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## A REPORT ON THE OCCURRENCE OF EULOPHID PARASITIDS ON THE CASHEW LEAF MINER *ACROCERCOPS SYNGRAMMA* MEYRICK (INSECTA: LEPIDOPTERA: GRACILLARIIDAE)

Kaliaperumal Vanitha

Crop Protection, Directorate of Cashew Research, Puttur, Karnataka 574202, India  
vanis102@gmail.com

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**Abstract:** Surveys were conducted from 2011 to 2015 in cashew plantations to document the parasitoids of cashew leaf miner. Three eulophid parasitoids, viz., *Chrysocharis* sp., *Closterocerus* sp. and *Aprostocetus* sp. were recorded for the first time as parasitoids on the larvae of Cashew Leaf Miner, *Acrocercops syngamma* Meyrick (Lepidoptera: Gracillariidae). Among the parasitoids, *Chrysocharis* sp. was dominant recording 99.0 % abundance. The parasitism of leaf miner larvae was observed from September onwards, which reached its peak during November coinciding with the population of leaf miner larvae. *Chrysocharis* sp. was found to be a solitary parasitoid, completing its life cycle within the mine of leaf miner and emerging as an adult. Parasitization was noticed only on the third and fourth instar leaf miner larvae but not on the first and second instar larvae. In cashew plantations, leaf miner parasitism ranged from 37 to 58% by *Chrysocharis* sp.

**Keywords:** Cashew, eulophidae, leaf miner, parasitism, parasitoid.

Leaf miner, *Acrocercops syngamma* Meyrick (Lepidoptera: Gracillariidae) is a defoliating pest of cashew, occurring in almost all the cashew growing regions of the country as well as the world. In India, it causes serious damage to the tender leaves of cashew attacking 2–80 % of the young leaves (Abraham 1958; Sundararaju 1984; Ayyanna et al. 1985). Upon hatching, the larva makes a silvery sinuous gallery on

the upper leaf side feeding below

the epidermal layer causing leaf blisters which later dry up, causing leaf distortion, browning and curling of the leaves. As many as 11 larvae have been observed feeding on a single leaf (Jena et al. 1985). The pest completes its life cycle in a short period of 20–22 days (Rai 1984) and spreads fast, causing leaf blisters over a wide area. Under field conditions, the population builds up and further spread is controlled to a certain extent by natural enemies, especially parasitoids. *Chelonus* sp. (Braconidae), *Cirrospilus* sp. and *Sympiesis* sp. (Eulophidae) were reported to be larval parasitoids of cashew leaf miners (Sundararaju 1984; Beevi et al. 1993). But, there are no further reports on parasitoids of the leaf miner or the level of parasitism from any of the cashew growing regions or countries. To understand the changing scenario of any pest and its natural enemy, it is essential to study the diversity of natural enemies and the intensity of parasitism from time to time. Hence, the present study was undertaken to document the species of parasitoids of cashew leaf miners and the extent of their parasitism so as to evolve a suitable management strategy.

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## MATERIAL AND METHODS

Extensive surveys were taken up in 140ha of cashew plantations of the Directorate of Cashew Research, Puttur, Karnataka located on the West coast of India (12.45°N & 75.4°E; elevation 90m) from August 2011 to February 2015. Every year, from the initiation of leaf miner infestation, infested cashew leaves were collected randomly at weekly intervals. A minimum of 100 leaf mines were collected every week from different locations of cashew plantations. Mines were sectioned carefully without causing damage to the blisters along with some portion of the healthy leaf and examined for healthy and parasitized larvae. Parasitized larvae can be easily located, for the mine wall covering them senesces and turns brown and the parasitized larvae turn black with its contents sucked up (Image 3b). Whereas, healthy larvae look greenish-white, turn reddish towards pupation. After recording the larvae number, mines were kept in glass bottles @ 25–30 mines/bottle of 250 ml capacity covered with a thick muslin cloth and kept under lab conditions (temperature 24–32°C; relative humidity 89–94%). The bottles were observed daily for any parasitoid emergence. The adult parasitoids were isolated and preserved in 70 % ethanol for identification. The voucher specimens were submitted to Prof. TC Narendran's Trust for Animal Taxonomy, Zoological Survey of India, Western Ghats Regional Centre, Calicut, Kerala for further studies.

