



Research Note

Biology of *Cardiochiles nigricollis* Cameron, a larval endo-parasitoid of *Cnaphalocrocis medinalis* (Guen.) and *Marasmia exigua* Butler

K. S. BEHERA

Central Rice Research Institute, Cuttack 753 006, Odisha, India
Corresponding author E-mail: beherak@rediffmail.com

ABSTRACT: The parasitoid *Cardiochiles nigricollis* Cameron usually parasitize the fourth instar larvae of *Cnaphalocrocis medinalis* and *Marasmia exigua*. Four instars were identified during the development of the parasitoid. The first instar larva is un-segmented and slightly curved. In the second instar segmentation appeared and tracheal system could be observed faintly. In the third instar head was well demarcated and the larva further grew in size. Six to eight days after egg laying the full grown larva came out of the host. The average pupal period lasted for 5.3 days in females and 6.7 days in males in the laboratory. Average incubation period, larval duration and pupal duration were 1.2 days, 10 days and 6.7 days respectively. *C. nigricollis* entered diapause at pupal stage and it started from the end of August and increased steadily till the first week of December when the entire population entered diapause. This phenomenon was observed only during wet season. On an average male emerged after 213 days and females after 224 days from the diapausing pupae. The gradual increase in the number of *C. nigricollis* entering diapause in the field population could possibly be due to occurrence of a heterogenous population of *C. nigricollis* in the field which responded gradually to fall in atmospheric temperature. *Brachymeria* sp., *Orgilus* sp., *Trichomalopsis (Eupteromalus) parnae* Gahan and *Elasmus* sp. were reared as hyper-parasitoids on pupae of *C. nigricollis*.

KEY WORDS: *Cardiochiles nigricollis*, *Cnaphalocrocis medinalis*, *Marasmia exigua*, biology, rice

(Article chronicle: Received: 14-02-2012; Revised: 21-09-2012; Accepted: 14-10-2012)

Cardiochiles sp. was recorded on the rice leaf folder, *Cnaphalocrocis medinalis* (Guen.) as a larval parasitoid at Siripur, Orissa (Rao *et al.*, 1970) and China (Hu and Wu, 1987). Ayyar (1927) recorded *Cardiochiles* sp. on the same host in India. *C. philippinensis* Ashm. was recorded on *C. medinalis* in the Philippines (Barrion *et al.*, 1979). The genus *Cardiochiles* has been reported on *Hymenia recurvalis* F. (Singh and Prasad, 1970), *Heliothis virescens* (Fabricius) (Martin *et al.*, 1982), *Neomarasma suspicalis* Wik. (Banarjee and David, 1982). *Cardiochiles* sp. (near *C. philippinensis*) has been reported as a common parasitoid of *Cnaphalocrocis medinalis*, (Gurr *et al.*, 2012). *C. philippinensis* Ashm. was reported to cause 3.4% larval parasitism at Aruppukottai, Tamil Nadu, India (Baby Rani *et al.*, 2007). Life history of *C. philippinensis* was studied by Yu-jie *et al.* (1991) in the Philippines. *C. philippinensis* completed its life cycle in 22.7 days. Total number of larvae parasitized by *C. philippinensis* was 16.7±0.2. Information on the biology and activity of *C. nigricollis* on *C. medinalis* is not available. Hence, an attempt was made to study the reproductive biology and bionomics of *C. nigricollis*

Cameron on *C. medinalis*, the dominant leaf folder species on rice.

C. nigricollis was reared from field collected *C. medinalis* larvae maintained on cut rice leaves in glass vials in the laboratory. Adult parasitoids from the parasitized larvae and field collected adults were used in the study. Larvae of *C. medinalis*, *M. exigua*, and pupae of *C. nigricollis* were collected from the field and reared in the laboratory to study the extent of parasitism by *C. nigricollis* in the field. Besides, a pair of freshly emerged (1 male + 1 female) *C. nigricollis* adults were released on potted rice plants (variety TN 1) with ten third instar *C. medinalis* larvae and covered with mylar cages to study its biology in the greenhouse. The potted plants with ten leaf folder larvae were replaced everyday till the female parasitoid was dead. Ten such pots were used in a batch in completely randomized design. Parasitized larvae were dissected periodically and examined under stereoscopic binocular microscope to study the development of the parasitoid inside the body of the host larva.

Two days old males and females mated in the laboratory. Mating lasted for 2-3 minutes. Egg laying was observed on the second day after mating. Field observations indicated that the female hovered above the infested rice plant and located the folded leaf. Later, it perched directly on the leaf fold and probed the roll with its ovipositor. While this process continued, the larva also moved inside the fold and at times fell into the water below. After locating the larva inside the roll, the female inserted its ovipositor through the leaf and pricked the host larva.

