# Developmental stages of *Hemerobius indicus* Kimmins (Hemerobiidae: Neuroptera) from western Himalaya, India

Santi Ranjan Dey

Department of Zoology, Berhampore Girls' College,
Berhampore, Murshidabad, West Bengal
[1]

Date of Submission: 30th August, 2014 Date of Acceptance: 22nd September, 2014

## Abstract

*Hemerobius indicus* Kimmins are very active foragers and predate upon the aphid *Prociphilus himalayensis* Chakrabarti infesting *Lonicera sp* in Western Himalaya. Developmental history of *Hemerobius indicus* Kimmins, an endemic aphidophagous hemerobid, was studied from Western Himalaya, India. The egg, larval, pupal developmental stages of *Hemerobius indicus* Kimmins were studied in detail. Oviposition, fecundity and longevity of the adult were noted along with their predatory efficiency. At low temperature (18 ± 1.9ºC) *Hemerobius indicus* Kimmins found to be a more efficient predator than other Hemerobiidae members.

**Key Words:** *Hemerobius indicus* Kimmins, Western Himalaya, Developmental stages, Hemerobiidae, Neuroptera

Email: srdey1@rediffmail.com

## 1. Introduction

The brown lacewings (Hemerobiidae) of the insect order Neuroptera are widely distributed throughout the world and are aphidophagous. Three larval instars of all three families of Neuroptera (Chysopidae, Coniopterygidae, Hemerobiidae) are found to be active predators, as are some of the adults[1]. Brown lacewings (family Hemerobiidae) are not as commonly seen as green lacewings because they prefer wooded areas. Members of the family Hemerobiidae are active predators of small aphids, coccids and other soft bodied insects. The sensitive ends of maxillae brushes against the aphids, by which the larvae sense and predate upon them. This sensory mechanism is probably due to poor vision. A revision of the family[2,3] revealed that nearly 500 species are found throughout the world[4,5]. Only 22 species are known from India[5]. *Hemerobius indicus* Kimmins is an endemic species described by Kimmins (1938) from the southern part of India. Only 6 species were reported from the Western Himalaya[6, 7].

## 2. Advantage of the Hemerobiidae Members Over Other Predators

**Low developmental threshold temperature:** Research interest about studying the life history of Hemerobiidae is due to the low developmental threshold temperature which is usually lower than most of the other predators and aphid prey[8]. Well adapted synchronisation with the host aphid population and as well as better reproductive numerical response than some other predators which enables them to be more efficient predators. These interesting characteristics of their life cycle give them an added advantage. This may enable Hemerobiidae to play an important role in biological contro,l especially early in the season when the aphid population is very small[9, 10].

**High fecundity rate:** Several reserach work has shown that Hemerobiidae have a high fecundity rate when reared on aphids in confinement. The large number of eggs laid by several members of Hemerobiidae were observed by various workers viz. *Hemerobius pacificus* Banks laid 715 eggs[8], *Boriomya subnebulosa* (Stephens) laid 1045 eggs[11], *Eumicromus angulatus* (Stephens) laid 1500-2300 eggs[12], *Micromus subanticus* (Walker) laid 898 eggs[13], *Micromus tasmaniae* Walker laid 116-583 eggs[10], and *Micromus vinaceus* (Gerstaecker) laid 558.61 eggs[14]. This high fecundity of the hemerobids may render them useful for commercial rearing purpose.

## 3. Study of the Biology of Indian Hemerobiidae

*Hemerobius indicus* Kimmins are very active foragers and predate upon the aphid *Prociphilus himalayensis* Chakrabarti infesting *Lonicera sp* in Western Himalaya. The genus *Lonicera* contains more than 200 species worldwide and is distributed in temperate and subtropical regions. It is commonly known as honeysuckle. Most of the species are small

trees or shrubs. Honeysuckle is cultivated in private gardens as an ornamental because of its large, fragrant flowers and brilliant red fruits. Aphid attack on honeysuckle causes economic loss as the plants a cultivated on a commercial basis as ornamentals.

*Hemerobius indicus* Kimmins was reported during the month of April to September. At the end of spring and beginning of early summer the adult *Hemerobius indicus* Kimmins appeared from the hibernating pupae when other predators were absent due to low temperature. The larvae walk with a side to side motion of the head.

