



Research Article

Biology of *Diaeretiella rapae* (Mc Intosh) (Hymenoptera: Aphidiidae) on cabbage aphid (*Brevicoryne brassicae* Linnaeus) and influence of host age on the developmental duration

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ABSTRACT: The biological parameters of *Diaeretiella rapae* and influence of the host age on the life cycle of the *D. rapae*. The fecundity of *Diaeretiella rapae* was 120-140 eggs per female. Eggs were transparent white but appeared light brownish under high magnification. Average incubation period was 1.90 days. Larvae of *D. rapae* underwent four moults. The first instar larva was transparent white, mandibulate, caudate and measured 0.57 mm in length and 0.14 mm in width and was active. The second instar larvae were creamy white and curved slightly, lacked mandibles, salivary gland and were hymenopteriform. They measured 0.77 mm in length and 0.19 mm in width. Third instar larvae were light yellow in colour, hymenopteriform and measured 1.22 mm in length and 0.43 mm in width. Fourth instar larvae measured 2.76 mm in length and 0.87 mm in width. The average total larval duration of *D. rapae* was 7.50 days. When the aphid host died, its body changed to hardened exoskeleton called mummy. Pupa measured 2.0 mm in length and 0.80 mm in width with average pupal duration was 5.60 days. Under laboratory condition, egg to adult development of *D. rapae* ranged from 13.75 to 16.00 days with an average of 15.0 days. The adult female parasitoid was bigger than male. Adult female measured 2.13 mm in length while male 1.78 mm in length. Longevity of adult was 6.4 days when 10% honey solution was provided and 4.4 days without honey solution. The life cycle parameters of parasitoid varied with the age of host insect. On 48 hrs old nymph of *B. brassicae*, the total duration required to form mummy was 13.6 days, in comparison to 14.6 days in case of 72 hrs old nymph and 11.5 days in case of 96 hours old nymphs. Total life cycle duration of the parasitoid was completed in 19.3 days, 20.1 days and 17.2 days when reared on 48 hrs, 72 hrs, and 96 hrs old nymph of *B. brassicae* respectively which indicated that the days required to form mummy, pupal period and duration from egg to adult emergence was comparatively shorter when *D. rapae* was reared on 96 hours old *B. brassicae* nymphs.

KEY WORDS: *Diaeretiella rapae*, *Brevicoryne brassicae*, fecundity, biology and life cycle.

(Article chronicle: Received: 04-03-2015; Revised: 18-03-2015; Accepted: 27-03-2015)

INTRODUCTION

The cabbage aphid, *Brevicoryne brassicae* is a serious pest of cabbage in India and is considered as one of the most damaging and consistently present insect causing 35-75% reduction in yield, (Rohilla *et al.*, 1987 and Shoaib, 2003) and 6% reduction in oil contents on Indian mustard (Singh *et al.*, 1987). The hymenopteran parasitoid *Diaeretiella rapae* (McIntosh) is most abundant parasitoid of *B. brassicae* (Couchman and King, 1977).

The hymenopteran parasitoid *Diaeretiella rapae* (Mc Intosh) is the most abundant parasitoid of *B. brassicae* (Saleh, 2008; Saleh *et al.*, 2009; Pramanik and Dey, 2012;

Saleh *et al.*, 2006, and Couchman and King, 1977). *Diaeretiella rapae* is a common cosmopolitan parasitoid with a wide range of host such as green peach aphid (*Myzus persicae*), Russian wheat aphid (*Diuraphis noxia*, *Rhopalosiphum padi* and *Schizaphis graminum*), cotton aphid (*Aphis gossypii*), broadbean aphid (*Aphis craccivora*), corn leaf aphid (*R. maidis*), reed plant aphid (*Hyalopterus pruni*) and oleander aphid (*A. nerii*) (Elliott *et al.*, 1994; Pike *et al.*, 1999; El- Heneidy *et al.*, 2006; Saleh *et al.*, 2006, and Saleh and Gatwaary, 2007).

Aphid mortality is caused by parasitisation resulting in decline in aphid number with apparent increase in mummy number. Host age as well as host species have an impact on

successful biological control. The choice of suitable aphid instar can effect considerably the population growth of both host and parasitoid.

The information on *Diaeretiella rapae* in relation to *Brevicoryne brassicae* is scanty and therefore a study was undertaken to study some biological parameters of *D. rapae* on cabbage aphid, *B. brassicae*. This study will help to utilize this biological control agent in various integrated pest management programme against various *B. brassicae*.

