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Natural parasitism of greater wax moth, *Galleria mellonella* Linnaeus larvae by *Apanteles galleriae* Wilkinson in Madurai district, Tamil Nadu

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Abstract
Apanteles galleriae Wilkinson, a larval parasitoid was observed from natural population of greater wax moth, *Galleria mellonella* Linnaeus larvae in Madurai region, Tamil Nadu, India. The per cent parasitisation and sex ratio (F: M) ranged from 9.09 to 23.08 per cent and 1:1 to 1: 1.40 respectively. Among different periods, high number (12) and parasitism (23.08%) were noticed during November, followed by December 2019. Thereafter, the per cent parasitism declined in March 2019. A similar trend was also observed with regards to sex ratio (F: M).

Keywords: *Galleria mellonella*, *Apanteles galleriae*, greater wax moth larvae, bee keeping and parasitism

Introduction
Greater wax moth is a very dangerous threat to bee keeping industry. It causes 60 to 70 per cent damage in bee keeping sector of developed countries (Paddock, 1918; Hanumanthaswamy *et al.*, 2009) [2, 5]. It destroys a large number of combs in the colony, wax foundation sheets, stored combs and stored hive products. Management of greater wax moth is unavoidable thing in bee keeping industry. Researchers have identified some biological control agents *viz*., *Bacillus thuringiensis*, *Solonopsis invicta* and *Solonopsis germinita* Fab., *Apanteles galleriae* and *Bracon hebetor*. However, the use of bio control agents are still lacking on commercial purpose (Kwadha *et al*., 2017) [4]. Among these, the hymenopteran larval parasitoid *A. galleriae* was found to be a prominent natural enemy of greater wax moth (Hanumanthaswamy and Rajagopal, 2017) [3]. *A. galleriae* belongs to the family braconidae: sub- family microgastrinae in the Hymenopteran order (Galindo-Cardona, 2019) [1]. It is a solitary koinobiont early-instar larval endoparasitoid of *G. mellonella* (Shimamori 1987) [6]. The duration of the incubation, larval, pupal and total developmental period of the *A. galleriae* were 3.2, 12.7, 7.7 and 23.6days, respectively (Verma and Desh Raj, 1997) [8]. Generally emergences of males were higher than the female (Subash Chander, 1995) [7]. Hence, an investigation was carried out to assess the nature and extent of parasitism of *A. galleriae* in Madurai district, Tamil Nadu.

Materials and Methods
During survey from October 2019 to March 2020 *G. mellonella* larvae were collected from five locations *viz.*, Alanganallur, Vadipatti, Melur, Madurai West and Madurai East. From each place one greater wax moth infested hive was selected and larvae were collected. The collected larvae were brought to insect mass culture laboratory, Department of Agricultural Entomology, AC & RI, Madurai and reared. Adult parasitoids that emerged from the larvae were collected and preserved in 70% ethanol. Then, the number of parasitoids emerged and sex ratio were observed. The parasitoid samples were send to ICAR-NBAIR, Bangalore for Identification. Images of *A. galleriae* were captured using Stereo zoom microscope in the Department of Bio-technology, Centre of Innovation, Agricultural College and Research Institute, Madurai. The extent of per cent parasitism was calculated and the relationship between *A. galleriae* and *G. mellonella* was subjected to regression analysis using SPSS statistical tool.

Results and Discussion

Identification of *A. galleriae*

The parasitoid was got identified as *Apantelles galleriae* from ICAR-NBAIR, Bangalore and it was a tiny black parasitoid (Plate 1. a). Adult body length measured about 40mm with long antenna (Plate 1.c). A deep brown stigma was noticed at the proximal end of fore wings. Legs were pale yellow in colour except coxae which were dark brown. Abdomen was pale brown in colour with a translucent pale-yellow band. Females were identified with a long ovipositor (Plate 1.c &1.d). The present finding on the description of the parasitoid is in accordance with the reports of Whitfield *et al*. (2001) [10]; Hanumanthaswamy and Rajagopal (2017) [3].

Per cent parasitisation and sex ratio of *A. galleriae*

From the table 1, it is evident that there were significant differences in per cent parasitisation and sex ratio at different periods. The extent of parasitism ranged from 9.09 to 23.33 per cent. Among different periods, high number (12) and parasitisation (23.08%) of *A. galleriae* was recorded during November 2019, followed by December 2019. A similar trend was observed with regard to sex ratio (F: M) also. No parasitism was observed during the month of March 2020.

