STUDIES ON BIOLOGY OF *GALERUCELLA PLACIDA* BALY INFESTING *POLYGONUM HYDROPIPER* LINN.

ROSHNA GAZMER, RAJKUMARI INDRANISANA, M.K. GUPTA

Abstract: *Galerucella placida* Baly is a small leaf beetle belonging to the family Chrysomelidae. *G.placida* feeds on aquatic weed *Polygonum hydropiper* Linn. The insect was reported from various regions of India during 1910- 1936. Investigation on some biological parameters of *G. placida* and influence of the host plant *P. hydropiper* on the life cycle of the *G. placida* was conducted in laboratory.

The results indicated that the fecundity of *G. placida* was 710-1210 eggs per female. Eggs were markedly bright yellow, pyriform basally rounded and oval at tip. It measured 0.72 mm in length and 0.47 mm in width. Average incubation period was 5.2 days.

Larvae of *G. placida* underwent three moults. The first instar larva was yellow in colour. The thoracic and abdominal segment was covered with long brownish bristles on brownish coloured raised tubercles and measured 1.25 mm in length and 0.46 mm in width. The second instar was yellowish in colour but after an hour of feeding, the colour of the grub changed to blackish brown from yellow. It measured 3.48 mm in length and 0.98 mm in width. The third instar was light yellowish in colour. Meso and meta thorax including entire abdominal segments were light yellowish and had black tubercles. It measured 4.66 mm in length and 1.41mm in width. The average total duration of *G. placida* was 10 days. The fully grown larvae fixes its abdominal tip on plant surface and went for pupation. The fully developed pupa looked black in colour and was C- shaped. Wings, legs and antenna starts developing and the pupa measured 3.83 mm in length and 2.04 mm in width. Adult emerges after 3.5-4.0 days. In adult there was no marked difference between the sexes except the posterior extremity of the abdomen. The adult female was bigger than male. The antennae were eleven segmented and annulate type, filiform and showed no sexual dimorphism. The adult male measured 4.75 mm in length and 2.04 mm in width and adult female measured 5.46 mm in length and 2.54 mm in width.

Longevity of adult male was 35.4 days and female adult was 40.4 days. Total life cycle duration of *G. placida* was completed in 19 days from egg to adult emergence.

Key words: *Galerucella placida, Polygonum hydropiper*, fecundity, biology and life cycle.

Introduction: *Polygonum hydropiper* (L.) is a warm or wet season annual herb, occurring wherever there is moist soil or standing water. It grows on poorly drained agricultural land, along creek, river, canal and stream banks, in marshes and swamps, in poorly drained hollows, and in seasonally flooded areas. *P. hydropiper* is a competitive weed in great many crops, especially in irrigated crops, in rice and in other crops grown on poorly drained soils (Holm *et al.,* 1997). The purplish seedlings of *P. hydropiper* are used as a relish with fish dishes in Japan, and the dried leaves as a condiment in South-East Asia (Holm *et al.,* 1997). Macerated plants are used as fish poison in India. It is also used for the treatment of haemorrhoids and as diuretic. *P. hydropiper* have significant biocidal properties, for example, against nematodes (Sukul, 1970). Cultural control of this weed required hand-pulling or mechanical control before flowering. They must be either uprooted or buried, as simply breaking the stem will result in resprouting at the soil surface. Little work has been conducted on the chemical control of *P. hydropiper*. In Korea, Park *et al*. (2005) showed that cyhalofop+bentazone and cyhalofop+pendimethalin gave good control of dryland rice weed mixture which included this species. Seong *et al*. (1991) obtained similarly good control with sequential applications of butachlor or benthiocarb (thiobencarb) followed by bentazone+quinclorac. In New Zealand pastures, Sanders and Rahman(1994) obtained good kill of *P. hydropiper* with thifensulfron. However, chemical control of weed is costly and requires long term application. Use of herbicides has detrimental effects on non target wetland plants. Contrary to this, biological control is highly cost effective, long term, non-polluting and self sustaining method of weed control. Biological control is defined as the human manipulation of a non- native plant's predators in order to manage its population.

