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BIONOMICS OF AN APHIDOPHAGOUS COCCINELLID PREDATOR *PSEUDASPIDIMERUS CIRCUMFLEXA* (MOTSCHULSKY) (COCCINELLIDAE : ASPIDIMERINI)

S. C. PODDAR

Entomology Laboratory, Department of Zoology, University of Calcutta, Calcutta

AND

A. K. GHOSH

Zoologicial Survey of India, Calcutta

(With 4 Text-figures and 2 Tables)

INTRODUCTION

The genus *Pseudaspidimerus* was described by Kapur (1948) while revising the tribe Aspidimerini Weise to include *circumflexa* (Motschulsky), *uttami* Kapur, *flaviceps* (Walker), *mauliki* Kapur and *pulcher* (Weise). *Pseudaspidimerus circumflexa* (Motsch.) is the only determined species under the genus known to be aphidophagous from India (Kapur, 1948 ; Puttarudriah and Channa basavanna, 1955, '56 ; Behura, 1963 ; Rao, 1969 ; Pushpaveni and Krishnamurty, 1971 ; Jhonson, 1979). Very little information is known about the biology of the different species under the genus *Pseudaspidimerus*. Tao and Chiu (1971) recorded the developmental period of different immature stages i.e. egg, larva and pupa of *P. japonesis* Nakane et Araki, in Taiwan; they suggested that the beetle prefers to feed on *Aphis citricola* v. d. Goot. *A. gossypi* Glover, *Toxoptera citricicidas* (Kirk.), *T. aurantii* (Boyer) and *Aphis craccivora* Koch.

Pushpaveni and Krishnamurty (1971) recorded *P. circumflexa* to feed on sugarcane aphid viz., *Longiunguis sacchari* Zehntner and also noted the developmental period of egg, larva and pupa of this beetle in India. Besides, *P. circumflexa* (Motsch.) has also been recorded to be aphidophagous by several workers from India (Kapur, 1948 ; Puttarudriah and Channa basavanna 1955, '56 ; Behura, 1963 ; Rao, 1969 ; Puspaveni and Krishnamurthy, 1971 ; Jhonsen, 1979). However, bionomics of this bettle specially the external morphology of different immature stages remained unknown. During the course of present biological studies of *Aphis craccivora* Koch and its natural enemies in West Bengal, bionomics of five species of Coccinellids viz., *Coccinella septempunctata* Linnaeus, *C. transversalis* Fabricius, *Menochilus sexmaculatus* (Fabricius) under the tribe Coccinellini, *Pseudaspidimerus circumflexa* (Motschulsky) under the tribe Aspidimerini and *Scymnus* (*Pullus*) *pyrocheilus* Mulsant,

under the tribe Scymnini could be worked out. Of this, the present paper deals with the biological studies of *P. circumflexa* only.

Materials and Methods

Studies on the seasonal occurrence of *P. circumflexa* (Motsch.) was made in the fields of Calcutta and its surroundings. These fields were visited at a fortnightly interval for two years. In order to study the developmental history, mode of feeding and voracity of this beetle following methods were adopted : A gravid female was collected in the field from *Dolichos lablab* which was found to be infested by *Aphis craccivora* Koch and this collection was made using glass vials (5″ × 1″) ; insect was then brought to the laboratory where it was transferred to a wide mouthed glass jar (6″×4″). The open end of jar was then covered with a piece of cloth, tied with a rubber guarder. Eggs laid by the gravid female were used for the purpose of study ; single egg was transferred to each jar for studying either the life history or the voracity of the insect. Each of such jar was provided daily with sufficient but counted number of aphid i.e. *A. craccivora* with fresh plant parts. From the day of transference of the eggs, observations were made at twenty four hours interval in order to note the developmental period of egg, larva and pupa and also to note the rate of of feeding of larva and adult. Ten and eight replications were used to study the life history and voracity respectively. This work has been carried out at the laboratory conditions from the end of December to end of February, 1980-1981, with temperature and relative humidity ranging between 23-29° C and 44-64% respectively and again during June to August, 1981 with temperature and relative humidity ranging between 30-36° C and 69-82% respectively.