One to three parasitoid larvae per host larva were observed developing in the body cavity corresponding to the last four segments of the host larva. However, only one fully developed parasitoid larva emerged from one host larva indicating cannibalism or competition at early stages of development. Tillman and Mullinix (2003) studied the host searching and ovipositional behaviour of *C. nigricollis* Viereck in *Heliothis virescens* and

reported that only one egg was deposited in the host. Usually, third and fourth instar larva of *C. medinalis* and *M. exigua* were parasitized by *C. nigricollis*. Four instars were identified during the development of the parasitoid (Table 1). The first instar larva is un-segmented and slightly curved. In the second instar segmentation appeared and tracheal system could be observed faintly. In the third instar head was well demarcated and the larva further grew in size. Six to eight days after egg laying the full-grown parasitoid larva emerged out of the host. The host larva continued to look normal and fed regularly until the full-grown *C. nigricollis* larva came out. The full-grown larva looked pale yellow with prominent fat granules and spiracles. Soon after emergence, the larva moved about on the leaf and spun a translucent, off-white oval cocoon on leaf surface or on the walls of the rearing tube in the laboratory. Examination of field samples revealed that majority of the cocoons of *C. nigricollis* (88.2%) was formed bottom of the rice plant.

Table 1: Life history of *Cardiochiles nigricollis* Cameron on *Cnaphalocrocis medinalis*

Attribute	Range	Average	SD
Mating (minute)	2-3	2.5	0.4
Age at mating (days)			
Male	2-3	2.5	0.4
Female	2-3	2.8	0.4
Oviposition by mated female (No. of eggs/female)			
Pre-oviposition period (hrs.)	12-18	14.5	1.5
Oviposition period (days)	3-5	3.7	0.9
Eggs/Host larva	1-4	2.6	1.1
No. host larva parasitized	5-12	6.5	2.7
Incubation period (days)	1-1.5	1.2	0.2
Larval duration (days)			
1 st instar	1.5-2.5	2.0	0.5
2 nd instar	2.0-3.5	2.5	0.7
3 rd instar	2.5-3.5	3.0	0.5
4 th instar	2.0-3.0	2.5	0.5
Pupal duration (days) Male	4-7	5.3	1.2
Female	6-8	6.7	0.9
Diapause duration (days)			
Male	191-223	213.0	13.2
Female	211-265	222.4	23.8
Longevity (days)			
Male	2-4	3.7	0.8
Female	2-7	4.5	2.0
Total life cycle (days)			
Male	13-21	15.3	3.34
Female	15-22	16.5	3.08

The average pupal period lasted for 5.3 days in females and 6.7 days in males in the laboratory. In a few cases, the pupal period was extended and adult parasitoids emerged after 191 to 265 days of cocoon formation indicating occurrence of diapause. Males emerged after an average of 213 days and females after 224.4 days of formation of pupa of *C. nigricollis*. *C. nigricollis* adults emerging from such cocoons behaved like normal parasitoids in the laboratory. Such behaviour of the parasitoid was observed both in the field-collected samples and in the laboratory culture. Population of *C. nigricollis* entered diapause from the end of August and continued till the first week of December when the entire population entered diapause (Table 2). This phenomenon was observed only during wet season (kharif).

Table 2: Progress of diapause in *Cardiochiles nigricollis* in the field during kharif

Month	% of larvae entering diapause
August	5.55
September	16.66
October	25.00
November	94.11
December	100.00

When fed on 10% aqueous honey solution, longevity of unmated male and female *C. nigricollis* was 3.50 and 4.38 day respectively. The sex ratio was even during warmer months but, turned out in favour of females, 1:1.8 during September and October. *C. nigricollis* parasitized larvae of *C. medinalis* and *M. exigua* both during kharif and rabi but more in the former season. Its peak activity (35.0 to 48.7% parasitism) was observed during July and August in kharif season. During rabi season maximum parasitism due to *C. nigricollis* (8.0 to 18.0%) was observed during March and April. Among the three species of rice leaf folders prevalent in Odisha, *C. nigricollis* attacked only *C. medinalis* and *M. exigua* but, not *Brachmia arotraea* Meyer.

During the course of study, *Brachymeria* sp., *Orgilus* sp., *Trichomalopsis (Eupteromalus) parnarae* Gahan and *Elasmus* sp. were reared as pupal hyper-parasitoids of *C. nigricollis*. The cumulative hyper-parasitism ranged from 0.8 to 2.5%.

