Biology of *Retipenna jubingensis* (Hölzel) (Neuroptera: Chrysopidae) from Murshidabad, West Bengal

Santi Ranjan Dey

Department of Zoology, Berhampore Girls' College,
Berhampore, Murshidabad, West Bengal
Email: srdey1@rediffmail.com

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Abstract

The family Chrysopidae (Neuroptera) includes many species that could be considered important biological control agents. The chrysopids, are studied for their obligate relationship with the aphids. Biology of chrysopid comprising the study of development, reproductive potential, larval consumption, rate of survival of the larvae and eggs and longevity of adult, helps in assessing the predatory efficiency. The biology of *Retipenna jubingensis* (Hölzel), an aphidophagous chrysopid, was studied from Murshidabad, West Bengal, India. The egg, larval, pupal description, their development, oviposition, fecundity and longivity of the adult were noted along with their predatory efficiency. At a relatively high average temperature (27 ± 2.1ºC) *Retipenna jubingensis* (Hölzel) found to be better predator than other chrysopids.

Keywords: Chrysopid, aphid control, *Retipenna jubingensis* (Hölzel), biological control

1. Introduction

Natural enemies of insect pests are important in pest management. They can reduce or eliminate pesticide use. The order Neuroptera of Insecta comprises of the alder flies, ant lions, dobson flies, dusty wings, lacewings, owl flies and the snake flies. They are cosmopolitan in distribution and in general exhibit a carnivorous habit. The larvae of many species and the adults of a some species are predaceous on many insects like aphids, coccids and other soft-bodied insects. As many of these prey insects are recognised as pests, Neuroptera are valuable allies of Man. Their frequent association with aphids and carnivorous nature offers a better scope to the people for deploying some of these Neuropteran insects in biological control measures. Three larval instars of three families of Neuroptera (Chysopidae, Coniopterygidae, Hemerobiidae) are found to be active predators, as are some of the adults.

2. Biological Control Using the Chrysopids

Biological control, within an integrated pest management program, is a challenging but potentially very beneficial tactic to develop[1]. Biological control is a method of controlling pests through the use of natural enemies in agriculture that is an environmentally sound and effective means of mitigating pest density[2]. The family Chrysopidae includes many species that could be considered important biological control agents. Green lacewings (Neuroptera: Chrysopidae) have long been recognized as effective biological control agents of a wide variety of arthropod pests, but their use has been directed almost exclusively toward the augmentative method for years[3,4].

Chrysopid larvae (Neuroptera: Chysopidae) are of great economic importance in agriculture. Chrysopids, commonly termed as green lacewings, are known to feed on over 80 species of insects and 12 species of tetranychid mites[5]. The chrysopids, are studied for their obligate relationship with the aphids. Aphids attack a wide variey of plants, both cultivated and wild and are established as major pests of several economically important plants[6]. The works on effectivity of natural enemies of aphids were initiated by in the sixties by some workers[7,8].

The elimination or addition of the predator have rapid visual effect on the population dynamics of aphids. For controlling aphid species attack in several economically important plants, use of chrysopids is being increasingly recognised throughout the world. Though all the adults are not predators but larvae of this family are aphidophagous in habit.

The antagonistic roles of Chrysopidae against aphids have been investigated both in open fields and greenhouse. The behavior of the adult, larvae and distribution in time and place of eggs in peach and vine[9]. It was found that the eggs were laid in the lower surface of the peach leaves whereas in vine it was laid on both the surface. Most of the Chrysopidae are arboreal for their larvae, relatively little moving than Hemerobiidae, rather few species occur on natural low vegetation. There are approximately 80 green lacewing species in the Mediterrianean region, about 20 are part of the natural beneficial fauna in the crops and the anthropic environment[10]. Review of aphid management by Neuroptera are found from the works of some authors[11, 12]. 21 species of chrysopidae associated with 22 different aphid species from Western Himalay[13] Information about Neuroptera and aphid association from Murshidabad district is got from the survey report[14].