MATERIALS AND METHODS

The life cycle of *D. rapae* was studied in 2013-14 in laboratory, Department of Entomology, Central Agricultural University, Imphal (Manipur) by releasing 10 pairs of newly emerged *D. rapae* adults in glass jars containing cabbage seedlings with 100 to 150 *B. brassicae* (host) nymphs cultured in the laboratory. 10 percent honey solution soaked in cotton swabs were provided as food to the adult parasitoids. The parasitized aphids on cabbage seedlings were taken out after 24 hours and replaced by fresh cabbage seedlings with new aphid colonies. 10 aphids were dissected daily under stereoscopic binocular microscope (Karl Zeiss Stemi 2000-C) and various developmental stages of *D. rapae* such as eggs, larval instars, pupa were observed. Mummies formed were kept separately in glass vials for recording the date of adult emergence. Size of egg, larval instars, pupa and adults and their description were made under stereoscopic binocular microscope. The female parasitoid was dissected in normal saline after 2 days of emergence and the fecundity was determined by counting the eggs after teasing out the ovaries under microscope. Adult longevity was determined by releasing twenty adult *D. rapae* in petriplates supplied with 5% honey solution and without honey.

To study the influence of host age on the developmental duration of *D. rapae*, cabbage aphid nymphs of different ages such as 48 hrs (2 days old), 72 hrs old (3 days old), 96 hrs old (4 days old) were selected as representatives of different sizes. Age of the cabbage aphid nymphs was positively correlated to the size of the nymph. Hundred numbers of adult aphids were transferred to a fresh plant and were allowed to produce nymphs provided with the cotton swab containing 10% honey solution as food for adult parasitoids in three different glass jars. About 15 numbers of adult parasitoids were released on cabbage aphid nymphs with different age group in the glass chimneys and were covered by fine muslin cloth held tight by rubber band and the process was repeated until the death of the parasitoids. Later on, those parasitized nymphs were removed after 24 hours and replaced by fresh cabbage seedlings with new

aphid colonies. Once the parasitised aphids were mummified, they were separated out and kept in glass vials for adult emergence. Observations were recorded for days required to form mummy, pupal period and total duration of *D. rapae*.

RESULTS AND DISCUSSION

The fecundity of *D. rapae* was 120 to 140 eggs. The eggs were deposited in the haemocoel of host aphid after stinging the host body with its ovipositor. Egg was ovoid and tapered anteriorly and posteriorly. Egg colour was transparent white but appeared light brownish under high magnification and was 0.69 mm in length and 0.25 mm in width. Incubation period was 1.90 days. However, Hafez (1961) reported that *D. rapae* can lay a maximum of 175 eggs and minimum of 25 eggs. It appears that the fecundity of *D. rapae* is inconsistent (Fig. 1).

The parasitic stage of *D. rapae* was the larval stage and the larvae underwent four moults during their development in the host body. Similarly, Spencer (1926) and Stary (1970) also reported that *D. rapae* underwent four moults. The first instar larva was transparent white and fed on the soft tissues of the host body (Fig. 2). It was mandibulate with black jaws and thick cuticle. They were clearly segmented with head, three thoracic segments and ten abdominal segment. The last abdominal segment had a well developed simple cauda. Salivary gland was present which enabled them to produce catalytic secretion causing biodegradation of host tissue before ingestion. Couchman and King (1977) also reported that the thicker cuticle of first instar larvae compared to second and third instar protected them from self digestion. It measured 0.57 mm in length and 0.14 mm in width. They fed on host embryos and other tissues and were very active. The second and third instar was creamy white to light yellow hymenopteri form, slightly curved and lack mandibles and salivary gland. (Fig. 3, 4). Cuticle was not thick. They lived in the host haemocoel and fed on liquid or semi-liquid food using sucking movement created by muscular pharynx. The caudal was reduced very much and caudal spines were absent. Second instar larva measured 0.77 mm in length and 0.19 mm in width while the third instar was 1.22 mm in length and 0.43 mm in width (Table 1).

Fourth instar larva was yellowish, mandibulate with strongly chitinized brownish jaws (Fig. 5). The caudal end of the abdomen was bluntly round but anterior portion was comparatively pointed. Larva was strongly curved in shape with no trace of cauda. Similar description was given by Spencer (1926), Stary (1970), Bodlah (2012) and Couchman and King (1977). They fed on the developing embry-

os and tissues of the host aphid. Fourth instar larvae were active like that of the first instar. It measured 2.76 mm in length and 0.87 mm in width. The total larval duration of *D. rapae* was 7.00 to 8.00 days (Table1).

The fully grown parasitoid larva pupated inside the host body (Fig. 6). Before pupation, the final instar made a small hole on the ventral side of the host which then fixed the aphid to the substrate by a secretion. The final instar larva spined a cocoon for protecting itself from any external injury. When the aphid host died, its body changed into a hardened exoskeleton called mummy (Fig. 7). In the beginning, differentiation started among the head, thorax and abdomen. In subsequent days, antennae, legs and wings started to develop but transparent in colour. Further, on the subsequent days, the head and thorax changed to dark brownish to black in colour. Once the development inside the mummy was completed, the adult made a small circular hole on the dorsal part of the abdomen of mummified aphid for adult emergence. The pupa measured 2.0 mm in length and 0.80 mm in width. The average pupal period of the parasitoid was 5.00-6.00 days.