The goal is not necessarily to completely rid the area of the invasive, but rather to regain control of the area so that an invasive monoculture can not establish and native plant communities can dominate. Lefroy (1909) reported a Chrysomelid beetle *Galerucella placida* Baly feeding on *P. hydropiper* from India. *G.placida* has wide distribution reaching Indo-china and Tonking on the east and Sumatra and Java on the south. It was reported from various regions *viz.* Srinagar (1917) in Kashmir, Jhellum valley (1918) in Punjab, Nainital (1918) and Lucknow (1911) in United Province, Pusa (1921) in Bihar, Burdwan (1906) in Bengal, Saraighat

(1909) in Assam (Maulik, 1936). Lefroy described the larval stage of *G. placida* and Maulik (1936) gave a brief description of *G. placida*. However, the insect was seen to feed on *P. hydropiper* voraciously and killing a large population of the plant in the Imphal region of Manipur state of India bordering Myanmar in 2011-2012. Considering the potentiality of the *G. placida* as a suitable biocontrol agent of *P. hydropiper*, it was thought worthwhile to study some aspects of biology of this insect.

Materials and Methods: The life cycle of *G. placida* was studied in 2013-14 in laboratory, Department of Entomology, Central Agricultural University, Imphal (Manipur). Field collected larva of *G. placida* feeding on smartweed, *P. hydropiper* (Plate.1) were reared on host leaves in glass petriplates (21 cm diameter) in the laboratory for pupation. Pupae formed were kept for emergence of adult beetle. The adult emerged were paired and released in potted plants in insect cages for mating and oviposition. The egg masses laid by the beetle were kept in petriplates over moist filter paper for hatching. On hatching, 20-25 neonate larvae were transferred to *P. hydropiper* leaves in glass petriplates (21 cm diameter) using a fine camel hair brush. The leaves of *P. hydropiper* were changed every alternate day with fresh leaves till pupation. The larvae were observed daily for moulting. Pupae formed were separated out and kept in a glass petriplates over moist filter paper till adult emergence. The adult emerged were paired and released on potted plants in insect cages for mating and oviposition.

Observation Recorded: Observation on Pre-mating and Mating period were recorded from 10 pairs of insect while Pre-oviposition, Oviposition and Post-oviposition period were recorded based on 10 individuals. Fecundity of the insect was recorded from 10 females and the hatching percentage obtained from 100 eggs. Adult longevity for male and female were recorded from 10 individuals.

Incubation period, duration of larval instars, total larval duration, pupal period and total life cycle duration from egg to adult emergence and egg to death of adult were recorded based on 10 individuals. Similarly, size of egg, larval instars, pupa and adult were recorded based on 10 individuals. Descriptions of egg, larval instars, pupa and adult beetle were made by observing under Stereoscopic binocular microscope (Karl Zeiss Stemi 2000-C).

Results and Discussion: The eggs of *G. placida* were markedly bright yellow, pyriform. It was basally rounded and oval at the tip (Plate. 3). Their length was 0.72 mm with a range of 0.70-0.75 mm and 0.47 mm width with a range of 0.45-0.50 mm (Table 1, Fig 1.). The incubation period was 5.2 days with a range of 5.0-6.0 days (Table 4 & Fig. 2.). The fecundity of *G. placida* was very high ranging from 710-1210 eggs with an average of 911 eggs per female. Similarly Urban (2007a &2007b) reported a very high fecundity of 122-887 eggs in case of Chrysomelid beetle *G. lineola* which similar to those obtained for *G. placida*.

