Coccinella septempunctata Linnaeus

Genus coccinella belongs to the tribe coccinellini of subfamily coccinellinae, family Coccinellidae. Bodenheimer (1943) made some investigations on the biology of *C. septempunctata* and studied its life history and ecology in Palestine. Islam and Nasiruddin (1978) studied the biology of the ladybird in Dacca and Varvara et al. (1982) carried out investigations on the biology of the predator in Moldavia.

In India, some preliminary investigations on the biology of the predator were made by Lefroy (1907), Bagal and Trehan (1945), Sharga (1948) and Singh and Malhotra (1979) too have contributed to the biology of *C. septempunctata*. However, detailed comprehensive studies have not been undertaken by these workers.

**Distribution:**

*C. septempunctata* is a palæarctic species and is cosmopolitan in its distribution, occurring in Europe, Northern Africa and parts of Asia including India. The predator was first reported by Linnaeus in 1758.

In Kashmir valley, the beetle *C. septempunctata* was collected at Srinagar, Anantnag, Yousmarg, Bandipore and Gulmarg (Fig. 1).
Host Range:

Lefroy (1909) considered it to be a various feeder of wheat aphid - *Macrosiphum granarium* and mustard aphid - *Aphis brassicae*. Fletcher (1914) stated that the predator chiefly occurred on wheat, mustard and sometimes on paddy throughout the year in Southern India. Puttarudriah and Channa Basavanna (1953) found the ladybird feeding on mustard aphid - *Rhopalosiphum pseudobrassicae* and to a lesser extent on lucerne aphid - *Thrio-aphis ononidis*. Alam et al. (1964) listed the predator on *Lipaphis pseudobrassicae*. Aziz et al. (1969) in their experiments on host preference studies suggested that *C. septempunctata* preferred *Lipaphis exsimi* more, followed by *Myzus persicae*, *T. ononidis* and *Aphis gossypii*. The results were deduced on the basis of the predator population. Verma and Chowdhuri (1976) observed them feeding on peach leaf curl aphid - *Brachycaudus helichrysi*, at Mashobra.

During present studies the predator *C. septempunctata* was found preying on different species of aphids attacking *Zea mays, Rosa indica, R. macrophylla, Brassica species, Argimone species* and *Salix species* plantations.
The overwintered adults resume their activity in May depending on the climatic conditions in the valley and start feeding on aphids. It commences oviposition on infested aphid plantations in second half of May. The activity of grubs was noticed to be maximum in early June when the oviposition by the pest is at its peak. The grubs prefer main infested stems and the predator seems to do a great deal of damage at this stage. The pupation occurs in late June and the adults emerge out in last week of June or early July. In the field, adults were found feeding during September but no eggs or larvae were observed on aphid infested plants. *C. septempunctata* hibernates in the adult stage in first week of October and presumably there are two generations in a year.

**Egg:**

The eggs are smooth, cigar shaped and bright yellow in colour, changing to orange after a few hours of their deposition. They are laid on leaves in close vicinity of aphids in adjacent rows and when observed from a distance they looked like small barrels. An egg tapers at both its ends but the anterior portion is relatively a little broader and rounded than the posterior one. The egg shell is colourless but before hatching it changes to light grey. Each egg measures 1.3 mm in length and 0.5 mm in breadth in average (Fig. 2-A). Bagal and Trehan (1945) found the average
egg measurements to be 1.29 mm x 0.53 mm while Singh and Malhotra (1979) found it to vary from 1.11 mm to 1.32 mm in length and 0.50 mm to 0.57 mm in breadth in *C. septempunctata*. The unfertilized eggs shrink within two days.

**First instar larva:**

The newly emerged larvae were dirty white in colour when they came out from the egg shell but later on changed to deep dark. The larva comes out from the egg shell slowly with the help of its wriggling movements and in the beginning shows sluggish activity. The freshly hatched larva is translucent and has a clear body segmentation. The mouth parts are present at the anterior end of the head segment and it bears dorsolaterally a pair of two segmented antennae. The head segment bears eighteen pairs of bristles while prothorax contains sixteen pairs and the meso and metathorax have nine pairs each. The first instar larva has six black patches on each abdominal segment, the break up being; two median, two dorsolateral and two lateral in position.

On the ventral side, the larva has small protubences in the thoracic and abdominal segments. The thorax and abdomen are covered thinly with hairs which increase in size terminating into a circular depression instead of being
pointed. The hairs on the head and legs are pointed and do not have a knob at their base (Fig. 2-B,C,D,E). This instar prefers to feed on small first instar aphids as compared to the older instars. The larva measures 1.6 mm in length and 0.5 mm in breadth.

Second instar larva:

The second instar larva, on an average, measures 3.2 mm in length and 0.6 mm in breadth. It is black coloured and the mouth parts are well developed and more sclerotised. The dorsolateral sides of prothorax develop small warts and the number of bristles increase by four in each segment. The second instar larva has light patches on the dorsolateral and lateral tubercles on the first and fourth abdominal segments. On the ventral side of the larva the protruberences develop into bristles (Fig. 3-A,B,C,D).

Third instar larva:

This larval instar is stouter, light black in colour with well developed mouth parts. On an average, each larva measures 5.1 mm in length and 2.0 mm in breadth. The mandibles are stout and sclerotised, bearing two blunt teeth. The prothorax has prominent bristles and the dorsolateral and lateral patches on the first and fourth abdominal
segments are orange in colour. Warts are present on the abdominal segments, and on the ventral side of the larva bristles are similar to that of the previous instar (Fig. 4, A, B, C, D).

**Fourth instar larva:**

The fourth and final instar larva measures an average of 10.0 mm in length and 2.8 mm in breadth. It colours deep grey or almost black. On the lateral sides, the head has white or dull orange coloured dots. A pair of distinct antennae are present dorsolaterally. The body is fusiform, stout and widest at the metathorax and the segments gradually narrow down posteriorly. The ninth abdominal segment is somewhat conical.