Results

A. Distribution and prey range :

The members of tribe Aspidimerini Weise, are known to be aphidophagous coccinellids (Kapur, 1848 ; Sasaji, 1971 ; Hodek, 1973), which are confined mainly to the Oriental region. The genus *Pseudaspidimerus* was originally reported from Burma, Sri Lanka, India, Java, Philippines and Thailand (Kapur, 1948) ; later the distribution of the genus *Pseudaspidimerus* has been extended to Taiwan (Tao and Chiu, 1971). Tao and Chiu (1971) suggested that *P. japonensis* Nakane et Araki, is known from southern Japan and Taiwan but Sasaji (1972) mentioned in the "Fauna Japonica" only two species viz., *Cryptogonus orbiculus* (Gyllenhal)

and *C. horishanus* (Ohta) from Japan. *P. circumflexa* is only known in India, Burma and Sri Lanka ; in India, the species being mostly found in eastern and southern part.

P. circumflexa has been recorded to feed on as many as six aphid species viz., *Aphis craccivora* Koch, *A. citricola* van der Goot, *A. gossypi* Complex, *A. nerii* Boyer de fonscolombe, *Aphis* Spp. and *Longiunguis sacchari* Zehntner. During the course of present study the predator has been found to feed on three species of aphids.

B. Predator—prey association and seasonal occurrence :

P. circumflexa (Motsch.) has been found to feed on *Aphis craccivora* Koch, *A. gossypi* Glover and *Lipaphis erysimi* (Kaltenbach) in the area of present investigations. These different aphids occur on a varied groups of plants. Occurrence of these aphids on their host plants appear to be somewhat seasonal and the incidence of aphid prey of this predator influences the incidence of the predator on such host plants (Table—1).

TABLE 1. Seasonal occurrent of *P. circuflexa* (Motsch.) preying on different aphids affecting their host plants.

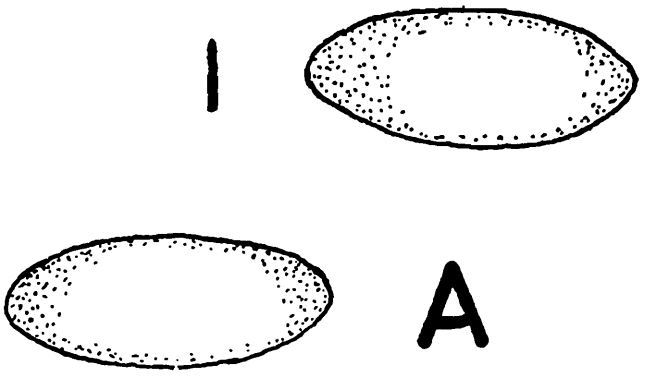
Aphid species	Plant species	Period
Aphis craccivora Koch	*Cassia alata*	VI—X, (1979 and 1980)
	Cassia sophera	VI—VIII (1979 and 1980)
	Cassia tora	VI—IX (1979)
		VI—VIII (1980)
	Dotichos lablab	IX—II (1979-80 and 1980-81)
	Phaseolus mungo	XIII—III (1979-80 and 1980-81)
	Vicia faba	X—II (1979-80 and 1980-81)
	Vigna catjang	VI—VII & XI—III (1979-80 and 1980-81)
Aphis gossypi Complex	*Gossyplum* sp.	XII—I (1979-80 and 1980-81)
	Psidium guyajava	VI—VIII (1979 and 1980)
Lipaphis erysimi (Kaltenbach)	*Brassica nigra*	XII—I (1979-80 and 1980-81)

From table-1, it appears that this predator is polyphagous in habit. During winter-spring season the predator has been found to prey upon all the aphid species recorded in this locality which serve as its prey and on the same prey aphids infesting different host plants. During rainy season (June to August) the predator could be found to prey upon *Aphis craccivora* Koch infesting different *Cassia* and *Vigna* species and *Aphis gossypi* complex infesting *Psidium guajava*. Of the *Cassia*, *C. alata* is a perennial plant and the others are seasonal plant. On *C. alata*

the predator could also be found with the aphids, in the month of September and October, probably because of the physiological condition of the plant which is suitable for these insect. During rainy season these leguminous weeds act as reservoir of these insects. Here, it may be mentioned that though both the prey and predator could be found to occur during the different climatological period excepting the hottest months i. e. April and May, they appear to be more abundant during the cooler months.

