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BIOLOGY OF *Hemerobius indicus Kimmins* FROM WESTERN HIMALAYA, INDIA

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ABSTRACT

Biology of *Hemerobius indicus* Kimmins, an endemic aphidophagous hemerobid, was studied from Western Himalaya, India. The egg, larval, pupal description, their development, oviposition, fecundity and longivity of the adult were noted along with their predatory efficiency. *Hemerobius indicus* Kimmins egg, larval, pupal stages has taken 6-7, 18-22, 10-12 days respectively and the three instars of larval stage consumed 65-76, 94-137 and 235-273 aphids. At low temperature (18 ± 1.9°C) *Hemerobius indicus* Kimmins found to be better predator than some other Hemerobiidae.

KEY WORDS

Neuroptera, Hemerobiidae, *Hemerobius indicus*, Biology , Himalaya

INTRODUCTION

Hemerobiidae are characteristic of low vegetation - sometimes as a part of a very broad habitat range. Particular interest about studying their biology is because of their developmental threshold temperature which is very low, usually lower than those of most other predators and aphid prey (Neuenschwander, 1975), 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 a probable better predator than others. These interesting characteristics of their life cycle give them an added advantage and important role in biological control especially early in the season, when aphid population is very small (New, 1989). It is evidant from the successful introduction of Australian *Micromus vinaceus* to Hawaii (Williams 1927) and European *Hemerobius stigma* Stephens to control the balsam wooly aphid, *Adelges piceae* (Ratzeburg) in Canada (Garland 1978). Though Smith (1923) found that *Hemerobius* species in confinement either failed to oviposit or rarely laid more than 30-40 eggs, which he thought disadvantagious for the commertial rearing. But he noted in one occasion *Hemerobius humulinus* L. laid 460 eggs. In other cases, it was found that when feeding on aphids in confinement, Hemerobiidae lay large number of eggs noted by various workers viz. *Hemerobius pacificus* Banks laid 715 eggs (Neuenschwander, 1975, 1976), *Boriomya subnebulosa* (Stephens) laid 1045 eggs (Laffranque and Canard, 1975), *Eumicromus angulatus* (Stephens) laid 1500-2300 eggs (Miermont and

Canard, 1975), *Micromus subanticus* (Walker) laid 898 eggs (Selhime and Kanavel, 1968), *Micromus tasmaniae* Walker laid 116-583 eggs (New, 1984) and *Micromus vinaceus* (Gerstaecker) laid 558.61 eggs (Williams, 1927). This high fecundity of the hemerobids may render them useful for commercial rearing purpose. The oviposition rate is also dependent upon the light: dark ratio and temperature (Miller and Lambdin 1982). They found that even at 18.3 ± 1°C *Hemerobius stigma* Stephens lay a mean of 133 (72-176) eggs in 6 :18, light : dark ratio. Many Hemerobiidae undergoes a winter diapause as adults, such as *Eumicromus angulatus* (Stephens) (Miermont and Canard, 1975). Some develops slowly but do not diapause, as in case of *Boriomyia subnebulosa* (Stephens) (Laffranque and Canard, 1975). This character enabling them to attack the aphids early in the season when they just begin to appear.

Biology of hemerobiidae is much less studied in India than the west though a large number of species are found in this region and some of them are endemic, only the works of Radhakrishnan *et al* (1989) and Shantibala *et al* (1994) have provided some information on life history and population dynamics of *Micromus timidus* Hagen. *Hemerobius indicus* Kimmins is an endemic species described by Kimmins (1938) from the southern part of India. Earlier Dey and Bhattacharya (1997) reported their development and vorasity. The species was found to predate on *Prociphilus himalayensis* Chakrabarti infesting *Lonicera sp* in Western Himalaya. Here an attempt has been made to study their biology with egg, larva and pupal structure; their development and adult longevity, also with their reproductive potential and predatory efficiency.

MATERIAL AND METHOD

Pupae of *H. Indicus* were 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 *H. Indicus* 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 *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 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. All the rearing and testing were done at 18 ± 1.9°C with sufficient moisture range and 16 : 8 light : dark ratio.

RESULTS

Egg : Freshly laid eggs are pale yellow in colour, darkens during incubation; 0.78-0.81 mm in length. 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.

First Instar Larva: 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. All the body characters are not prominent except the trumpet shaped empodium of legs.

Second Instar Larva: After the first moult the second instar larvae come out; 2.10-2.61 mm in length. 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.

Third Instar Larva : 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; somewhat flattened dorsoventrally; smooth in texture; covered with fine inconspicuous hairs; no setagerous tubercles are present.