The level of parasitism was calculated as,

$$\text{Percent Parasitism} = \frac{\text{No. of parasitoids emerged}}{\text{No. of leaf miner larvae}} \times 100$$

## RESULTS

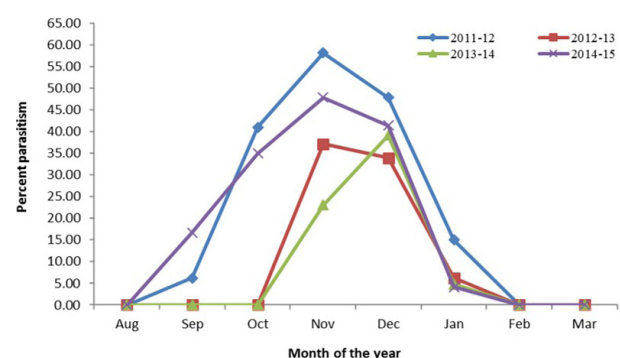
In cashew, leaf miner infestation occurs during the flushing period which is generally between August and September and reaches the peak during October–November and gradually decreases thereafter. Infested leaves exhibit transparent blisters (Image 1) that later dry up resulting in manifestation of holes. During the present investigation, three larval parasitoids namely, *Chrysocharis* sp., *Closterocerus* sp. and *Aprostocetus* sp. all belonging to Eulophidae have been recorded as larval parasitoids on cashew leaf miner for the first time (Table 1 and Image. 2). Among the three parasitoids, *Chrysocharis* sp. was the dominant species (99.0 %) in all the four years of observation, while *Closterocerus* sp. and *Aprostocetus* sp. were recorded only during 2011 at 0.5% level. Because of the relatively high dominance, this study focused mainly on the parasitic behaviour of *Chrysocharis* sp. Across four years of observation, it was

found that, there was no parasitism on leaf miner larvae during August, when the initial infestation of leaf miner occurred. But from September onwards, parasitism started and higher parasitism was noticed during October, November and December and a maximum extent of 37–58 % parasitism was observed during the different years (Fig. 1). During October, the incidence of leaf miner was noticed up to 17, 8, 5 and 19 % in cashew plantations during 2011, 2012, 2013 and 2014, respectively. Correspondingly, a high parasitism of leaf miner larvae by *Chrysocharis* sp. was observed during 2011 and 2014.

Leaf miner larvae parasitized by *Chrysocharis* sp. appeared brownish-black in colour and the inner contents were sucked up (Image 3b). Fully matured parasitoid larvae came out of miner larvae for pupation (Image 3c) but pupated within the mines (Image 3d). Pupae transformed into adults and emerged from the mines by making a way out through tiny holes. It was found to be a solitary parasitoid and a maximum of six leaf miner larvae in a single leaf was found to be parasitized at a time. The proportion of female parasitoids was more compared to males (male: female - 1:1.5). Among the instars, it was observed that the first and second instar leaf miner larvae were not parasitized, but the third and fourth instar larvae were generally parasitized. Because of the existence of differential

**Table 1. Larval parasitoids recorded on Cashew Leaf Miner in Puttur**

	Parasitoid	Family	Period of occurrence and year	Relative abundance (%)
1	<i>Chrysocharis</i> sp.	Eulophidae	Sep–Jan (2011, 2012 & 2014); Oct–Mar (2013)	99.0
2	<i>Closterocerus</i> sp.	Eulophidae	Nov (2011)	0.5
3	<i>Aprostocetus</i> sp.	Eulophidae	Nov (2011)	0.5



**Figure 1. Percentage of parasitism of leaf miner larvae by *Chrysocharis* sp. from 2011 to 2014**



**Image 1.** Leaf miner infestation during a - flushing stage, b - flowering stage

flushing periods of differently aged cashew varieties and variable overlapping populations of leaf miner larvae, parasitism continued for a longer period, even up to five months under field conditions. Furthermore, adult parasitoids of *Chrysocharis* sp. could successfully emerge from the pupae from the leaf mines collected even from the insecticides (lambda cyhalothrin) sprayed plots, indicating that there was no detrimental effect of lambda cyhalothrin on this parasitoid during the pupal stage, and thus *Chrysocharis* sp. population could remain in the system even during occasions of insecticidal spray on cashew.

#### DISCUSSION

This is the first report of three eulophid species namely *Chrysocharis* sp., *Closterocerus* sp. and *Aprostocetus* sp. as parasitoids of cashew leaf miner. Earlier, *Chrysocharis* spp. were reported as endoparasitoids of leaf mining larvae of Gracillariidae and also of other insects belonging to Diptera, Lepidoptera, Coleoptera and Hymenoptera (Zulal & Uygun 2006; Yefremova & Mishchenko 2008; Sharma et al. 2011). In the present study, a positive influence on the abundance of the parasitoids by the leaf miner population was noticed. Parasitism by *Chrysocharis* sp. was more during 2011 and 2014, than 2012 and 2013, coinciding with the population of the leaf miner. This is in accordance with Grabenwager and Lethmayer (1999), who reported a positive influence of the number of chestnut leaf miner, *Cameraria ohridella* (Lepidoptera: Gracillariidae) on the abundance of its parasitoid, *Pnigalio agraulis* (Eulophidae).