The information about the early stages of the life cycle of Hemerobiidae is scanty. Early studies on the voracity of *Hemerobius pacificus* (Banks) [15] and *Micromus posticus* (Walker) [16] showed that *H. pacificus* (Banks) consumed an average of 25 aphids per day whereas *M. posticus* (Walker) had 41 aphids per day. The larval developmental period have an obligate relationship with the aphid population. It is reported that the larval duration has variation [13] found the larval duration (4-10 days) in *M. posticus* (Walker). The larval duration in *Micromus tasmaniae* Walker when reared on *Brevicoryne brassicae* (Linnaeus) the larval duration was 6-10 days at 25ºC. [10] The larval voracity of the aphidophagous *Hemerobius indicus* Kimmins was considerable[17].

This investigation is to study their develpmental history of *Hemerobius indicus* Kimmins with the detailed description of the developmental stages. The larval duration and adult longevity was also noted. Their reproductive potential and predatory efficiency of the developmental stagesof *Hemerobius indicus* Kimmins was also studied.

## 4. Materials and Methods

Pupae of *Hemerobius indicus* Kimmins was collected in the field and reared in the temporary station in Harsil-Dharali valey (2620msl), Uttranchal, India. After the emergence of adults, several pairs of *Hemerobius indicus* Kimmins were placed for mating in open mouth transparent plastic vials (7.2 x 7cm), mouth covered with nylon net. Gravid females were provided with aphid infested *Lonicera* sp 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 separate containers and number of aphids counted. *Prociphilus himalayensis* Chakrabarti (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 fresh aphids of the same stage 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. All the rearing and testing were done at 18 ± 1.9ºC with sufficient moisture range and 16 : 8 light : dark ratio.

## 5. Results

The different developmental stages are as follows:

**Egg** Eggs are elongate, elliptical without a stalk unlike that of Chrysopidae; anterior end with prominent button like micropyle; attachment site is very minutely flattened; surface of chorion under high magnification shows minute, raised, reticular arrangements. Freshly laid eggs are pale yellow in colour, darkens during incubation; 0.78-0.81 mm in length.

**First Instar Larva:** All the body characters are not prominent except the trumpet shaped empodium of legs. After 6-7 days, the first instar larvae come out; 1.10-1.67 mm in length; pale, yellowish white in colour, after 24 hrs become brownish.

**Second Instar Larva**: Immediately before moulting cuticle become dull; posterior portion become broader than earlier instars; the terminal portion of abdomen stick firmly with the substratum. The skin split along the thorax and posterior part of the head. The trumpet shaped empodium is reduced into pad like empodium; brown in colour. After the first moult the second instar larvae came out; 2.10-2.61 mm in length.

**Third Instar Larva** : The larval body somewhat flattened dorsoventrally; smooth in texture; covered with fine inconspicuous hairs; no setagerous tubercles are present.Body pale yellowish brown or deep cream in colour; 6.29-7.10 mm in length; spindle shaped, widest at the region of metathorax to first abdominal segment.

**Head:** The antennae arise from a prominence in between the eyes and the base of the mandibles; antennae three segmented; 0.59-0.62 mm in length; small pedicel with minute imbrications; second and third segment almost equal in length with lateral striations and serrated lateral margins. The head is pale yellow brown with a triangular dark brown area; 0.43-0.47 mm in length and 0.47-0.51 mm in width, covered with knobbed hairs. Head covered with knobbed hairs. Eyes black; two lateral brown bands run laterodorsally; each eye consisted of group of six ocelli. The jaws are stout, caliper like structures but shorter and less curved. The mandibles 0.50-0.51 mm long; more slender than maxilla and pointed internally with three barb like serrations near the tip. Ventral groove present, a thickening present in between the tip and midpoint. A number of oblique ridges are present ventrally. The maxilla 0.48-0.50 mm long, grooved dorsally, blunt ended with sense organs; the ventrolateral margin with four transverse ridges; one long seta present towards the apex of the groove at ventrolateral margin; dorsolateral margin bearing seven setae, 4 setae present inside the groove. Labium reduced. A pair of labial palp present, 0.47-0.49 mm long, each three segmented; first one as long as broad with 2 long hairs; second segment slightly longer than broad also with 2 long hairs; third segment striated laterally.