C. Developmental Biology :

Egg (Text-fig. 1) : Fggs are usually laid in batches though sometimes laid singly under the aphid exuvae on the leaf near the aphid colony. The number of eggs laid in each batch varies from 2-8. These are about 0.62-0.64 mm. in length and about 0.36-0.39 mm. maximum width, oval in shape and brownish in colour. Incubation period lasts for 2-3 days during December to February and 2 days during June to August.

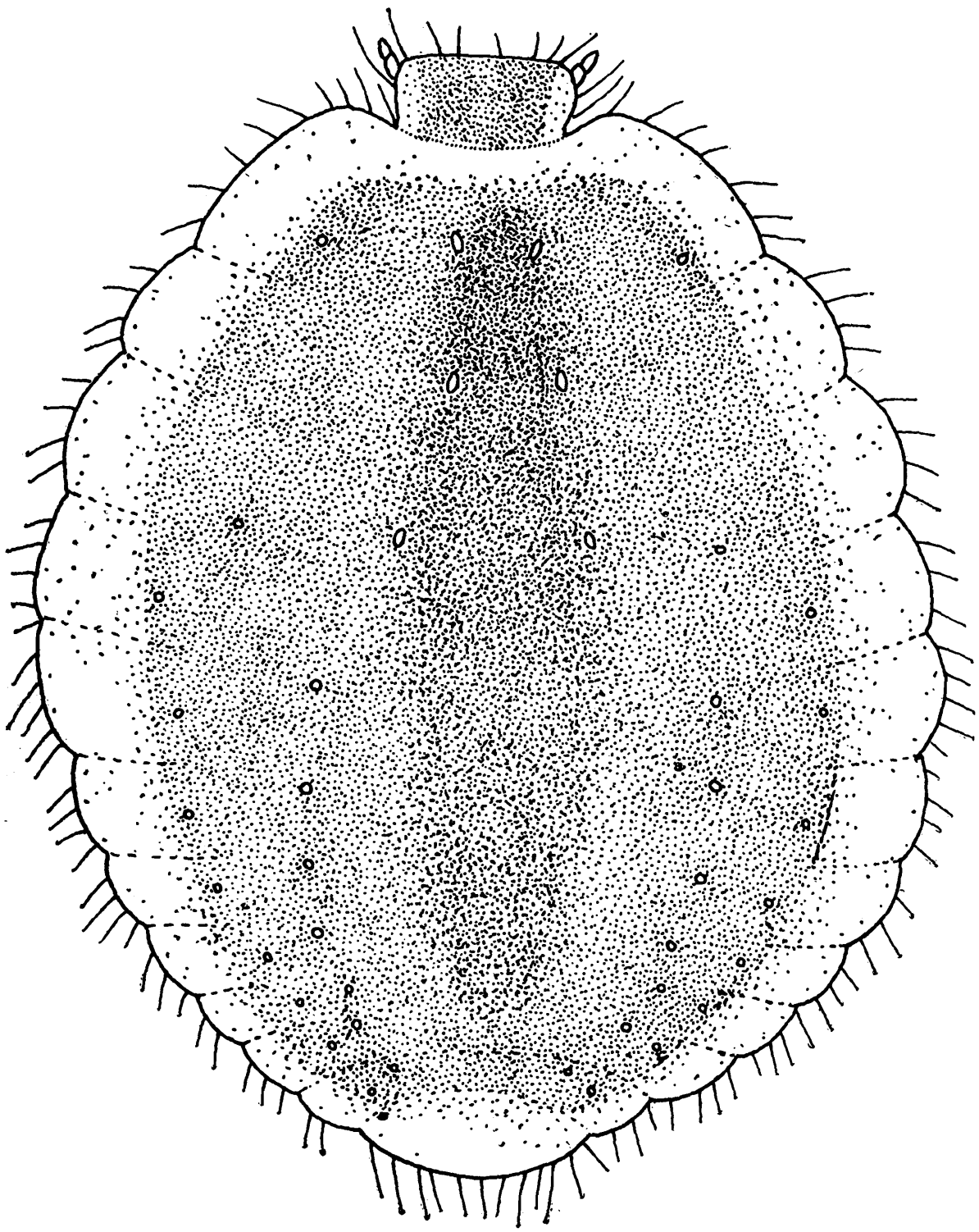


Text-fig. 1. Eggs of *Pseudaspidimerus circumflexa* (Motsch.)

Larva (Text-fig. 2) : Full grown larvae measure about 4.0-4.5 mm. in length and about 2.1-2.4 mm. in maximum width ; Head deep brown ; antennae whitish ; mouthpartrts pale yellow ; thorax and abdomen deep brown with the lateral aspect pale yellow, spiracular walls blackish ; coxae pale brown, femora and tibio-tarsi pale yellow.

Body broadly oval. Head slightly sclerotized, 1.5-1.7 times as broad as long, lateral margins medially concave, front margin with a few short hairs at the middle and 7-8 pair of long hairs on either side, about $\frac{1}{2}$ the length of the head, antennae 2-segmented, less sclerotized, basal segment broad and second segment 1.5 times as long as its width with a preapical hair which is as long as the apical one ; apical segment of maxillary palpi large and triangular ; mandibles elongated triangular with a pointed tooth ; coxae broad, quadrate, trochanters small, femora gradually broadened apically, tibio-tarsi wide with moderately long

dense hairs and apically with a pair of pointed claws, having a broad basal tooth ; margins of the spiracular walls more chitinized ; dorsum of thorax and abdomen with ten pair of smaller pores near the lateral margin and ten pair of relatively larger pores, which are 1.5-1.7 times as long as smaller ones, present medially ; lateral margins of thorax and first eight abdominal segments with short, dense hairs and the ninth segment surrounded with moderately long hairs.