3. Study Area

Murshidabad is a district of West Bengal in eastern India. The Murshidabad district has 26 blocks, lying between 23°43'30" and 24°50'20" north latitudes and 87°49'17" and 88°46' east longitude. The rich fertile clayey-loam, loam, loamy-sandy etc. soils provide the local population to pursue agriculture as a primary occupation. Situated on the left bank of the river Ganges, the district is very fertile. Rice, jute, legumes, oilseeds, wheat, barley, and mangoes are the chief crops in the east; extensive mulberry cultivation is carried out in the west. The district is known for the quality and diversity of mango produced. The cropping pattern of Murshidabad District is high diversification in many blocks where irrigation and other favorable facilities entertains multiple cropping system[15]. The notorious aphid *Brevicoryne brassicae* (L.) is a common and destructive pest of mustard, causing serious losses to oil seeds.

4. Biology of Chrysopid

Biology of chrysopid, which is the study of development, reproductive potential, larval consumption, rate of survival of the larvae and eggs and longevity of adult, helps in assessing the predatory efficiency. Thus the information from chrysopid biology is important if the predator is to be used in the biological control of a particular aphid pest [16]. Genus

Retipenna Brooks under family Chrysopidae of the order Neuroptera has eight species of which *Retipenna jubingensis* (Hölzel) is found from India. An attempt has been made to study the egg, larval and pupal structure; developmental period; larval consumpton; oviposition; egg, larval and pupal survival and predatory efficiency of *Retipenna jubingensis* (Hölzel) by rearing it on the aphid *Brevicoryne brassicae* Linnaeus.

5. Materials and Methods

Pupae of *Retipenna jubingensis* (Hölzel) were collected in the brassica field and reared in Berhampore Girls' College, Murshidabad, West Bengal, India. After the emergence of adults, several pairs of *R. jubingensis* (Hölzel) were placed for mating in open mouth transperant plastic vials (7.2 x 7cm), mouth covered with nylon net. Gravid females were provided with aphid infested plant parts, these aphids were the food source and stimulus for oviposition. A thin aluminium sheet was placed inside each container which was taken out after each day of oviposition to prevent cannibilism by the adult and then counted. Freshly hatched larvae (10 in number) were placed in seperate containers and counted number of aphids *Brevicoryne brassicae* L. (last instar and adults) were given to them as food. Obeservations were made to record the duration of each life stage. Surviving aphids were removed and freash aphids of the same stge were offered to the predator daily. Mortality of the respective developmental stages were observed. To get the actual number of aphid consumed, dead aphids were removed from the cointainer and the number of alive aphids were recorded. Temperature was recorded daily for 3 months (November to January), is found to be $27 \pm 2.1^{o}C$ and the experiment was conducted for two consecutive seasons (2012-2013).

6. Results

Egg (Fig. 1, Plate 1): Elongated, oval in shape, solitary with stalk, 0.82-0.86 mm in length and 0.39-0.45 mm in breadth. When freshly laid, whitish in colour and yellowish during the incubation period, later become greyish yellow and segments of the embryo are visible through the chorion. Micropyle, a white flattened disc shaped structure.

Larva: There are three larval instars -

First Instar Larva: After 4-6 days larvae hatches out from eggs and come down through the stalk. Larva tapering caudate, 1.10-1.89 mm in length and 0.30-0.48 mm in breadth at the third thoracic segment, no marking on head, no cervical segment, presence of trumpet shaped empodium in legs, well developed basally dilated claws, external morphological characters were not prominent. Prominent head and jaws, body hairy, head relatively larger than body.

Second Instar Larva: The first instar moults after 3-5 days, fully grown second instar 2.10-2.98 mm in length, 0.45-0.69 mm in width at thoracic region, with elongated caudal segments, other characters are same as third instar larva.

Third Instar Larva (Fig. 2, Plate 2): After 2-3 days the second instar moults into third instar. Mature larva is spindle shaped, much longer than wide, 7.10-8.85 mm in length and 1.45-2.51 mm in breadth.