The larvae of *G. placida* underwent three moults during their development. Similarly, related species *G. lineola* also moults three times as reported by Sadeghi *et al.* (2004). The first instar larva after hatching was light yellow in colour. Head capsule was brownish in colour. The thoracic and abdominal segments were covered with long bristles which were brownish in colour on raised tubercles.

The first instar larva measured 1.25 mm in length with a range of 1.15-1.35 mm and 0.46 mm in width with a range of 0.45-0.46 mm (Table 1, Plate 4 & Fig 1). The abdomen had 10 distinct segment and eleventh segment had a flat flap like structure at the caudal end. Three pairs of thoracic legs were distinct. The shape of the larva was elongate, almost parallel sided narrowing slightly anteriorly and posteriorly. The duration of first instar larva was 3.3 days with a range of 3.0-3.5 days (Table 2 & Fig. 2). The first instar larva after about three days of feeding underwent moulting. Immediately after casting off the old cuticle, the second instar larva looked yellowish in colour including head, leg, abdomen and thorax except the body hairs which were black in colour. After about one hour, it started feeding on host leaf and the colour of grub changed to blackish brown from yellow. The head, thorax, abdomen and legs became black including the body hairs. However, the inter segmental membranous portion were dirty white to yellowish in colour.

The prothoracic shield was black in colour and was distinct from meso and meta thorax. The black tubercles on the mesothorax, metathorax and the abdomen were arranged in longitudinal rows. There were four dorsal and two lateral tubercles arranged in longitudinal rows arising from black coloured chitinous plates or tubercle or warts of different size and shape. The last segment of the abdomen had the black coloured chitinous plate or tubercle of comparatively very large size and contained numerous bristles.

The second instar larva measured 3.48 mm in length with a range of 3.08-3.85 mm and 0.98 mm in width with a range of 0.77-1.08 mm (Table 1, Plate 4). The duration of the second instar larva was 2.3 days with a range of 2.0-2.5 days (Table 2& Fig 2.). The third instar larva was light yellowish in colour. Head was dark brownish to black in colour. Pro-thoracic shield was light brownish in colour. Meso and metathorax including entire abdominal segments were light yellowish and had black tubercles. The hairs arising from the black tubercles were black. Thoracic legs were black in colour. The last abdominal segment

was also black in colour. The third instar larva was a voracious feeder.

Full grown third instar larva stopped feeding and searched a suitable place on the the leaves and prepares for pupation. The colour of the larva becomes dark yellowish. The larva shrunk in body length. The tubercles became dark black in colour. The setae or hairs on the raised tubercles were black. The prothoracic shield became dark black in colour. The head was also dark black. Legs were black. After two days, the larva fixed its abdominal tip on the plant surface and underwent moulting. The moulted skin remained attached to the abdominal tip of the grub. The black coloured tubercles on the thorax and abdominal segments disappeared and appeared light brownish in colour. However, the body still appeared light yellow in colour. The exoskeleton get sclerotised and darker in colour on the thoracic and abdominal segments. Antennae and wings start developing. The third instar larva measured 4.66 mm in length with a range of 4.46-4.92 mm and 1.41mm in width with a range of 1.23-1.54 mm (Table 1, Plate 5 & Fig. 1). The duration of third instar larva was 4.4 days with a range of 4.0-4.5 days (Table 2). The total larval duration was 10 days with a range of 9.5-10.5 days (Table 2 & Fig. 2). The fully developed pupa looked black in colour. Wings, legs and antenna started developing. The head, thorax and abdomen turned black in colour. The appearance of pupa was C-shaped. The pupa measured 3.83 mm in length with a range of 3.69-4.00 mm and 2.04 mm in width with a range of 2.00-2.15 mm (Table 1). The duration of pupa was 3.8 days with a range of 3.5-4.0 days (Table 2 & Fig. 2). However, the pupal duration in case of *G.calmariensis* was 4 days (Matos and Obrycki 2007) which is similar to those of *G. placida*.