The full grown fourth instar larva has four faint orange coloured patches on the prothorax which is wider than long and oval in outline. The meso and metathorax are subequal in size. The colouration in the dorsolateral and lateral tubercles of first and fourth abdominal segments changes from bright orange to dull orange. On the ventral side of the larva, warts are well developed and bristles are conspicuous (Fig. 5-A, B, C, D). The legs are well developed, long and stout. The proximal portion of the tarsal claw is provided with a distinct appendiculate tooth. This instar is the most voracious feeder in the life-cycle so far as food consumption of aphids is concerned.
**Pupation:**

After completion of their feeding period, the fourth instar larvae stop feeding and change into pre-pupa by attaching to a leaf surface, rarely on the upper but generally on the ventral surface, with the help of the posterior caudal segment. It remains in inactive condition for sometime. The pre-pupa is shorter in size than the larva but is capable of producing the defensive secretion just like the larva.

**Pupa:**

The pupa measures 6.5 mm in length and 3.7 mm in breadth. The freshly formed pupa is yellow in colour which later on develops black markings on its dorsal side. The anterior portion of the pupa is oval while the posterior end is irregular in shape resembling, however, the letter 'V'. In the early pupa eyes are not clearly visible but in later stage a pair of compound eyes are found on the head region which is slightly curved towards the ventral side (Fig. 6).

In the pupal stage, three body divisions, viz. head, thorax and abdomen are quite distinguishable. Antennae are short and enclosed in thin sheaths running closely on either side of the head. The segmentation of the antennae are poorly differentiated. Elytra is visible within the sacs and
has got three prominent black dots which extend to the first two abdominal segments. The prothorax also possesses black coloured dots while the meso and metathorax each carry a pair of black coloured dots. The first and fourth abdominal segments have a pair of faint orange coloured dots and the spiracles are clearly visible on 1-8 abdominal segments.

Eclosion:

The convulsive movements of the abdomen were observed to help in rupturing the puparium in the process of eclosion which took place antero-dorsally. The process of eclosion was completed in 15-20 minutes time duration.

Adults:

On emergence from pupa, the elytra and the wings are light yellow in colour with no spotting. After a couple of hours, the spots start appearing and gradually turn distinctly black in colour. After the full attainment of spotting, adults were observed to feed and mate frequently.

Adults are ovoid in shape having convex dorsum. On an average, adult measures 6.1 mm in length and 5.2 mm in breadth. Head black with white spots near eyes. Antenna brown, eleven segmented arising from the antennarium located between the compound eye and labrum. The mouth parts vary
from brown to black in colour, mandibles bifid and at the apex each bears a tooth.

Seven black coloured, almost round or oval, spots present on both the elytra; three each on the left and right elytron and the seventh medially placed, large in size, lies half on left elytron and half on right. Scutellum black, triangular and somewhat depressed or sunken with very fine and dense punctuation. The punctation of elytra is quite distinct as that of the pronotum. The legs are black in colour (Plate 1).
LIFE CYCLE

Pre-oviposition:

The eggs are usually glued to the undersurface of a leaf but occasionally a female would lay them on the stems of the host plant also. In laboratory, however, the eggs were found laid on the sides of rearing dishes and their muslin coverings. Egg number per batch varied from 9 to 30 and as many as 6 to 10 egg batches were laid by a female. The pre-oviposition period of C. septempunctata in the present investigations was found to range from 5.0-8.0 days with an average of 5.9 days in the laboratory.

Incubation:

The incubation has been studied by some workers in C. septempunctata. Bodenheimer (1943) recorded the incubation period in C. septempunctata to vary from 4-14 days in Palestine while Bagal and Trehan (1945) observed it to be 30 days in South India. Pulwarudriah and Channa Basavanna (1953) too found the egg period to last for 3-4 days. Islam and Nasiruddin (1978) while working on C. septempunctata in Dacca recorded the incubation period to average 3.3 days whereas Singh and Malhotra (1979) found that the eggs did not hatch at low temperature of 10°C. A temperature of 40°C too was detrimental for hatching purposes. During their experiments at 15°C, 20°C, 25°C and 30°C the incubation period
was observed to be 8.5 days, 5.2 days, 2.8 days and 2.0 days respectively. Varvara et al. (1982) found the duration of incubation in *C. septempunctata* to be 4-7 days in field and 4-6 days in the laboratory.

In the present set of experiments, the incubation period of *C. septempunctata* eggs was recorded to range from 3.5-5.0 days with an average of 4.1 days in the laboratory. Under field conditions, however, the incubation period lasted for 4.5 to 5.0 days in May while in June and July it took only 3.5 days for an egg to hatch.

**Larval duration:**

The first instar larva in *C. septempunctata* in the present investigations was found to vary from 3.0-5.0 days, the second instar took 2.0-3.5 days to undergo the second moult, the third instar larva lasted for 2.5-3.5 days while the fourth instar larva enjoyed a period of 3.5-5.5 days. The total larval span from the first instar to the fourth instar till pupation was found to be 11.0-17.5 days.

Bodenheimer (1943) recorded the larval duration in *C. septempunctata* varying from 18-38 days in Palestine. Bagal and Trehan (1945) observed it to be 9.16 days during the month of October and 11.5 days during January and February in India. Puttarudriah and Channa Basavanna (1953) observed
the larval duration in *C. septempunctata* lasting from 6-12 days. Islam and Nasiruddin (1978) while working on life-history and feeding of *C. septempunctata* in Dacca found the larval duration to average 9.6 days in the laboratory while it ranged from 9-10 days under natural conditions. Singh and Malhotra (1979) found the larval duration of 11.1 days, 7.2 days and 6.7 days at 25°C, 30°C and 35°C temperatures respectively under laboratory conditions. Varvara et al. (1982) observed larval development in *C. septempunctata* in Moldavia and found it to vary from 14-18 days.