Head: Prognathus; strongly chitinised than rest of the body; triangular in outline; brown in colour; 0.71-0.87 mm in length, 0.85-0.90 mm in width; dorsal side without any markings; numerous long and short pointed hairs present. Mandibles highly pointed, curved, 1.33-1.35 mm in length, longer than head, at apex five backwardly directed saw like serrations present. Maxillae 1.21-1.26 mm in length, similarly curved, blunt apex bearing minute sensory hairs, inner groove start from the apex, both mandible and maxilla have series of closely set oblique internal ridges probably to crush the solid particles. Labial palp 4-segmented 0.82 mm long, basal segment short with 3-4 minute hairs, second one from base long with 5-6 long hairs and its lateral margin serrated due to presence of a series of broad transverse thickenings, third segment short and stout with three long hairs and distal one fusiform in shape, hairless, lateral margin shows annulations, apex with a tuft of sensory hairs. Antenna 5 segmented, filliform, longer than jaws, 1.16-1.18 mm in length, scape short, stout, without hairs; second segment very long, strengthened by annular band of thickenings, lateral margin serrated, setaeless; third one is smaller than the second, setaeless, bears narrow transverse rows of dense thickenings, lateral margin serrated; fourth and fifth segment bristle like, three ocelli present on the ventral side of the antennal base.

Thorax: Brownish in colour; numerous long and short hairs on dorsal side; each segment with a pair of tubercles; a pair of spiracles in between meso- and metathorax; anterior subsegment of prothorax shorter, not so well developed. The legs well developed; with femur and tibiae of about equal length; single segmented tarsus; basally dilated claws; elongated trumpet shaped empodium, the apex of which is hollow, cup like, furnished internally with many minute hairs.

Abdomen: 10 segmented; elongated; tapering caudate; the first eight segments with lateral pairs of annular spiracles; last abdominal segment with tail like structure; dorsal side have some long, fine hairs; ventral side spinulated. Body densely covered with microscopic spinules.

Pre-Pupa: Mature third instar larvae after 6-8 days enter innto the prepupal stage. The larvae leave their support and look for a dark place when ready to spin their cocoons; darkness is not essential for spinning but dry substratum is always preferable than wet. Pre-pupa with a comma shaped structure, head ventrally located, 2.70-3.06 mm in length and 2.32-2.51 mm in breadth.

Cocoon: Cocoons oval in shape and the silk used are always fine and white. The cocoon is thin, parchment like but very tough. It is not a true double structure; on the outer side there are a number of loose supporting strands. At the anterior end a circular, hinged lid is present for emergence of the adult.

Pupa (Fig.3): The pupa brownish in colour; globular in shape, 2.66-2.87 mm in length and 1.68-1.96 mm in breadth; wings and limbs folded ventrally. Brownish or brownish-green wing pad; eye dorsally located, brownish in colour. Antenna turn round just above the eyes and run longitudinally down the wing pads, then curve ventrally, cross one another and turn back towards the head for a short distance; heavily chitinised symmetrical mandibles, the apices of which are bilobed, internal margins are armed with two blunt teeth; abdomen curved ventrally; second and third abdominal segments with a hump on dorsum.

Adult: The pupa emerge as adult by cutting open the pupal skin and rupturing the cocoon shell after 9-12 days.

Development: *Retipenna jubingensis* (Hölzel) passes through three larval stages. The development was studied at avarage 27 ± 2.1 °C feeding on *Brevicoryne brassicae* Linnaeus. Duration of each instar showed that the second instar develop fastest (3-4 days) whereas the third instar larvae take a maximum of 6-8 days. The first instar moult after 3-5 days. Pupal period last for 9-12 days. Thus the larvae take 20-28 days to develop.

Larval Voracity (Table-I): Prey consumption is different in different developmental stages at an avarage of 27 ± 2.1°C. It was found that *Brevicoryne brassicae* Linnaeus is the preferred food for *R. jubingensis* (Hölzel). The first instar larvae consume 27-42 (35.91± 6.32) aphids, the second instar consume 54-78 (66.12± 10.87) aphids but huge uptake of aphids is by the third instar where 122-142 (134.21± 9.84) aphids are consumed. The avarage daily larval consumption was 16.15 ± 3.2 aphids.

Survival: Survival of the egg, larvae and pupae was 97%, 85% and 83% respectively. Larval mortality was high in the first instar due to poor adaptability to the environment.