Adult Longevity: The longevity of the adults of *G.placida* was considerably long. The adult female lived longer than those of male counterpart. The average female longevity was 40.4 days with a range of 29.0-44.0 days. While the average male longevity was 35.4 days with a range of 28.0- 49.0 days (Table 4 &Fig. 3).

Life cycle duration: The total life cycle duration from laying of egg to adult emergence varied from 18.0–20.0 days with an average of 19.0 days (Table 2 & Fig. 2). Similarly, Yadav and Gargav (1992) obtained a total life cycle duration of 15.5 to 44 days in case of *G. birmanica*.

Oviposition and Mating: After about 2-3 days of intense feeding on the leaves of *P. hydropiper,* the imagoes mate for the first time. The females copulate repeatedly. The copulating imagoes were observed in the nature as well as in the laboratory nearly the whole period of occurrence. The average pre-mating period of the insect was 2.25 days with a range of 2.0-2.5 days. The average mating period lasted 12.5 minutes with a range of 10.0-15.0 minutes (Table 3). However, Sadeghin *et al.* (2004) reported pre-mating and mating period of about a week and oviposition period of 15 days in case of *G. lineola.*

The pre-oviposition period was 4.2 days with a range of 3.0-5.0 days. The insect had a long oviposition period of 44.5 days with a range of 38-50 days. However, the post-oviposition period was comparatively of shorter period of 1.0-2.0 days with an average of 1.35 days (Table 3).

Adult: The general colour of the adult was dirty brown (Plate 2& 6). The adult male measured 4.75 mm in length with a range of 4.46-4.92 mm and 2.04 mm in width with a range of 2.00-2.15 mm (Table 4.& Fig. 3). The female adult measured 5.46 mm in length with a range of 5.23-5.85 mm and 2.54 mm in width with a range of 2.15-2.92 mm (Table 4, & Fig. 3)). Similarly Maulik, (1936) also reported length of adult beetle of *G. placida* was 5.00 mm and width of 2.5 mm. The duration of adult from egg to adult emergence was 19.0 days with a range of 18.00-20.00 days and from egg to death of adult was 55.3 days with a range of 47.50-67.00 days (Table 2).

There was no marked difference between the sexes except for the posterior extremity of the abdomen. Comparatively, the female was slightly larger than the male and her body was slightly broader. When the body was in its natural position only the head, the prothorax and the elytra were visible. Between the prothorax and the elytra, the subtriangular scutellum was seen which was the only part of the meso-cum-metathorax visible from above. The rest of the body was covered by elytra which extended a little behind the posterior limit of the last abdominal segment. The filiform antennae were situated close together in front of the convex eyes and due to the close approximation of their bases constrict the part of the fronto clypeal area which lied between them.

This area showed no difference between the sexes as was common in many Galerucinae. Out of the five visible abdominal sternites, the last showed modification in the two sexes owing to the exigencies of copulation. The entire body of the beetle was covered with fine hairs which were specially abundant on the ventral surface of the tarsi.

Table 1: Size of Egg, Larval Instars and Pupa of *G. placida*

	Mean/Size in mm (± S.D)			
Stage	**Length**	**Range**	**Width**	**Range**
Egg	0.72 ± 0.26	0.7 0 - 0.75	0.47 ± 0.03	0.45 - 0.50

Instar I	1.25 ± 0.06	1.15-1.35	0.46 ± 0.04	0.45 - 0.46
Instar II	3.48 ± 0.25	3.08-3.85	0.98 ± 0.71	0.77 - 1.08
Instar III	4.66 ± 0.15	4.46 - 4.92	1.41 ± 0.12	1.23 - 1.54
Pupa	3.83 ± 0.11	3.69 - 4.00	2.04 ± 0.07	2.00 - 2.15