**Thorax:** Anterior prothorax with an anterio-dorsal thickening; mid prothorax with two crescent shaped lateral thickening, giving an impression of median triangular inner area and the posterior subsegment bearing a pair of lateral spiracles. Meso- and metathorax rather similar with anterior thickenings and faint lateral thickenings. Entire thorax covered with numerous minute tubercles and setae. The prothorax, 1.074-1.083 mm in length and 0.78-0.81 mm in width, distinctly divided into three subsegments. Thoracic hairs knobbed. Leg, length 1.61-1.64 mm, well developed; a transverse ring like thickening present at each joint; a pair of basally dilated claws, 0.050-0.053 mm long; small, median, padlike empodium present, tarsi 0.33% of the tibia with serrated lateral margin; stout tibial spine at the distal end; numerous hairs in the inner and outer margins (8-10 in number); femur also hairy (3-5 in both inner and outer margin).

**Abdomen:** Abdominal hairs are knobbed. Entirely covered with numerous, minute tubercles and setae; 1.48-1.51 mm in length; soft, tapered distally; first 8 segments bear a pair of spiracles on each; $10^{th}$ segment bearing one dorsal triangular plate, two lateral triangular plates and one longitudinal plate. A fully grown larva stops feeding and becomes bulky with lobed sides and distended abdomen.

**Cocoon:** Through the cocoon the inner pupa can be seen clearly. The cocoon elliptical in shape, double layered though the outer layer shows few strands; woven with fine white silk.

**Pupa**: Antenna curls round just above the eyes and runs longitudinally down the wing pads, again curves ventrally, crosses one another and turns back towards the head for a short distance. Head, anterior part of thorax and abdomen are curved ventrally. Body brownish in colour, wing pale (may be transparent but looks brownish due to brown body); antenna dark brown; eyes reddish brown; jaws well developed. At the base of the wing pads, mesothoracic spiracles are seen; abdominal spiracles 7-8 in number.

**Adult:** After 10-12 days of pupal stage, at the end of metamorphosis, pupa pushes itself outside through an irregular hole by tearing the cocoon. It crawls some distance, then takes rest on a hard support then the adult cuts open the pupal skin through the mid-dorsal line and comes out.

**Development:** *Hemerobius indicus* Kimmins passes through three larval stages before pupation. Duration of each instar shows that the second instar larvae develops fastest (within 4-5 days), while the third instar larvae takes the maximum number of days (9-11 days) for development. The pupal period is longer (10-12 days) which is almost twice the duration of the first instar larvae (5-6 days). Thus *H. indicus* Kimmins takes on an average 28-34 days for the metamorphosis of the larva into adult at 18±1.9ºC .

**Larval Voracity**: Prey consumption rate is different in different developmental stages at 18±1.9ºC. First instar larvae consume a mean number of 68.85 ±1.8 aphids (65-76 aphids per larva), about 16.63% of the total consumption and 12.51±1.2, about 3.02% of total aphids per day. Second instar larvae consume mean number of 103.14±9.09 aphids (94-137 aphids per larva), only 24.91% of total aphids consume and 22.92±2.2 aphids, about 5.54% of total aphids per day. The highest consumption is by the third instars, which consume 242±12.23 aphids (235-273 aphids per larva), 58.45% of total and 24.20±2.40 aphids, about 5.85% of total aphids consumed per day. The voracity of third instar is slightly higher than the second and 1.93 times higher than the first instar larva. The reslts are shown in Table I.

**Survival:** Survival of eggs, larvae and pupae were 72%, 78% and 85% respectively. Mortality occur because of variable abiotic factors.

**Oviposition and Fecundity:** Before oviposition females have large abdomens which can be easily noticed. Females bend their abdomen towards the substratum and oviposit. Females also secrete a sticky substance by which the eggs adhere to the substratum by their dorsal surface. Micropylar ends are last to appear. Eggs were laid in clusters of 3-5, mostly on the walls and floor of the container. Lowest number of eggs were 33 and the highest number of eggs laid were 172 by one female at 18 ± 1.9ºC with sufficient moisture range and 16 : 8 light : dark ratio.

**Longevity:** Adult longevity of *Hemerobius indicus* Kimmins was found to be 26-31 days while feeding on aphid, *Prociphilus himalayensis* Chakrabarti.