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Text-fig. 2. Larva of *Pseudaspidimerus circumflexa* (Motsch.)

The larval period lasts for 6-7 days during December to February and 6 days during June to August, and this small effect at difference of 7°c on development may perhaps be attributed to use of different host plant material (*Cassia* in Summer and *Dalichos* in Winter) in the laboratory.

Feeding behaviour of Larva ; The predatory larva when reaches to its prey,strikes it by the mendibles and then by jerking of the head, punctures the prey body at the anterior abdominal dorsum. Sucking of the prey body is accomplished by the forward and backward movement of the head of larva and during feeding it keeps its head downward. The predator then holds the prey up by lifting its head forward and slightly upward. On completion of feeding, the larva lifts its head and anterior part of the thorax along with the prey as a result of which the fore-and mid legs remain above the substratum. The predator then discards the prey after one or two such lifting. The larva then again moves in search of another prey. It may be mentioned that during prey searching the movement of the predator appears to be rather slow as compared to the other Coccinellid larvae viz., *Coccinella septempunctata* Linnaeus, *C. transversalis* Fabricius, *Menochilus sexmaculatus* (Fabricius) and even *Scymnus* (*Pullus*) *pyrocheilus* Mulsant. The feeding behaviour and sluggishness of larva may be attributed to the peculiar shape of body, unlike other larvae.

