sufficient hosts for adult parasitoid.

The average number of eggs left in the ovary was 141.55 (Table 1). The female parasitoid may lay more eggs if the host provides sufficient nutrition for the development of eggs. Therefore, the number of eggs laid were more than the eggs left in the ovary. The more eggs placed on their host, the less eggs left in the ovary. Godfray (1994) stated that host quality influences the preference of female parasitoid to lay eggs.

This study showed that parasitism rate *of A. taragamae* was 96% (Table 1). Previous study by Mohan and Sathiamma (2007) showed that parasitism of *A. taragamae* on *C. cephalonica* and *Opisina arenosella* was 60.6% and 64.6% respectively. Peter and David (1990) in their study reported that the parasitism of *A. taragamae* on *D. indica* depend on the type of *D. indica* host plants and their larval age. The parasitism in four days old larva of *D. indica* (64%) was higher than in five (56%) and six (24%) days old (Peter & David, 1992). In another study, Dannon (2010a) reported that the parasitism of *A taragamae* in *M. vitrata* was 15−35% and will increase along with the increasing of host density. Therefore, the parasitism is affected by species, age and host density of the pest and the host plant fed by that pest.

This research showed that *A. taragamae* female had an average longevity of 5.64 days (Table 1). The results of the study of Mohan and Sathiamma (2007) reported that the longevity of female exposed to the host *O. arenosella* and *C. cephalonica* respectively was eleven and thirteen days. Research conducted by Dannon (2011) showed that the longevity of *A. taragamae* female exposed to *M. vitrata* hosts ranges from eight to eleven days. This explains that the longevity of the parasitoid is different in different hosts, the length of life of the parasitoid *A. taragamae* in the host *D. indica* in the cucumber plant is shorter. Conditions induced the differences of parasitoid longevity are explained by Godfray (1994) which stated that the longevity of an adult parasitoid is influenced by the type of food source provided and the availability of the host. In addition, the relatively short longevity of the parasitoid may be caused due to the effort and energy was more spent on producing more offspring.

***Distribution of* A. taragamae *Eggs Laid on* D. indica**

The number of eggs laid by female *A. taragamae* was similar during observation (Figure 1). The number of eggs laid tend to decrease since the second day until the eighth day, although there was a similar decreasing during second−sixth days (Figure 1). A newly emerged female adult has developed eggs in her ovary (pro-synovigenic), thus both mated female and unmated females are able to do oviposition immediately (Nurkomar, 2017).

The number of eggs laid on the first day was higher than the next day. This might be caused by the adaptability of adults to her first host. Therefore, we found less number eggs laid on the last day (eigthth day). This result was similar to a study by Markhamah (2012) that there were fewer eggs on the last day of oviposition. A similar result was also reported by Garcia and Tavares (2001) that when the host was provided continuously, *Trichogramma cordubensis* has the highest number of eggs laid on their first day and tend to decrease along with their age.

The number of eggs laid per larvae was similar (six to eight eggs/larva) (Figure 2). The highest number of laid eggs was in the first larvae, then decreased in the eighth larvae and then constant in the next larvae (Figure 2). The highest number of eggs laid in the first host showed that female adults will maximize laying eggs on their first parasitization. This result was similar to Handayani *et al*. (2004) that the parasitoid will maximize laying eggs when they first reach the host and the number of eggs laid will decrease at the next days. Tarla (2011) also reported that the number of eggs laid by the *Trissolcus grandis* Thompson (Hymenoptera: Scelionidae) in the host was higher on the first day and decreased on the following day.

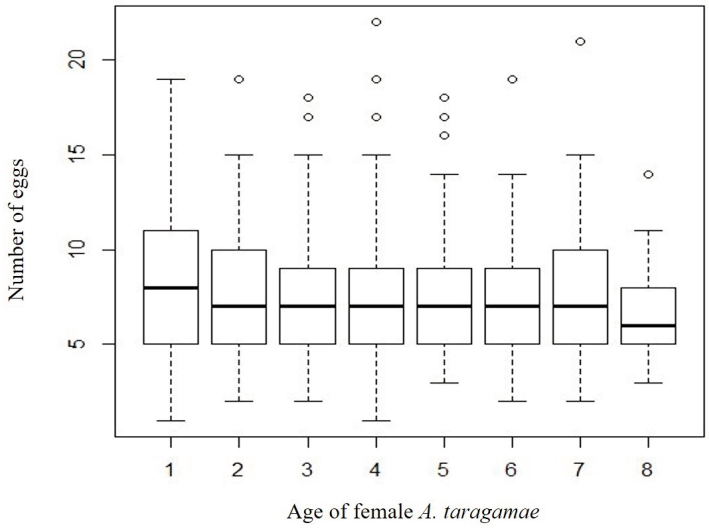

Figure 1. Number of eggs laid by *Apanteles taragamae* female in each larva of *Diaphania indica* per day

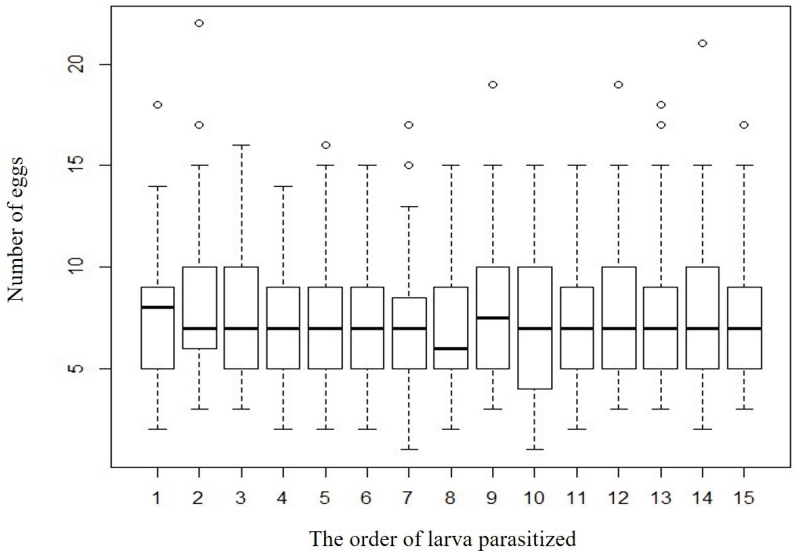

Figure 2. Number of eggs laid by *Apanteles taragamae* female in *Diaphania indica* according to the order of parasitized *D. indica* larvae

CONCLUSION

A. taragamae is an egg parasitoid potentially be able to control *D. indica* larva population in the field. *A. taragamae* female tends to lay eggs constantly in the host with most eggs laid on the first day.

ACKNOWLEDGEMENT

This research is a part of the Superior Research College - Bogor Agricultural Institute funded by the Ministry of Research Technology and TA Higher Education in 2015.

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