**Pupal duration:**

During present findings, the pupal period ranged from 4.0-7.0 days with a mean of 5.2 days in *C. septempunctata* in the laboratory.

Bodenheimer (1943) in Palestine found the pupal period in *C. septempunctata* extending from 4-8 days depending upon temperature fluctuations. Bagal and Trehan (1945) reported pupal stage of 3.0-5.7 days while Puttarudriah and Channa Basavanna (1953) found it to vary from 4-6 days. Islam and Nasiruddin (1978) while working on the predator in Dacca reported a pupal period of 5-6 days. Singh and Malhotra (1979) studied the pupal duration of *C. septempunctata* at different temperatures and recorded it to last for 3.9 days at 25°C, 3.1 days at 30°C and 2.7 days at 35°C.
whereas Varvara et al. (1982) observed a pupal period of 6-8 days at Moldavia.

*G. septempunctata* was found to complete its whole life cycle from egg stage to the adult emergence in 18.5 to 29.5 days with a mean of 23.1 days time duration under laboratory conditions at 25 ± 5°C temperature and 60-70 relative humidity during present investigations.
Table 2. Duration of different developmental stages in Coccinella undecimpunctata (in days).

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<th>Incubation period</th>
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Mean 5.9 4.1 3.8 2.5 2.5 4.5 5.2 29.5

Range 5.0-8.0 3.5-5.0 3.0-5.0 2.0-3.5 2.5-3.5 3.5-5.5 4.0-7.0 26.5-35.0
Fig. 2: Structure of first instar larva of C. septempunctata.

A. Egg
B. Head
C. Thoracic segment
D. Abdominal segment
E. Caudal segment
Fig. 3. Structure of second instar larva of *C. septemponctata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment
Fig. 4. Structure of third instar larva of *C. septempunctata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 5. Structure of fourth instar larva of *C. septempunctata*.

- Head
- Thoracic segment
- Abdominal segment
- Caudal segment
Fig. 6: Structure of Pupa of *C. septempunctata*. 
Plate 1. *C. septempunctata* adult.
Coccinella undecimpunctata Linneaus

Although work on systematics of coccinellids has progressed steadily since Linneaus (1758), scanning of literature reveals that only few workers have paid attention to the study of biological aspects of C. undecimpunctata.

According to the Commonwealth Institute of Entomology, London communiqué, C. undecimpunctata is currently under review and the species under discussion here may be specifically distinct from the true 11-punctata of Europe. Some of the specimens collected from field as well as the laboratory reared ones showed variations in their elytral pattern from the typical C. undecimpunctata spotting.

Hawkes and Marriner (1927) were the first to give a preliminary account of the life-history of C. undecimpunctata after carrying out their investigations in the artificial passage holes in dung pads. Ibrahim (1954) also made preliminary observations on the morphology of the early stages of C. undecimpunctata aegyptiaca. Harpaz (1958) described the life-cycle of the predator in sub-tropical climate of Israel and found only three larval stages while Benham (1970) studied the ecology of C. undecimpunctata. Singh and Malhotra (1979) have recorded some observations on its biology in a brief communication from India.
Keeping in view the above resume of *C. undecimpunctata*, the present work was undertaken to study in detail the morphology and biology of the predator beetle in the valley of Kashmir and this seems to be the first step in this direction.

**Distribution:**

*C. undecimpunctata* is a widely distributed coccinellid. Watson (1979) gave the distribution of *Coccinella undecimpunctata* in North America while in India Singh and Malhotra (1979) have reported it from Panjab.

During present survey, a large number of *C. undecimpunctata* beetles were collected from Srinagar, Anantnag, Badgam, Baramulla, Pulwama and Kupwara areas in the valley (Fig.1).

**Host Range:**

Hawkes and Marriner (1929) found *C. undecimpunctata* feeding on dung pads while Jotwani et.al. (1972) observed the predator feeding on sorghum stem borer, *Chilo zonellus*.

During present investigations, the predator was observed feeding on aphids infesting *pseudoacacia - Robinia pseudoacacia*, Apple - *Malus sylvestris*, Willow - *Salix sp.*, Artemesia - *Artemisia absinthium* and Maize - *Zea mays* plantations in the field.
In nature, the overwintering adults of *C. undecimpunctata* resume their activity in May. The beetle was observed ovipositing in the field in the third week of May depending on the prevailing climatic conditions in the valley. It oviposits on aphid infested plantations of *Malus sylvestris*, *Brassica* sp. and *Prunus* sp. During the month of June, the grubs were seen actively moving on their hosts. The pupation starts in the third week of June and the adults emerge out by ending June. Maximum population levels of adults and larvae were observed in the field during the months of June and July on *Malus sylvestris* and *Robinia pseudoacacia* hosts. During the month of October a decline in their population level was observed and only the adults could be seen in small numbers in the field on *Zea mays* and *Salix* sp. The predator, *C. undecimpunctata*, starts hibernating in the adult stage in second or third week of October and it has three generations per year.

**Egg:**

The eggs are oval in shape and yellow in colour. The outer membranous chorion is transparent and an egg acquires the colour of its inner contents. The egg shell is colourless and has an irregular surface (Fig. 7-A). On an average, each *C. undecimpunctata* egg measures 1.1 mm in length and 0.7 mm in breadth.

Hawkes and Marriner (1927) found the eggs to be 2.0 mm long whereas Ibrahim (1954) recorded an average length of
0.88 mm with a maximum of 1.0 mm and a minimum of 0.72 mm, while the average width of the widest part read 0.40 mm with a maximum of 0.44 mm and a minimum of 0.36 mm.

First instar larvae:

The first instar C. undecimpunctata larvae were observed breaking open their egg shells rather than eating them up. On hatching they are greyish black in colour which steadily becomes darker except the head and legs which remain greyish black. The first instar larva is oval in shape with broader mesothorax and the dorsal surface of the larva is more convex in comparison to the ventral side which is moderately so. The mouth parts are located slightly on the ventral surface and the head is hemi-spherical bearing dorsolaterally a minute two segmented antenna located anterior to ocelli on each side. The distal segment possesses pits and setae which are probably sensory.