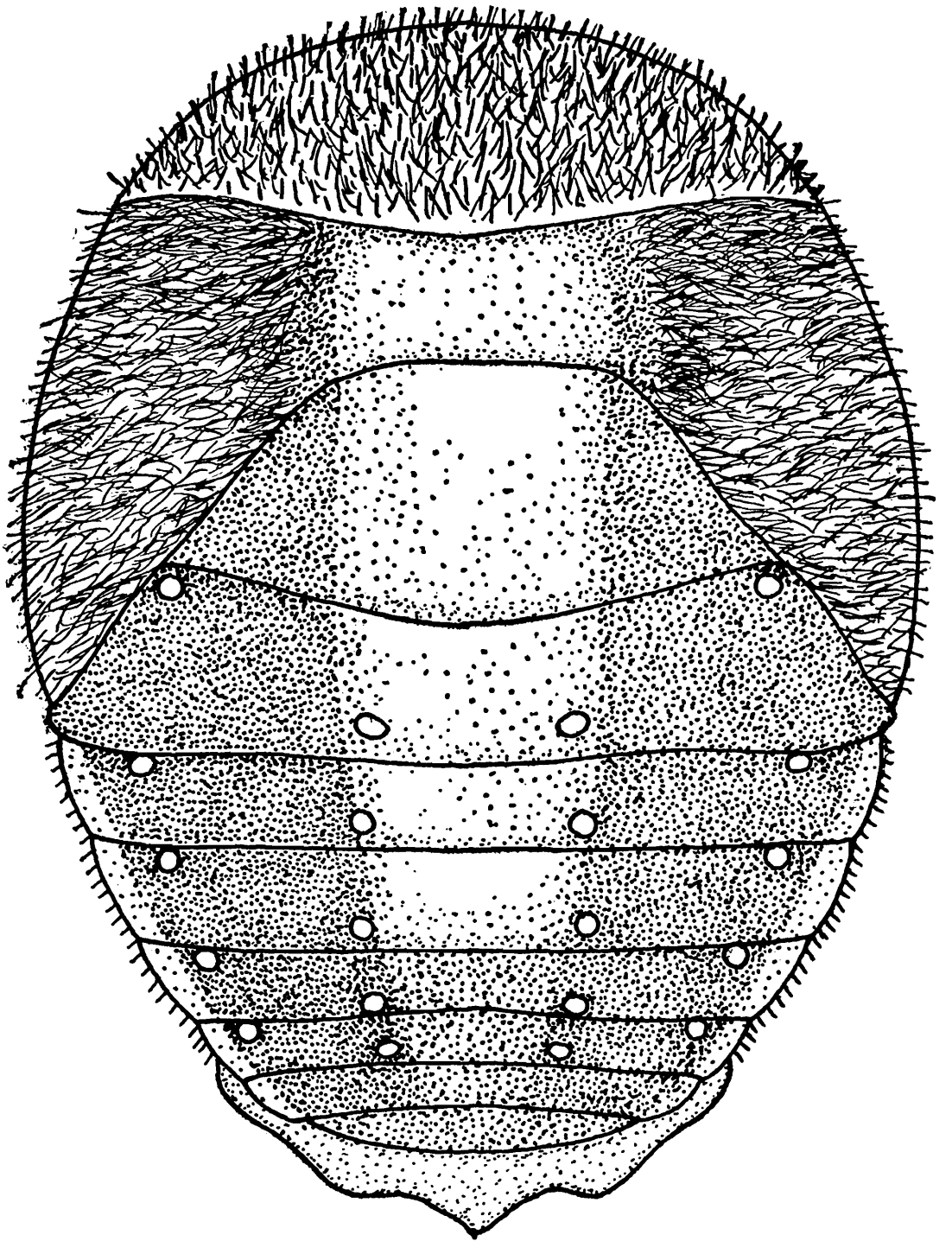
Voracity of larva : The larva of *P. circumflexa* consumes 110-126 individuals of a mixed population of *A. craccivora* to complete its development. Daily observations on the rate of consumption of aphids reveal (Table-2) that there is a progressive increase in the number of aphids consumption with the larval growth and on the penultimate day of active life, the consumption of aphid being maximum. During the last day, the rate of consumption has been lowered down abruptly due to its approach to a prepupal condition.