Oviposition: 71-113 eggs were laid by the adults. When the gravid female oviposit, a sticky secretion comes out first, which hardens to form the filament of the eggs. The eggs are laid next with the micropylar ends coming out last.

Longevity: The adult live on honey up to 17 days. Old age was the common cause of death of the adults.

6. Discussion

Aphid control schedule in India is mainly based on chemical poisons because of its immediate effectiveness. Several aphid associated insects and their role as predators are known from the Indian region. But their effectiveness as predators has not been estimated critically. Yet many such predators may help in suppressing the aphid infestation below the economic threshold level.The green and brown lacewings show many favourable traits such as wide prey range and high voracity to be considered potential biological control agents[17].

7. Efficiency of *Retipenna jubingensis* (Hölzel) as a Predator:

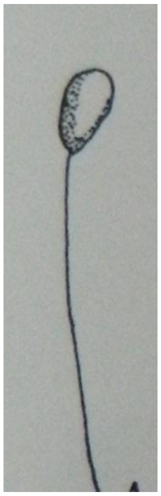
The efficiency of Chrysopidae as predator of aphids was studied in different species. It was found the preimaginal developmental period were 31.9, 26.7 and 20.6 days in *Chrysopa oculata* Say*, Chrysoperla plorabunda* (Fitch) and *Chrysoperla rufilabris* (Burmeister) respectively while feeding on *Aphis gossypii* at 25ºC[3]. Abid *et al* (1978) observed the preimaginal period of *Chrysopa septempunctata* Wesmael was 28.0 days while feeding on *Myzus persicae*[18]. For *Chrysoperla mutata* (McLachlan), while feeding on *Hyalopterus pruni* at 25 ± 1.0ºC, 3.1 and 17.4 days required for egg and larval development[18]. *Retipenna jubingensis* (Hölzel) is found to complete its generation within 24-34 days (27 ± 2.1ºC) similar to the other predators but at a higher temperature[18]. Prey consumption of *Retipenna jubingensis* (Hölzel) (total 203-262 aphids) in its larval period (11-16 days) was much lower than *Chrysopa septempunctata* Wesmael. The latter consumed 1108 aphids (*Aphis gossypii*) at 12.6-16.1 ºC. This is due to the larger size of *Chrysopa septempunctata* Wesmael and longer larval duration at low temperature. But at 25ºC *Chrysopa oculata* Say and *Chrysoperla plorabunda* (Fitch) consumed 243- 399 and 227-409 aphids (*Theriaphis maculata*)[19]. So the aphid consumption of *Retipenna jubingensis* (Hölzel) was quite similar to that of *Chrysopa oculata* Say and *Chrysoperla plorabunda* (Fitch) but at slightly higher temperature [19].

The future of biological control in agriculture will be played in two different arenas: the enhancement of "big" technology (biotechnology, industry, worldwide market) to apply to large scale productions, and the increase of "sustainable" technology to apply to local development policies[20]. *Retipenna jubingensis* (Hölzel) have the potential to contribute in both these arenas and become a key player as in Integrated Pest Management (IPM).

TABLE - I

Duration in days and larval consumption (Mean ± SD) of the immature stages of *Retipenna jubingensis* (Hölzel) reared on *Brevicoryne brassicae* Linnaeus (at 27 ± 2.1ºC)

Stage	Duration in days	No. of aphids consumed / arva	Average no. Aphids consumed / larva
Egg	4-6	----	----
1st instar larva	3-5	27-42	35.91 ± 6.32
2nd instar larva	2-3	54-78	66.12 ± 10.87
3rd instar larva	6-8	122-142	134.21 ± 9.84
Pupa	9-12	---	----
Total	**24-34**	**203-262**	**238.38± 25.77**



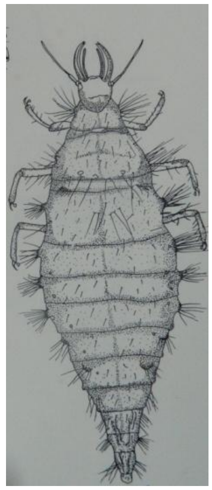


Figure 1: Egg Figure 2: Larva (3rd Instar) Figure 3: Pupa

Plate 1: Egg Plate 2: 3rd Instar Larva

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