The body segmentation is clear and each thoracic segment bears a pair of legs which are similar in shape. The abdomen narrows down posteriorly and is spindle shaped. The spiracles are light brown in colour and are located on the mesothorax and first eight abdominal segments. The first abdominal segment has pale dorsolateral spots on it. Three pairs of setae were found on each of the abdominal segments. The arrangement of these setae being a pair on the
mid-dorsal line; a laterodorsal pair, one each on either side, and a lateral pair. The larval body is covered with long hairs but at some places tufts of short setae are also present. On an average, the 24 hours old larvae measure 1.7 mm in length and 0.6 mm in breadth (Fig.7-B, C, D, E).

**Second instar larva:**

The second instar larva is similar in appearance as the first instar except that the widest part here is the first abdominal segment. The head, legs and the general body colour is black. The mouth parts are more sclerotised and the maxillary lobe is bifid. The last abdominal segment is somewhat reduced and telescoped within the ninth segment. Chaetotaxy is almost similar to that in the first instar larva. The legs are larger in size than the first instar larva. The colouration of the dorsolateral and the lateral tubercles on the first and fourth abdominal segments is light grey. This instar on an average measures 2.8 mm in length and 0.9 mm in breadth (Fig.8-A, B, C, D).

**Third instar larva:**

The third instar larva on an average measures 3.8 mm in length and 2.0 mm in breadth. This instar is stouter than the previous one and the mandibles are more sclerotised. In
this instar the widest portion of the larva is metathorax and the first two abdominal segments. In comparison to the first two instars the colouration of the body is comparatively darker. The head and the pronotum are light in colour and the pattern of setae on the abdominal segments is similar to that of the first and second instar larvae (Fig.9-A,B,C,D).

**Fourth instar larva:**

The full grown fourth instar larva is almost black in colour with metallic black head and legs. The dorsal surface is more convex. Antennae are distinct and located dorsolaterally near the ocelli which are six in number and arranged in two groups of three each, positioned dorsally near the antennal fossa and forming a triangle. The antennae are conical in shape and apparently consist of two segments, the basal one being cylindrical and more sclerotised than the distal one which is smaller in size. Mandibles have a triangular base and are hollow, possessing two teeth - one dorsal and the other ventral in position.

Head is relatively smaller in comparison to the large body and is hemispherical in shape. The legs are stout, well developed, black in colour and heavily covered with setae. The abdomen tapers posteriorly and is cone shaped. The dorsolateral and lateral tubercles turn dull
orange in this instar and the dorsolateral spots on the sixth and seventh abdominal segments are lacking. The tenth abdominal segment is not clearly visible when looked from the dorsal surface and appears only as a small ring of thin membrane. It is lighter in colour than the other abdominal segments and bears a pair of dorsally located dark spots on it. The spiracles are located laterally on the mesothorax and the first eight abdominal segments (Fig. 10-A, B, C, D).

The full grown fourth instar larva measures 8.4 mm in length and 2.6 mm in breadth.

Pupation:

After voracious feeding by the fourth and final instar, full grown larva attaches itself to a leaf surface or stem with the help of its posterior end of the abdomen which it fastens with the substratum and starts pupating.

Pupae:

The pupa of C. undecimpunctata is convex in shape and on an average measures 5.1 mm in length and 2.9 mm in breadth. Freshly formed pupa is dull yellow in colour and with the passage of time changes to deep grey. During early pupal phase a faint impression of a pair of compound eyes appears on the ventral side of the head region which is visible under the prothorax.

The head, thorax and the abdomen are clearly
distinguishable and the antennae run closely on either side of the head. The abdomen is spindle shaped and tapers posteriorly. There are six visible pairs of spiracles present on the first six abdominal segments, located at the anterior corners on the latero-dorsal surfaces. The first and the fourth abdominal segments possess faint orange coloured spots, one each on the dorsum. The pronotum has a pair of black dots on the posterolateral margin while each wing pad possesses a round black spot at its basal portion. The posterolateral margins of wing pads are black in colour. The cast off larval moulst of the fourth instar larva remains attached with the last three segments of the pupa till the adult emergence (Fig.11).

Eclosion:

By the process of movements caused by the abdomen of the pupa, the puparium splits apically and the adult emergence takes place.

Adult:

On emergence from pupa, the elytral colouration was faint yellow and spotless while the pronotum had full colouration. Generally after two hours duration, the spots start appearing which slowly and gradually turn distinctly dark black. Till this stage adults were not observed feeding although a good number of aphids was offered to them. Appearance of the full complement of body
spots determined maturity of the adults which started consuming the prey forthwith.

Adults are almost spherical having a pair of oblique pale yellow spots at their lateral margins. Antennae and mouth parts are dark brown or black. The antenna is eleven segmented, tenth segment wider than long. Scutellum black, triangular with fine punctations. Elytra strongly and densely punctated, bearing eleven black coloured spots - five each on the left and the right half of the elytron. The eleventh spot is slightly bigger, present apically on both the elytra, half being on the left and the other half on the right (Plate 2). The adult on an average measures 5.4 mm in length and 2.7 mm in breadth.
LIFE CYCLE

Pre-oviposition:

In the present investigations on *C. undecimpunctata*, the pre-oviposition period was observed to be 4.2 days duration on an average, ranging from 3.5-5.0 days.

Incubation:

The eggs are laid in clusters and a majority of them were found laid on the shady sides of the leaves. The egg number in the laboratory varied from 12-29. Prior to hatching, the yellow colouration of the egg gradually becomes paler and on the day of hatching it first changes to light grey and then turns completely black.