Data based on 10 individuals

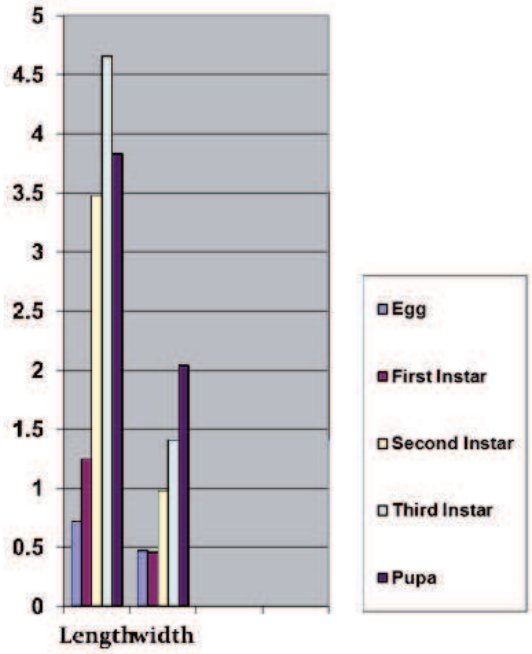

Fig.1: Size of Egg, Larval and Pupa of *G. placida.*

Table 2: Incubation, Larval, Pupal and Total life cycle duration of *G.placida.*

Parameters	**Mean (days) ± S.D**	**Range**
Incubation Period (in days)	5.2 ± 0.42	5.0 - 6.0
Instar I	3.3 ± 0.26	3.0 - 3.5
Instar II	2.3 ± 0.26	2.0 - 2.5
Instar III	4.4 ± 0.39	4.0 - 4.5
Larval Period (in days)	10 ± 0.41	9.5 - 10.5
Pupal Period (in days)	3.8 ± 0.26	3.5 - 4.0
Total life cycle duration from Egg to adult emergence	19.0 ± 0.62	18.0 - 20.0

Data based on 10 individuals.

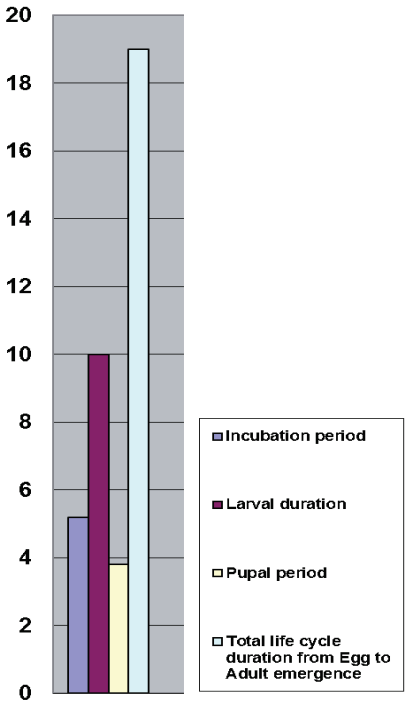

Fig.2: Incubation, Larval, Pupal and Total life cycle duration of *G.placida*

Table 3: Pre-mating, Mating, Pre-oviposition, Oviposition and Post-oviposition period of *G. placida*:

Parameters	**Mean (days) ± S.D**	**Range**
*Pre-mating period (in days)	2.25 ± 0.26	2.0 - 2.5
*Mating-period (in mins)	12.5 ± 1.78	10.0 - 15.0
**Pre-oviposition period (in days)	4.2 ± 1.03	3.0 - 5.0
**Oviposition period (in days)	44.5 ± 1.78	38.0 – 50.0
**Post-oviposition period (in days)	1.35 ± 0.47	1.0 - 2.0

* Data based on 10 pairs.