## 6. Discussion

*Hemerobius indicus* Kimmins completed its larval life in 18-22 days at 18± 1.9ºC. In the short larval period of 7-8 days *Micromus timidus* Hagen reared on *Lipaphis erysimi* at 29.5 ºC it consumed 140-179 aphids. [18] Whereas at low temperature 18± 1.9ºC *Hemerobius indicus* Kimmins completed its larval period within 18-22 days and consumed huge amount aphids 443.12± 67.21 (394-486 aphids). The average per larva per day consumption was 15.28 ±1.50 aphids and significantly higher than *M. timidus* Hagen. Thus *H. indicus* Kimmins appeared to be a much more efficient predator than *M. timidus* Hagen. At low temperature (18 ± 1.9ºC) *Hemerobius indicus* Kimmins found to be a more efficient predator than other Hemerobiidae members. This baseline data will be important if commercial rearing of *Hemerobius indicus* Kimmins is undertaken as a part of a biological control measure against aphids**.** Further investgations are required to determine the economic viability of using *Hemerobius indicus* Kimmins to control aphid infestation of honeysuckle, *Lonicera* sp. which is an important ornamental plant.

**Table I. Larval consumption (mean ± SD) of immature stages of *Hemerobius indicus* Kimmins reared on the aphid *Prociphilus himalayensis* Chakrabarti (at 18± 1.9ºC) along duration of each developmental stage**

| DEVELOPMENTAL STAGE | DURATION (IN DAYS) | AVERAGE APHID CONSUMPTION (MEAN ± SD) |
|---|---|---|
| EGG | 6-7 | ---------- |
| 1ST INSTAR LARVA | 5-6 | 68.85 ± 1.8 |
| 2ND INSTAR LARVA | 4-5 | 103.14 ± 9.09 |
| 3RD INSTAR LARVA | 9-11 | 242.00 ± 12.23 |
| PUPA | 10-12 | ---------- |
| TOTAL | 34-41 | 443.12 ± 67.21 |

## References:


1. S. R. Dey, *The Beats of Natural Sciences*. (ISSN-2348-7615) **1**, Issue 1 (March), Article No. 6. 1 (2014). url: *www.sncwgs.ac.in/academics/journal/the-beats-of-natural-sciences*
2. J. D. Oswald, *Journal of the New York Entomological Society*, **101,** 143 (1993)
3. B. Tjeder, In, South African Animal Life, Swedish Natural Science Research Council, Stockholm, **8**: 296 (1961).
4. C. Gillot, In, *Entomology*, Plenum Press, New York and London. (1995).
5. S. K. Ghosh, In, Faunal Diversity in India. ZSI publication. (1998).

6. D. K. Bhattacharya and S. R. Dey, *Trans. Zool. Soc*. East India, **4(2**): 49 (2000).
7. D. K. Bhattacharya and S. R. Dey, *Entomon* **26** (Spl. Issue): 320 (2001).
8. P. Neuenschwander, *Environmental Entomology***, 4**, 215 (1975).
9. T. R. New, *Trans. Royal. Ent. Soc. London*, **127,** 115 (1975).
10. T. R. New, In, Progress in *World Neuropterologgy. Proc.* 1st Int. Symp. Neur., 153 (1984).
11. J. P. Laffranque and M. Canard, *Annales de Zoologie, Ecologie Animale***, 7**: 331 (1975).
12. Y. Miermont and M. Canard, *Entomophage***, 20**, 179 (1975).
13. A. G. Selhime and R. F. Kanavel, *Annals of Entomological Society of America*, **61,**1212 (1968).
14. F. X. Williams, *Hawaiian Planterer's Record*, **31,** 146 (1927).
15. G. F. Moznette, In, Second Biennial Crop Pest and Horticultural Report, 1913-1914. Oregon Agricultural College Experiment Station, 181 (1915).
16. C. R. Curtright, *J. Ecol. Ent*., **16,** 448 (1923).
17. S. R. Dey and D. K. Bhattacharya, *J. Aphidology***, 11(1),** 129 (1997)**.**
18. D. N. Raychaudhuri, D, Ghosh, S. C. Poddar and S. K. Ghosh, *Science and Culture*, **47,** 223 (1981).