The incubation has been studied by some workers in *C. undecimpunctata* as well as in certain other allied species of the genus. Hawkes and Marriner (1927) while working out the life-history of *C. undecimpunctata* on cow dung observed the eggs hatching in 4 to 5 days time duration at room temperature of 50-55°F. Benham (1970) recorded 4 to 6 days time period for hatching after the egg laying while Singh and Malhotra (1979) reported 2 days incubation period in *C. undecimpunctata*. Roy (1976) while working on *C. transversalis* recorded the incubation period to vary from 7-10 days. Abraham and Mathew (1975) observed the egg stage to last for 3 days in *C. arcuata*. Samalo and
Mohendernath (1976) found the egg stage lasting for 4 days at 25°C and 2 days at 30°C respectively. Islam and Nasiruddin (1978) recorded the incubation in C. repanda to be 2 days while Saharia (1981) found it to vary from 1.8 and 10.2 days in different months in Assam.

In the present investigations, the incubation period in C. undecimpunctata was recorded to be varying from 4.5-5.5 days. The incubation period varies monthwise in nature as the temperature varies from month to month thereby affecting developmental duration.

Larval duration:

Hawkes and Marriner (1927) observed a larval period of 15-19 days duration in C. undecimpunctata. Benham (1970) while working on the ecology of C. undecimpunctata recorded the first instar lasting for 4-5 days, second for 4-7 days, third for 3-4 days and the last or fourth instar for 9-11 days. Abraham and Mathew (1975) recorded a larval period of 12 days in C. arcuata. Roy (1976) while working on C. transversalis observed the larval stage ranging from 17-21 days and Samalo and Mohendranath (1976) reported the larval duration in C. repanda to be 7.4 days at 25°C and 6.5 days at 30°C in Andhra Pradesh. Islam and Nasiruddin (1978) recorded the first larval duration as 1.5 days, second as 1.5 days, third as 2.0 days and fourth as 4-5 days in
**C. repanda.** In total, the larval period from first to fourth instar ranged from 9-10 days. Saharia (1981) observed the larval period in *C. repanda* to vary from 9.2 days to 31.9 days at temperatures ranging from 17.4°C to 29.8°C.

In the present set of experiments, the first instar larva enjoyed a time period of 3.5-5.5 days, the second instar lasted for 3.0-4.0 days, the third was observed to take 2.5-4.0 days and the fourth completed its life span in 3.5-6.0 days. The mean duration for the first, second, third and fourth larval instars being 4.6, 3.7, 3.1 and 4.6 days respectively.

**Pupal duration:**

In the present observations on *C. undecimpunctata*, the pupal period was observed to be of 5.1 days duration on an average, ranging from 4.0-6.5 days.

Hawkes and Marriner (1927) recorded the pupal stage in *C. undecimpunctata* lasting for 7-8 days. Benham (1970) reported a pupal period of 5-7 days in *C. undecimpunctata* while Singh and Malhotra (1979) recorded it to be 3.3 days on an average. Abraham and Mathew (1975) found 4-7 days pupal period in *C. arcuata*. Roy (1976) while studying the pupal period of *C. transversalis* found it to take 7-10 days time and Samalo and Mohendernath (1976) recorded 4.4 days
as the pupal duration at 25°C and 2.5 days at 30°C in case of C. repanda. Islam and Nasiruddin (1978) found a period of 3-4 days in C. repanda while Saharia (1981) observed it varying from 3.4 days to 5.8 days at 17.7°C to 29.3°C.

In the present investigations, C. undecimpunctata was found to complete its whole life cycle from egg to adult in a minimum period of 21.0 days and a maximum of 32.5 days depending mainly on the prevailing environmental conditions, especially the temperature. The mean time duration to complete the life-cycle from the egg stage to adulthood was found to be 26.5 days.
Table 3. Duration of different developmental stages in *Coccinella undecimpunctata* (in days).

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Mean 4.2 5.3 4.6 3.7 3.1 4.6 5.1 30.7

Range 3.5-5.0 4.5-6.5 3.5-5.5 3.0-4.0 2.5-4.0 3.5-6.0 4.0-6.5 27.0-36.0
Fig. 7. Structure of first instar larva of *C. undecimpunctata*.

A. Egg
B. Head
C. Thoracic segment
D. Abdominal segment
E. Caudal segment
Fig. 8. Structure of second instar larva of *C. undecimpecttata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment
Fig. 9. Structure of third instar larva of *C. undecimpunctata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 10. Structure of fourth instar larva of *C. undecimpunctata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment
Fig. 11. Structure of pupa of *C. undecimpunctata*.
Plate 2. A. *C. undecimpunctata* adult

B. Variation in elytra pattern.
Adalia tetraspilota Hope

The genus Adalia belongs to the tribe Coccinellini of the subfamily Coccinellinae and family Coccinellidae. Adalia tetraspilota has a close resemblance with A. bipunctata in its morphological characters including the elytra pattern except some marked differences in the arrangement of hairs on tarsi.

Hawkes (1920) made some observations on the life-history and genetics of the ladybird A. bipunctata. Blackman (1967) found the larvae of A. bipunctata developing quickly on Aulacorthum circumflexum, Myzus persicae, Acrhythsiphum pisum and Microlophium evansi but Aphis fabae and A. sambuci significantly slowed the beetle's larval development. Ellingsen (1969) studied the effect of constant and varying temperature on the development, feeding and survival of A. bipunctata. Aleksidze (1970) made field investigations on the two spotted ladybird beetle, A. bipunctata in Georgia. Rao and Ghani (1972) made preliminary observations on the seasonal life-history of A. luteopicta feeding on aphids attacking Artemisia sp. and detailed morphology of A. tetraspilota was studied. Dimetry and Mansour (1976) made observations on the choice of oviposition sites in case of A. bipunctata and found females laying eggs with an additional stimulus in absence of aphids.
Distribution:

The genus *Adalia* is cosmopolitan in its distribution. *A. tetraspilota* however, is less common as compared to *A. bipunctata* which is a widely occurring species. Rao and Ghani (1972) recorded *A. tetraspilota* from the Murree hills, Skardu, Parachinar, Galis, Davban, Kulu and Dalhousie from the Indian subcontinent.