Table 4: Size of Adult *G.placida*

Size of Adult *G. placida* in mm (Mean ± S.D.)				
Sex	Average Length	Range	Average Width	Range
Male	4.75± 0.15	4.46 - 4.92	2.04 ± 0.07	2.00 - 2.15
Female	5.46± 0.20	5.23 – 5.85	2.54± 0.29	2.15 - 2.92

Data based on 10 individuals

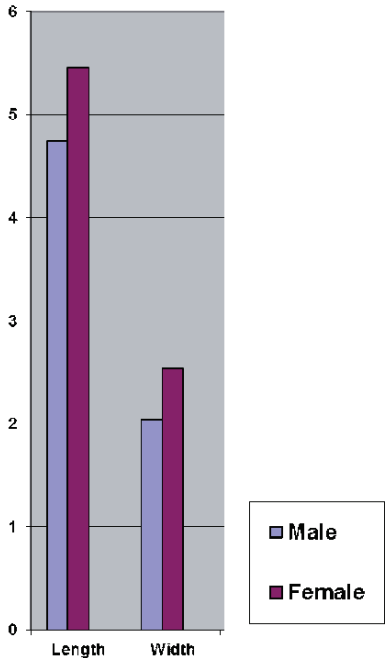

Fig.3: Size of adult Male and Female of *G. placida*

Plate 1. *Polygonum hydropiper* with Chrysomelid beetle *Galerucella placida* Baly. feeding on it.

Plate 2. Chrysomelid beetle *Galerucella placida* Baly.

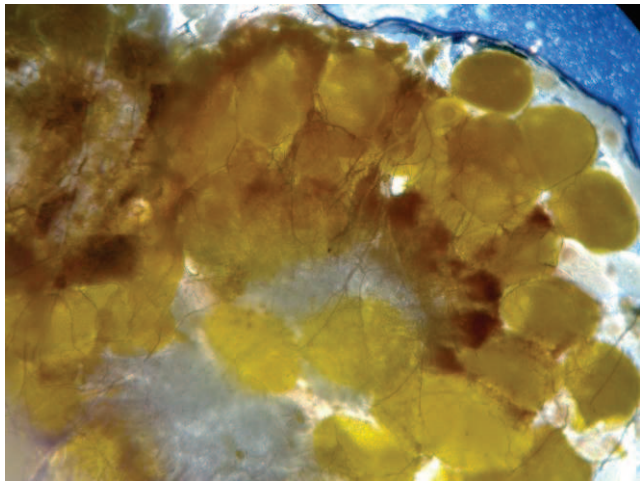

Plate 3: Eggs of *Galerucella placida* Baly.

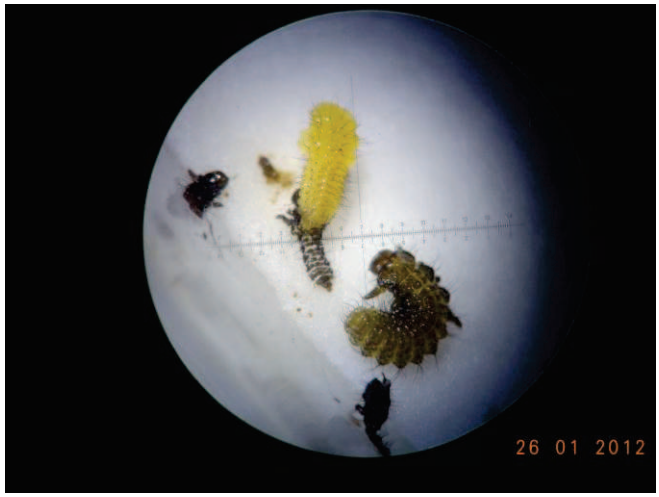

Plate 4 . The First instar and second instar larvae of *Galerucella placida* Baly.

Plate 5: The Third instar larvae of *Galerucella placida* Baly.

Plate 6: Female and male of *Galerucella placida* (Baly) respectively.

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Roshna Gazmer/ Rajkumari Indranisana/ M.K. Gupta/
Department of Agricultural Entomology/College Of Agriculture/Central Agricultural University/Lamphel/ Post Box No. 23/ Imphal/Pin: 795004/ Manipur/ India/