The adult female parasitoid was bigger than the male. The head and thorax were blackish in colour. The antenna was dark brownish to black in colour. The abdomen and legs were brownish in colour. Wings were transparent and hyaline, pterostigma was greenish yellow in colour. Antenna was filiform and mostly 14 segmented in female sometimes 13 or 15 segmented and comparatively shorter than male (Fig. 8). The antenna in male was 16 to 17 segmented, scape and pedicel were almost of same length. The flagellar segments were of equal in length except terminal flagella which was comparatively longer. The adult female measured 2.13 mm in length. The adult male measured 1.78 mm in length (Fig. 9). The total life cycle duration from egg to adult emergence took 15.0 days with a range of 13.75- 16.00 days (Table 1). The adult longevity of the parasitoid was 6.0 to 7.0 days when 5% honey solution was provided and was 4.0 – 5.0 days without honey solution. Adult female lived for 10-15 days and males lived for 7-10 days. And the sex- ratios were usually divergent from equality and generally female-biased.

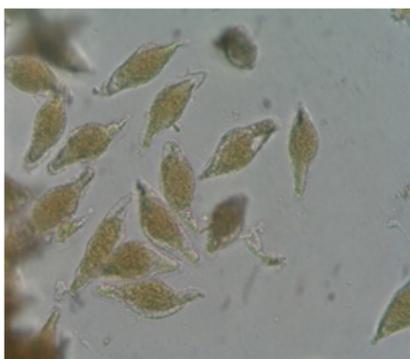


Fig. 1. Eggs.



Fig. 2. First instar larva.



Fig. 3. Second instar larva.



Fig. 4. Third instar larva.



Fig. 5. Fourth instar larva of *D. rapae*.

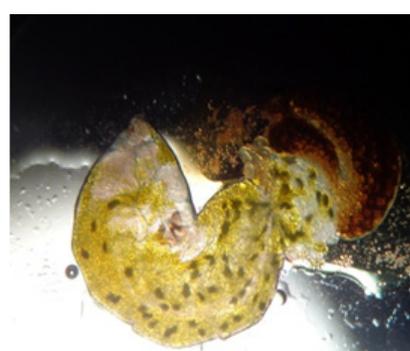


Fig. 6. Pupae.



Fig. 7. Mummy with emergence hole on the upper side.



Fig. 8. Adult female.



Fig. 9. Adult male.

Table 1. Incubation, larval, pupal and total life cycle duration of *Diaeretiella rapae*

Parameters	Mean \pm S.D	Range
Incubation Period (in days)	1.90 \pm 0.02	1.75 – 2.00
Larval Period (in days)	7.50 \pm 0.15	7.00 – 8.00
Pupal Period (in days)	5.60 \pm 0.15	5.00 – 6.00
Total life cycle duration (Egg to adult emergence) in days	15.0 \pm 0.23	13.75 – 16.00

Data based on 10 individuals.

Table 2. Influence of host age on the development period of *Diaeretiella rapae*

Age of the host (<i>B. brassicae</i>)	Days required to form mummy		Pupal period (days)		Total Duration	
	Mean days \pm S.D	Range (in days)	Mean days \pm S.D	Range (in days)	Mean days \pm S.D	Range (in days)
48 hrs old nymph	13.6 \pm 0.15	13.0- 14.0	5.60 \pm 0.15	5.0- 6.0	19.3 \pm 0.10	19.0 - 20.0
72 hrs old nymph	14.6 \pm 0.18	14.0 - 16.0	5.50 \pm 0.10	5.0- 6.0	20.10 \pm 0.20	19.0 - 21.0
96 hrs old nymph	11.5 \pm 0.10	11.0- 12.0	5.70 \pm 0.12	5.0- 6.0	17.2 \pm 0.20	16.0- 18.0

Data based on 15 individuals

Influence of host age on the development of *D. rapae*

The life cycle parameters of the parasitoid varied with the age of the host insect. On 48 hours old nymph of *B. brassicae*, the total duration from egg laying to the formation of mummy was 13.6 days with a range of 13.0-14.0 days while the pupal period was 5.60 days with a range of 5.0 - 6.0 days. The total life cycle duration of the parasitoid was completed in 19.3 days with an average of 19.0-20.0 days. On 72 hours old host nymphs, the total duration from egg laying to formation of mummy was 14.6 days with a range of 14.0-16.0 days while the pupal period was 5.50 days with a range of 5.0-6.0 days. The total duration required for completion of life cycle from egg to adult emergence was 20.1 days with a range of 19.0 - 21.0 days when the parasitoid was reared on 72 hours old nymph. The days required to form mummy, pupal period and total duration of life cycle from egg to adult emergence was comparatively shorter when reared on 96 hours old nymphs of *B. brassicae*. The duration from egg laying to the formation of mummy was 11.5 days with a range of 11.0-12.0 days while the pupal period was 5.70 days with a range of 5.0 -

6.0 days and the total duration from egg to adult emergence was 17.2 days with a range of 16.0-18.0 days (Table 2). It was found that 96 hours old i.e. four days old nymph took shorter duration for completion of development from egg to adult. Therefore, the present study indicates there is scope to culture parasitoid on fourth stage aphid nymph which took shorter duration for the formation of mummy, pupa and total life cycle for adult emergence.

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