In the present investigations *A. tetraspilota* was collected in the field at Srinagar, Baramulla, Anantnag and Pulwama areas in the valley (Fig. 1).

Host Range:

Rao and Ghani (1972) found the immature stages of *A. tetraspilota* in aphid colonies on *Prunus cornea, Populus ciliata, Cirsium sp.* and *Viburnum cotinifolium*. Wratten (1973) studied the effectiveness of the coccinellid beetle, *A. bipunctata* as a predator usually on lime aphid, *Eucallipterus tiliace*, in Glasgow and rarely on the cicadellid *A. alneti*. Mills (1982) also studied the response of *A. bipunctata* to the density of its principal prey *Eucallipterus tiliace* and found that the ladybird can only respond to the lower range of lime aphid densities through its aggregative and reproductive numerical responses.

During the present survey in Kashmir valley, *A. tetraspilota* was observed feeding on aphids attacking

The hibernating adults leave their winter quarters in the month of May and start ovipositing on aphid infested plantations. The immature stages were commonly observed on *Malus* sp., *Prunus* sp., *Salix* sp., *Indigofera* sp. and *Robinia pseudoacacia* trees in June and July. Mating was observed to occur repeatedly after the emergence of adults from their hibernating sites and it lasted for 40-80 minutes duration. In September only few stray adults are found when it again starts hibernating. The predator seems to have three overlapping generations per year. The adults of *A. tetraspilota* collected both from the field and reared in the laboratory showed variations in their elytral pattern.

**Egg:**

The eggs of *A. tetraspilota* are spindle shaped, deep amber yellow in colour and tapering at both the ends. The basal end is somewhat flattened and colours yellow when freshly laid but turning darker before the onset of hatching. On an average, an egg measures 1.3 mm in length and 0.6 mm in breadth (Fig.12-1).
First instar larva:

After hatching, the larval cuticle darkens and hardens and remains clinging to the egg shell for 12-14 hours duration. The newly hatched larva is pale brown, the colour turning to dark grey with the passage of time and finally to black. The antenna is two jointed and has two sclerotised rings. The terminal antennal segment bears papillae which may be sensory in function. The head, labrum and antennal regions bear setae and on either side three ocelli are borne on the head. The sclerotised tergal plate of the pronotum possesses spines on its anterior, lateral and posterior margins. The meso and metanotum and the abdomen too bear spines. The last abdominal segment is slightly bulged as compared to other segments and has four pad-like lobes which help the larva in getting adhered to some surface. The legs are covered with bristles and have a typical femoral groove. They are dark brown in colour and the pretarsal claw has a large basal tooth. The first instar larva measures 2.4 mm in length and 1.0 mm in breadth (Fig.12-B,C,D,E).

Second instar larva:

The second instar larva on an average measures 3.4 mm in length and 1.5 mm in breadth. It is fusiform and its antennae have long sensory papillae. The lateral and mesolateral areas bear pale whitish spots on the first abdominal
segment. A median pair of whitish spots is located on the fourth abdominal segment. The penultimate segment is semi-circular and bears two spines and a large number of short and long bristles. This segment colours dark brown while the thoracic and abdominal sclerites are pale grey. The lateral tubercles of the eighth abdominal segment are less raised (Fig.13-A,B,C,D).

Third instar larva:

The third instar larva on an average measures 5.3 mm in length and 1.9 mm in breadth. The ventral side of the larva is pale brownish in colour and bears bristles which are directed backwards. The first to eighth abdominal segments have six rows of dorsal tubercles, the position being— two median, two pleural and two marginal. All the six rows of tubercles bear spines and the penultimate segment generally bears more bristles on its caudal marginal (Fig.14-A,B,C,D).

Fourth instar larva:

The general body colouration of the fourth instar larva is slightly brownish on the dorsal surface and dirty white on the ventral side. The body is elongate and oval in outline. The dorsal part of the head is dark brown to black in colour and is heavily chitinized. The mouth is hypognathous in position and the meso and metathoracic spiracles are distinct and are located in between the segments.
The third and fourth abdominal segments are wider as compared to other abdominal segments. The pronotum is heavily covered with spines and bristles. The legs are well developed and black in colour. The inner sides of the tarsi bear hairs which are arranged in rows. Claws in all the four instars have a rectangular basal tooth. On an average, the fourth larval instar measures 7.8 mm in length and 2.8 mm in breadth (Fig.15-A,B,C,D).

**Pupation:**

After its feeding span, the full grown fourth instar larva attaches itself to some substrate and starts pupation.

**Pupa:**

The ground colour of the pupa is pale or flesh coloured, the wing pads are light brownish to blackish and meso and metathorax are light black in colour. It is oval in shape and the anterior portion is truncate while the posterior one is tapering. Dorsally the pupa is convex and the ventral side has slight concavity.

In the early stages of pupal formation, faint impressions of ocellar spots and compound eyes are visible. The differentiation between the head, thorax and abdomen becomes clear in the late pupal stage. The antennae run close on either side of the head segment. The thoracic portion
is pale yellow and has dark brown patches on it. It bears three pairs of segmental appendages which extend up to the middle of the abdomen. The abdominal portion is pale and a part of it remains hidden under the exuviae of the last larval instar. The dorsal portion of the abdominal segments bears small brownish spots in an irregularly fashioned pattern (Fig. 16).

**Eclosion:**

The abdominal movements help the adult in rupturing the puparium apically and thereby the adults emerge out from their pupal cases.

**Adult:**

The body of an adult is sub-ovoid and on emergence from the pupa its colouration varies from pale yellowish to pale reddish. In about four hours duration the normal bright colour of the adult is observed. After attainment of full spotting, the adults start feeding and move in search of prey.