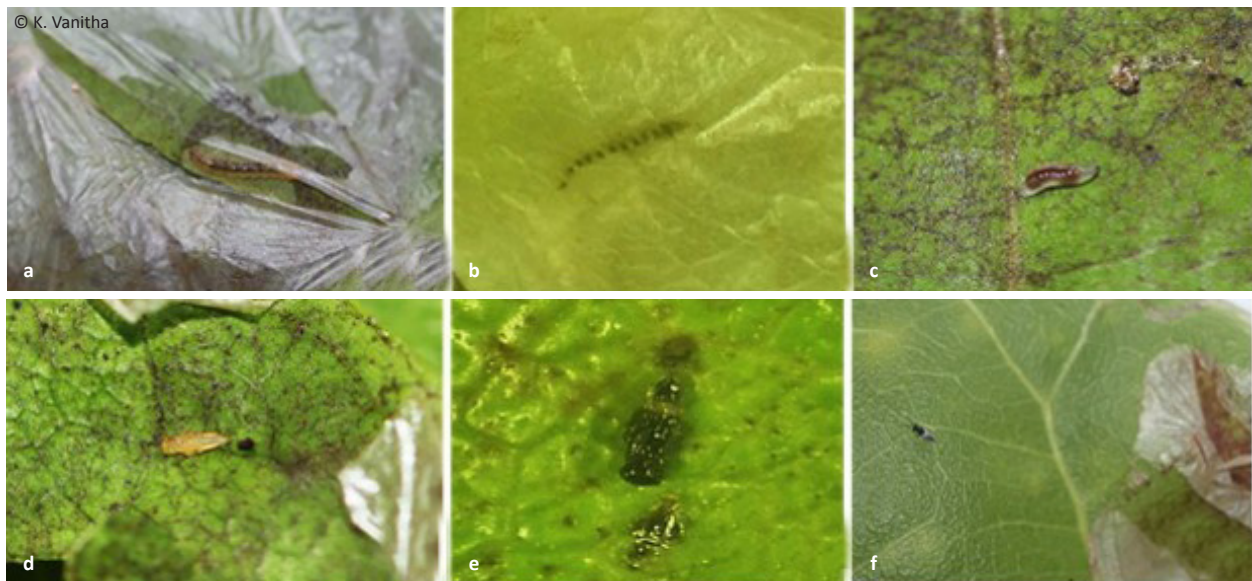
Among the larval instars of cashew leaf miner, the third and fourth instar larvae were generally parasitized. For many parasitoids, preference for different stages of hosts for parasitization was reported (DeBach 1943; Bartlett 1964). Parasitism at the third instar stage may be economically important from the pest management point of view, since in cashew, a large portion of the damage and reduction of leaf area was found to be caused by the third instar leaf miner larva (Jacob &



**Image 2.** Larval parasitoids of Cashew Leaf Miner. a - *Chrysocharis* sp. female; b - *Chrysocharis* sp. male; c - *Closterocerus* sp.; d - *Aprostocetus* sp.

Belavadi 1990). Similarly, preference of *Chrysocharis pentheus* for the third instar larvae of citrus leaf miner *Phyllocnistis citrella* (Lepidoptera: Gracillariidae) and third instar of *Phytomyza ranunculi* (Diptera: Agromyzidae) for oviposition and feeding, respectively were documented (Sugimoto & Ishii 1979; Mafi & Ohbayashi 2010).

Parasitoids namely *Cirrospilus* sp., *Sympiesis* sp. (Eulophidae) and *Chelonus* sp. (Braconidae) were reported on cashew leaf miner in Karnataka and Kerala respectively, and a parasitism of 35 % by *Chelonus* sp. and 59 % by *Sympiesis* sp. were reported in those states (Sundararaju 1984; Beevi et al. 1993). During the present investigation, none of the previously reported parasitoids were recorded in any of the years of study. Hence, the present report indicates that there might be a shift in the species spectrum of parasitoids parasitizing larvae of cashew leaf miner over the years. Hence, documentation or redocumentation of leaf miner parasitoids in other cashew growing regions of the country as well as in other parts of the world is desirable to understand the current scenario. In view



**Image 3.** Stages of *Chrysocharis* sp. infestation: a - healthy leaf miner larva (5<sup>th</sup> instar); b - parasitized leaf miner larva; c - grub of *Chrysocharis* sp. came out of the dead leaf miner larva for pupation; d - pupa of *Chrysocharis* sp.; e - pre adult *Chrysocharis* sp. male; f - just emerged *Chrysocharis* sp. female.

of the extent of parasitism caused by the parasitoids, the study would suggest that except in the nursery and very young cashew plants, there would be no need of insecticidal spray to manage leaf miner unless required, since *Chrysocharis* sp. could manage this secondary pest even up to 50 % under field conditions.

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