TABLE 2. Larval voracity of *P. circuflexa* (Motsch.) in days

Larval days	1st day	2nd day	3rd day	4th day	5th day	Total
Range	6—9	10—13	27—34	37—45	28—34	110—126
Mean	7.5	11.5	30.5	41	31	117.5

Pupation and pupa (Text-fig. 3) : The full grawn larva usually prefers curled leaves for pupation. Before pupation the larva anchors itself to the substratum and remains motionless ; finally the membrane like cuticle is shed and pupa is formed. *Pupae* about 1.9-2.0 mm. in length

and about 1.5-1.7 mm. in maximum width. Head black ; thorax pale brown with two pale yellow large spots on the posterior end of the thoracic dorsum ; wing buds deep brown ; abdomen pale brown ; each of the first six abdominal segments with a pair of pale yellow small spots mid dorsally.



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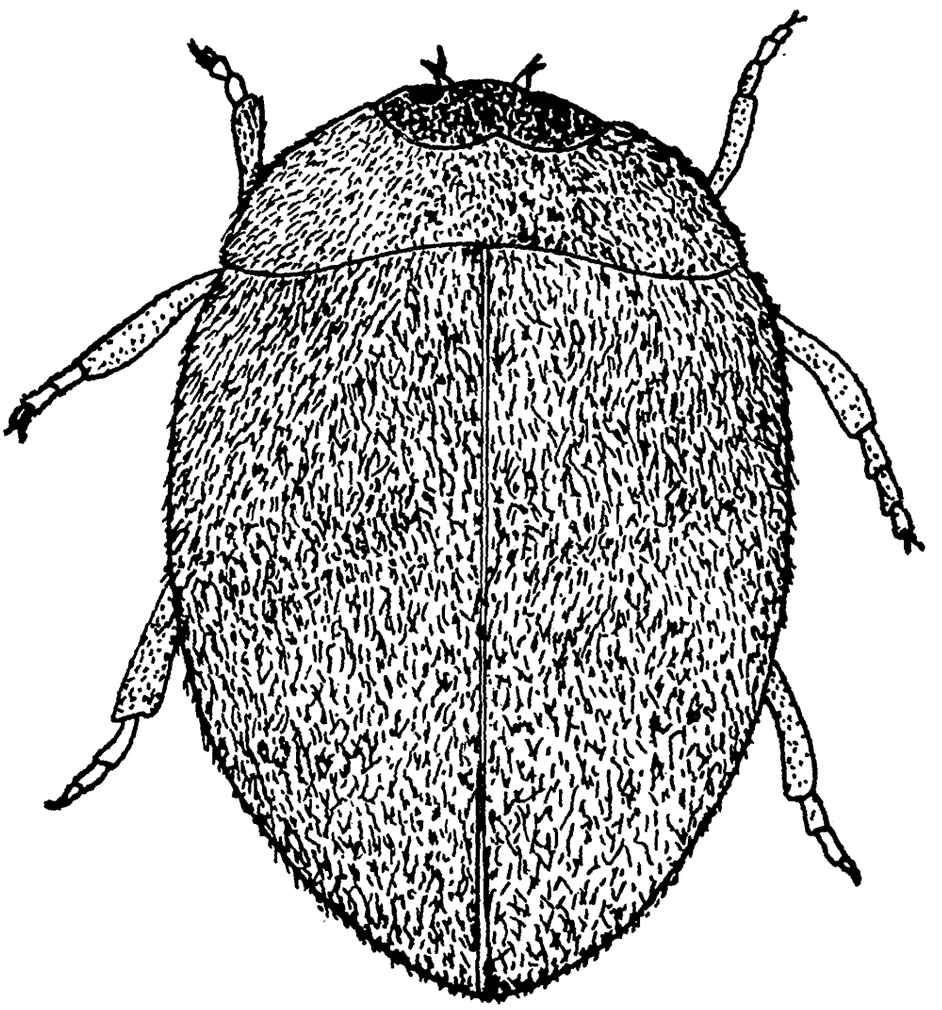
Text-fig. 3. Pupa of *Pseudaspidimerus circumflexa* (Motsch.)