The table 2 revealed that a highly significant correlation was found between number of *G. mellonella* larvae and *A. galleriae* (Fig. 1). Similar result was also obtained in the case of relationship between number of *G. mellonella* larvae and per cent parasitism. This present finding is in agreement with reports of several authors: Shimamori (1987) [6] reported that *A. gallariae* 15 per cent parasitism on *G. mellonella* larvae. Galindo-Cardona *et al*. (2019) [1] observed that 27% *A. galleriae* emerged from lesser wax moth (*Achroia grisella* Fab.) larvae. Hanumanthaswamy and Rajagopal (2017) [3] reported that parasitism ranged from 12 to 54.44% and highest sex ratio (F: M) ranged from 1: 1 to 1: 1.5 depending upon the environmental conditions. Vinay Kumar (2019) [9] reported that the per cent parasitisation of *A. galleriae* ranged from 5 to 40 at different periods. Subash Chandar (1995) [7] observed that 14.29% to 44% parasitisation of *A. galleriae* on greater wax moth.

Table 1: Parasitism by *A. galleriae* on *G. mellonella* larvae at different periods

Month/Year	No. of. *G. mellonella* larvae	No. of. *A. galleriae* emergence	Per cent parasitisation	Sex ratio F:M
October 2019	42	08	19.05	1:1.00
November 2019	52	12	23.08	1:1.40
December 2019	40	09	22.50	1:1.25
January 2020	32	04	12.50	1:1.00
February 2020	22	02	9.09	1:1.00
March 2020	8	00	0.00	0:0

Table 2: Relationship between *G.mellonella* larvae and *A. galleriae*

Parameters	"r"	Regression equation	P> and significance
No. of. *G.mellonella* larvae vs No. of. *A. galleriae* adult emergence	0.93	Y= 13.26+ 3.32X	< 0.01**
No.of. *G.mellonella* larvae vs Per cent parasitisation	0.94	Y= 8.20 + 1.70X	< 0.01**

** significant at level of 1%

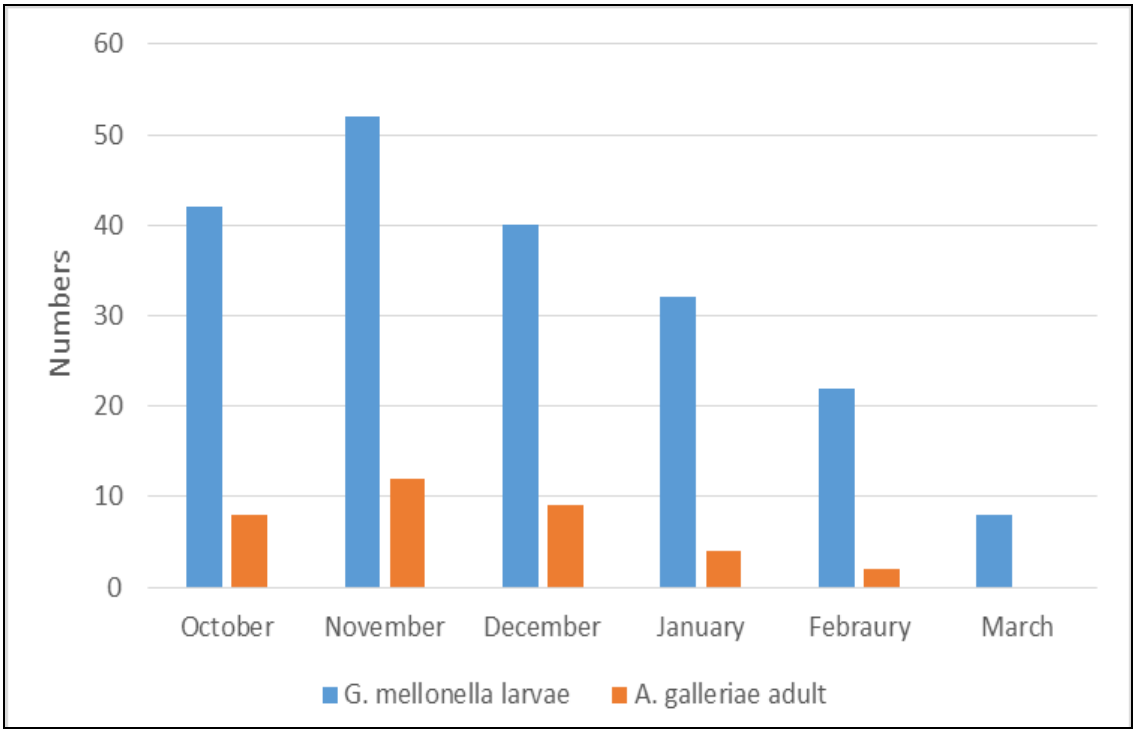

Fig 1: Relationship between *G. mellonella* larvae and *A. galleriae* in different periods

a. Adult

b. Antennae

c. Female of *A. galleriae*

d. Ovipositor

Plate 1: Images of *A. gallariae*

Conclusion

As the natural occurrence, the extent of parasitism by *A. galleriae* and the relationship between greater wax moth larvae and *A. galleriae* is found promising, an attempt may be made to mass multiply *A. galleriae* for field release.

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