Singh and Prasad (1970) observed that four eggs were laid by *Cardiochiles hymeniae* in its host *Hymenia recurvalis*, but only one parasitoid developed. In the present study also up to three developing larvae of

C. nigricollis were observed in the body cavity of the host larva but, only one parasitoid developed ultimately. They also observed that field population of *C. hyminae* disappeared after first week of September, despite the presence of its host population and concluded that *H. recurvalis* was an alternative host for the parasitoid. However, in the present study field population of *C. nigricollis* disappeared by December as the entire parasitoid population entered diapause. Such overwintering was observed by Lopez (1982) in *C. nigriceps* parasitizing *Heliothis armigera* (Hubner) on *Cajanus cajan* in Texas. He observed over-wintering in the pest as well as the parasitoid. Butler *et al.* (1983) observed that at temperatures below 22.5°C, the insects remained in diapause. In the present study overwintering was noticed in the parasitoid only. The gradual increase in the number of *C. nigricollis* entering diapause in the field population appears to be due to occurrence of a heterogenous population of *C. nigricollis* in the field which responded gradually to fall in atmospheric temperature. Runjie *et al.* (1996) studied the relationship between temperature and functional response in *C. philippinensis* and concluded that the highest attack rate was at 28°C but, was followed by a decrease with increasing temperature. Yu-jie *et al.* (1991) recorded 22.7 days as the duration for completion of life cycle, whereas in the present investigation it was observed to be 16.5 days and 15.3 days for females and males, respectively.

ACKNOWLEDGEMENTS

The author is grateful to the Director, International Institute of Entomology, London for identifying the parasitoid and hyperparasitoids.

REFERENCES

- Ayyar TVR. 1927. The parasitic hymenoptera of economic importance noted from south India. *Bull Ent Res.* **18**(1): 73–78.
- BabyRani W, Amutha R, Muthulakshmi S, Indira K, Mareeswari P. 2007. Diversity of rice leaf folders and their natural enemies. *Res J Agri Biol Sci.* **3**(5): 394–397.
- Banarji DK, David H. 1982. Record of some hymenopterous parasites of the gregarious leaf roller *Neomarasmia suspicalis* Wkr. *Entomon* **7**(3): 334–335.
- Barrion AT, Litsinger Medina JA, Aguda RM, Bandong JP, Pantua Jr PC, Viajante VD, dela Cruz CG, Vega CR, Soriano JS, Camang EE, Saxena RC,

- Tryon EH, Shepard BM. 1991. The rice *Cnaphalocrocis* and *Marasmia* (Lepidoptera: Pyralidae) leaffolder complex in the Philippines: Taxonomy, bionomics and control. *Philippine Entomol.* **8**: 987–1074.
- Butler GD, Hamilton AG, Lopez JD. 1983. *Cardiochiles nigriceps* (Hymenoptera: Braconidae): Development time and fecundity in relation to temperature. *Annals Ent Soc America* **76**(3): 536–538.
- Gurr GM, Read DMY, Catindig JLA, Cheng J, Liu J, Lan LP, Heong KL. 2012. Parasitoids of the rice leaffolder *Cnaphalocrocis medinalis* and prospects for enhancing biological control with nectar plants. *Agric Forest Ent.* **14**: 1–12.
- Hu XQ, Wu SX. 1987. Observations on the control effect of parasitic natural enemies on *Cnaphalocrocis medinalis* *Natural Enemies of Insects* **9**(4): 187–189.
- Lopez JDJP. 1982. Emergence pattern of an overwintering population of *Cardiochiles nigriceps* in Central Texas. *Env Entomol.* **11**(4): 838–842.
- Martin PB, Lingren PD, Greene GL, Grissel EF. 1982. The parasitoid complex of three noctuidae (Lepidoptera) in a northern Florida cropping system: seasonal occurrence, parasitization, alternate hosts and influence of host habitat. *Entomophaga* **26**(4): 401–419.
- Rao VP, Chacko MJ, Phalak VR, Rao HD. 1970. Leaf feeding caterpillars of paddy and their natural enemies in India. *J Bombay Nat Hist Soc.* **66**(3): 455–477.
- Runjie Z, Heong KL, Domingo IT. 1996. Relationship between temperature and functional response in *Cardiochiles philippinensis* (Hymenoptera: Braconidae), a larval parasitoid of *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae) *Env Ent.* **25**(6): 1321–1324.
- Singh RP, Prasad B. 1970. Bioecological notes on *Cardiochiles hymeniae* Maxfischer and Baldev Prasad (Braconidae: Hymenoptera). *Indian J Ent.* **32**(2): 127–129.
- Tillman PG, Mullinix Jr. BG. 2003. Comparison of host-searching and ovipositional behaviour of *Cardiochiles nigriceps* Viereck (Hymenoptera: Braconidae), parasitoid of *Heliothis virescens* (Fabricius) (Lepidoptera: Noctuidae), in tobacco and cotton. *J Insect Beh.* **16**(4): 555–568.
- Yu-jie G, Heong KL, Basilio RP. 1991. Life history of two braconid parasitoids of rice leaffolder (LF) in the laboratory. *IRRN* **16**(2): 22–23.