Head is black with medium sized eyes. Antennae 12 segmented, arising from antennarium located between compound eyes and the labrum. Antennal segments differ in shape and the tenth segment wider than long. Antennal club compact and scutellum minute, triangular with very fine punctuation. Elytral base nearly as broad as pronotum and gently round. Claw has a small tooth at the base. Spots on the elytra
are usually four in number. However, during the course of laboratory rearing and field collections, some different varieties in elytra pattern were also found. The break up of spots on elytra is two each on the left and right. The inner spots are small in size, located just centrally close to the median line while the other two are slightly bigger, located slightly close to the lateral margins. On an average the adult of *A. tetraspilota* measured 5.7 mm in length and 4.8 mm in breadth (Plate 3).
LIFE CYCLE

Pre-oviposition:

In the present investigations on *A. tetraspilota* the pre-oviposition period on an average was found to be 3.7 days, ranging from 3.0-4.5 days.

Incubation:

The eggs are laid in batches, generally in depressions on the trunks, branches, crevices and on the undersurface of the leaves of its host plants. The number of eggs per batch varied from 12-32 in the laboratory and the egg count per female ranged from 78-128.

Hawkes (1920) made observations on the life-history of ladybird, *A. bipunctata*, and observed the egg stage ranging from 5-9 days with an average of 5.6 days. Ellingsen (1969) studied the development of immature stages in *A. bipunctata* at seven constant temperatures ranging between 6-28°C and found that the varying temperature conditions did not appear to alter significantly the egg duration. Rao and Ghani (1972) found incubation period in *A. tetraspilota* to last for 3 days.

In the present set of observations the incubation period in *A. tetraspilota* in the valley of Kashmir ranged from 5.5-7.0 days with an average of 6.2 days. The period varied from season to season depending mainly on the prevailing climatic conditions.
**Larval duration:**

During the developmental stages in the life-cycle of *A. tetraspilota*, the larval period enjoys the largest duration amongst the immature stages. The first instar larva ranges from 3.0-5.5 days with an average of 4.2 days, the second instar varies in its life span from 2.5-3.5 days with an average of 2.9 days, the third instar lasts from 2.5-3.0 days with an average of 2.8 days while the last and fourth larval instar enjoys a period of 4.0-5.0 days with an average of 4.3 days. The total larval duration ranges from 12.0-17.0 days with a mean duration of 13.8 days.

Hawkes (1920) observed larval duration in *A. bipunctata* ranging from 16 to 39 days varying from year to year. Ellingren (1969) found that the larval duration in *A. bipunctata* is greatly influenced by the temperature. Aleksidze (1970) while making observations on *A. bipunctata* in the laboratory at 18 to 28°C and 58 to 62% RH found the total larval duration lasting from 12-13 days. Rao and Ghani (1972) recorded a larval period of 10-11 days with an average of 10.3 days in *A. tetraspilota*. Dimetry (1974) studied the effect of egg supply on the larval duration in *A. bipunctata* and found a total larval period of 20.0 days when given 10 eggs of the same species as food; 16.1 days on 15 eggs, 14.8 days on 20 eggs and 13.2 days on 40 eggs respectively. The time durations of the four larval instars
when offered 10-40 eggs of the same species as food on an average ranged: I instar - 2.5-4.2 days, II instar - 1.0-3.5 days, III instar - 2.0-5.6 days and IV instar - 3.5-17.0 days.

**Pupal duration:**

The pupal duration in the present investigations on *A. tetraspilota* was observed varying from 7.0-8.0 days with an average of 7.3 days.

Hawkes (1920) reported a pupal period of 13.0 days in *A. bipunctata* on an average ranging from 2-22 days and it was found to vary from year to year. Ellingsen (1969) found no significant alteration in the duration of the pupal state in *A. bipunctata* under varying temperatures as compared with the constant temperature. Hao and Shani (1972) recorded a pupal period of 4-5 days with an average of 4.3 days in *A. tetraspilota*. The pupal stage was observed varying in its duration from 7.3-7.7 days.

In the present observations, *A. tetraspilota* was found to complete its life-cycle from egg to the adult emergence in 27.7 days on an average with a minimum of 23 days and a maximum of 32.0 days at 25±5°C temperature and 60-70 relative humidity. In the laboratory the adult longevity was observed to range from 60-75 days.
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Mean 3.7 6.2 4.2 2.9 2.8 4.3 7.3 31.5

Range 3.0-4.5 5.5-7.0 3.0-5.5 2.5-3.5 2.5-3.0 4.0-5.0 7.0-8.0 28.0-36.5
Fig. 12. Structure of first instar larva of *A. tetraspilota*.

A. Egg
B. Head
C. Thoracic segment
D. Abdominal segment
E. Caudal segment.
Fig. 15. Structure of second instar larva of *A. tetraspilota*.

A. Head
B. Thoracic segment.
C. Abdominal segment.
D. Caudal segment.
Fig. 1. Structure of third instar larva of *A. tetraspilota*.

A. Head
B. Thoracic segment.
C. Abdominal segment
D. Caudal segment.
Fig. 15. Structure of fourth instar larva of *A. tetraspilota*.

A. Head
B. Thoracic segment.
C. Abdominal segment.
D. Caudal segment.
Fig. 16. Structure of pupa of *A. tetraspilota.*
Plate 3. A. *A. tetraspilota* Adult
B. Variation in elytra pattern.
Mulsant (1850) observed some larvae of the genus *Hippodamia* on water plants infested with aphids, and this seems to be its first record from India. Palmer (1914) made some preliminary observations on the life history of *H. convergens*, *H. sinuata* and *H. parenthesis*. Cutright (1924) studied the bionomics of *H. tridecempunctata* and found it frequently in the vicinity of aquatic environs. Nielsen and Currie (1960) studied the biology of the convergent ladybird, *H. convergens*, on alfalfa aphids. Simpson and Burkhardt (1960) made observations on the biology of three species of *Hippodamia*, i.e. *H. convergens*, *H. glacialis* and *H. parenthesis* while Butler and Dikerson (1972) recorded the life-cycle of *H. convergens* in relation to temperature and Obrycki and Tauber (1982) too studied the thermal requirements for the development of the same. The genus *Hippodamia* belongs to the tribe *Hippodamini* of the subfamily *Coccinellinae* and family *Coccinellidae*.