Head: 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. Eyes black; two lateral brown bands run laterodorsally; each eye consisted of group of six ocelli. 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 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. Head covered with knobbed hairs.

Thorax: 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. 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. 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: 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. Abdominal hairs are also knobbed. A fully grown larva stops feeding and becomes bulky with lobed sides and distended abdomen.

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

Pupa : 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. 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. 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±1.9°C .

Larval Voracity: Larvae of *H. indicus* Kimmins are very active foragers and predate upon the aphid *Prociphilus himalayensis* Chakrabarti. The larvae walk with a side to side motion of the head. 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. Prey consumption rate is different in different developmental stages at 18±1.9°C. 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.

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 ± 1.9°C 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.

Seasonal Occurrence: *Hemerobius indicus* Kimmins had been found during the month of April to September. During the early summer the adult insects appeared from the hibernating pupae when other predators were absent due to low temperature.

Efficiency of *Hemerobius indicus* Kimmins as a Predator: The information about the early stages of the life cycle of Hemerobiidae are scattered. Early studies about the voracity of *Hemerobius pacificus* (Banks) [Moznette,1915] and *Micromus posticus* (Walker) [Cutright,1923] showed that *H. pacificus* (Banks) ate an average of 25 aphids per day whereas *M. posticus* (Walker) consumed 41 aphids per day. The larval developmental period have an obligate relationship with the aphid population. Selhime and Kanavel (1968) found the larval duration (4-10 days) in *M. posticus* (Walker). New (1984) found 6-10 days at 25°C larval duration in *Micromus tasmaniae* Walker when reared on *Brevicoryne brassicae* (Linnaeus). *Hemerobius indicus* Kimmins completed its larval life in 18-22 days at 18± 1.9°C. Raychaudhuri et al (1981) studied *M. timidus* Hagen reared on *Lipaphis erysimi* at 29.5 °C found that in the short larval period of 7-8 days it consumed 140-179 aphids. Whereas at low temperature 18± 1.9°C *H. 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. Thus *H. indicus* Kimmins appeared to be a much more efficient predator than *M. timidus* Hagen.

Duration of days and larval consumption (mean ± SD) of immature stages of *Hemerobius indicus* Kimmins reared on *Prociphilus himalayensis* Chakrabarti (at 18± 1.9°C)

	Duration in days	No. of aphids consumed / larva	Average no. of aphids consumed / larva
Egg	6-7	---	---
1st instar Larva	5-6	65-76	68.85± 1.8
2nd instar Larva	4-5	94-137	103.14± 9.09
3rd instar	9-11	235-273	242.00± 12.23

Larva			
Pupa	10-12	---	---
Total	34-41	394-486	443.12± 67.21

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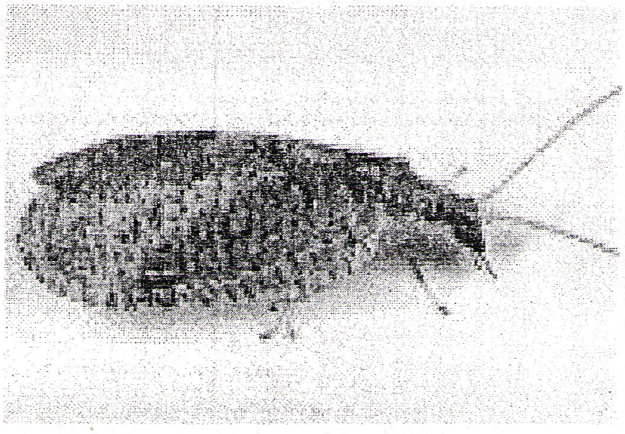
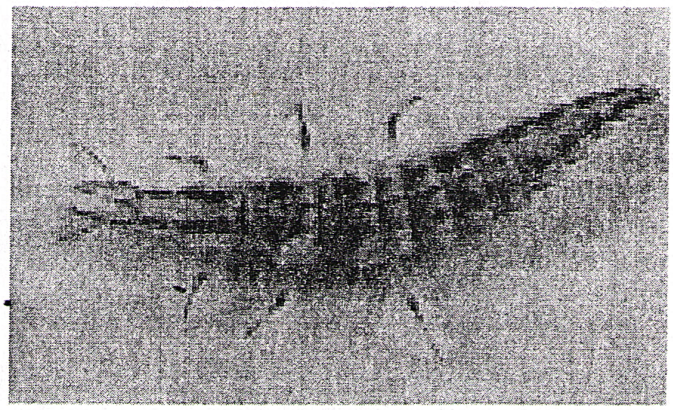
ADULT



LARVA



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