Head projected downward and inward, with dense pubescence ; hairs short and fine ; prothorax bent downward with the rest flattened ;

distal part of wing buds and legs concealed under the body ; thorax and wing buds densely pubescent ; abdomen arched dorsally and flattened ventrally ; five pairs of small white apically bifurcated elevations present laterally on the dorsum of the first five visible abdominal segments.

Pupal period varies from 4-5 days during December to February and 4 days during June to August.



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Text-fig. 4. Adult of *Pseudaspidimerus circumflexa* (Motsch.)
[all figures drawn in same scale]

Adult (Text-fig. 4) : Body about 2.0-2.5 mm. in length and about 1.8-2.0 mm. in maximum width. Head chasis red in colour ; eyes black ; antennae and mouthparts brown ; pronotum chasis red, lateral margin yellowis with a black spot laterally extending towards the middle, scutellum black ; elytra chasis red with a black spot at the basal $\frac{1}{3}$ of the suture and a subrounded discal spot at the middle near the sutural margin ; ventral surface chasis red with prosternum medially black ;

mesosternum yellowish and middle part of metasternum and first abdominal sternum blackish and legs brown.

Body covered with short recumbent hairs. Antennae 9-segmented and geniculate, situated anterior the eyes in the dorsolateral corner of the frons, first segment rather large, the second segment almost concealed by the first, rest of the segments together form a clump-shaped flagellum. Mandible with a bifid apex and a subcuspidate basal tooth ; labrum partially covered by clypeus ; prosternum broad medially and narrowed laterally, with two distinct longitudinal parallel carinae at the middle. Lateral margins of prosternum straight with the corners rather blunt, mesosternum small ; metasternum large with the middle part directed forward, the anterior margins of which rounded and the lateral margin straight, lateral margin of metasternum pointed at anterior angle which is blunt at the posterior angle ; elytra round with apices blunt ; trochanters and femora much broadened concealing the tibiae and tarsi ; first abdominal sternite large with middle part forwardly projected, the anterior margin of which straight, femoral line distinct. In case of male, the last abdominal sternum deeply emerged. [Adult has been described in details by Kapur, 1948].

DISCUSSION

From the predator prey association and seasonal occurrence it can be said that there is a close coincidence between the predator and aphid population, that is the predator becomes active and reproduces with the increasing prey populations and becomes quiescent or inactive when it faces scarcity of its prey. During the winter period or cooler months of the year the predator exhibits its greatest activity and usually respond by increasing rate of fecundity to the aphid preponderence, but during rainy period the predator becomes inactive with the less aphid abundance. During hottest months i. e. April and May the predator seems to disappear with the aphids.

Pushpaveni and Krishnamurty (1971) noted the developmental period of different immature stages i. e. egg, larva and pupa of *P. circumflexa* (Motsch.) feeding on sugar cane aphid viz., *Longiunguis sacchari* Zehntner in south India. Compairing their works with the present study it appears that *P. circumflexa* (Motsch.) has longer developmental period in south India than in this part of eastern India (egg, larva and pupa : 4-6, 10-12 and 9-10 days vs. 2-3, 6-7 and 4-5 days respectively). Present study on the voracity of this beetle reveals that the two active stages i. e. larva and adult, devour 22-25 and 21-23 individuals of *A. craccivora* Koch per day respectively.

SUMMARY

A study on bionomics of *Pseudaspidimerus circumflexa* (Motschulsky), one of the important Coccinellid predator of aphids, has been carried out. This paper deals with the distribution and prey range of the species, and presents results of study on developmental history, feeding behaviour and voracity and seasonal occurrence. *Lipaphis erysimi* (Kaltenbach) is recorded here for the first time as a aphid prey species of *P. circumflexa* from India.

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