**Distribution:**

Various members of the genus *Hippodamia* viz. *H. convergens*, *H. sinuata*, *H. parenthesis* and *H. glacialis* are widely distributed in palaearctic and holartic regions and are recorded from China, India, Africa and South America.
particularly in California, Mexico, Kansas, North and South Carolina, USSR and Czechoslovakia. In India, *H. variegata* occurs in northern parts, viz. Panjap, Uttar Pradesh and Delhi.

During present survey, *H. variegata* was collected in the field at Srinagar, Badgam and Baramulla areas in the valley (Fig. 1).

**Host Range:**

Palmer (1914) found *H. convergens* feeding outdoors on *Aphis pomif.* *Macrosiphum rudbeckiae,* *Chaitophorus nigundinis,* *Mycus cerasi,* *M. pisi* and *M. cynogblati* whereas *Hippodamia sinuata* infested *Rhopalosiphum braggi* and *Calliphorus flabellus.* *H. parenthesis* was also found predating on the same aphid species as *H. sinuata.* Vaundell and Storch (1972) gave a detailed food range of the genus *Hippodamia* enlisting Arachnids and Insects (Hemiptera, Homoptera, Lepidoptera and Coleoptera) as their prey. Escalante (1976) recorded *H. convergens* feeding actively on aphids infesting a wide range of crops.

In the present investigations, *H. variegata* was observed feeding on the aphids of Mustard - *Brassica* sp. *pseudoacacia* - *Robinia pseudoacacia.* Rose - *Rosa macrophylla.* Maize - *Zea mays.* *Indigofera* sp., Plum - *Prunus communis.* Artemisia sp., Thesile - *Urtica* sp. and Willow - *Salix* sp. in the field.
The overwintered adults resumed their activity in ending April in the valley depending mainly on the climatic conditions and started feeding on the available aphids of Brassica crop. A large number of eggs were observed on the seed pods of mustard plantations and the larval activity was observed to be maximum during May and June. *H. variegate* larvae were observed voraciously feeding on mustard aphids, i.e. *Lipaphis erysimi*, both in the field and in the laboratory. The beetle population was abundant upto ending July and in the months of August and September only adults could be observed and collected from Maize plantation. The beetle overwinters in adult stage in ending August and there seem to be two generations per year in the valley. *H. variegate* adults collected in the field and some of the specimens collected during breeding experiments in the laboratory showed certain variations in their elytra pattern.

**Egg:**

The eggs of *H. variegate* are pale, deep amber or yellow in colour. They were laid in batches on the terminal shoots of mustard crop generally on pods in aphid colonies. Occasionally the eggs were observed on the undersurface of leaves. On an average, an egg of *H. variegate* measures 1.2 mm in length and 0.5 mm in breadth (Fig. 17-A).

The eggs of certain other *Hippodamia* species too fall
in the same size range. In. *H. convergens* it measures 1.33 mm in length and 0.55 mm in breadth; *H. sinuata* eggs measure 1.4 mm in length and 0.6 mm in breadth while *H. parenthesis* eggs measure 1.0 mm in length and 0.4 mm in breadth (Palmer, 1914).

**First instar larva:**

The body of the first instar larva is sub-depressed and fusiform in shape. Three ocelli are present laterally on each side of the head a little above the antennal fossa. They are triangularly arranged and are dark black in colour. The antenna is three jointed and possesses tactile setae at its tip. The dorsal shield of the prothorax is not heavily chitinized and there are eight pairs of abdominal spiracles located on first to eighth abdominal segments. The entire larva is black in colour and has pale areas on lateral and dorso-lateral margins of the first abdominal segment. The full grown first instar larva measures 1.8 mm in length and 0.6 mm in breadth (Fig. 17-B, C, D, E).

**Second instar larva:**

The second instar larva on an average measures 2.8 mm in length and 1.7 mm in breadth. The margins of pronotum change to yellowish grey and the head and legs become totally
black. The thoracic tergites bear sensory setae at their margins and the pale spots on the first abdominal segment change to dull orange. Faint orange spots become also visible on the fourth abdominal segment (Fig. 18-A, B, C, D).

**Third instar larva:**

The third instar larva is very active and on an average measures 3.9 mm in length and 1.9 mm in breadth. The spots on the abdominal segments turn deep orange in colour. The tubercles of sclerites are as long as wide and the body is widest at metathorax. The head is brown to dark brown in colour and distinctly setaceous. The mouth is directed ventrally and the dorsum of thoracic segments is provided with distinctly chitinized dorsal shield. The tergum of ninth abdominal segment is setaceous with a broadly rounded caudal margin. The legs are well developed, stout and with not so distinct tarsal claw (Fig. 19-A, B, C, D).

**Fourth instar larva:**

The fourth instar larva is very stout and on an average measures 5-7 mm in length and 2.1 mm in breadth. The general colour is brownish tan to dark greyish brown and the head is darker than the remaining body. The head in this instar is heavily chitinized and the prothorax is wider
than long. The cephalic, thoracic and abdominal and caudal margins are provided with distinct Chalazae. Legs are well developed and the sixth and seventh abdominal segments possess pale orange spots (Fig. 20-A, B, C, D). In all the four larval instars the claw is dilated at the base.

**Pupation:**

Before the onset of pupation, the fourth instar grub undergoes final moult and the cast off skin remains attached to the posterior end of the pupa. In the field, however, the fourth instar larva after completing its life-span was observed to go in directly for pupation on the undersurface of leaves but on the walls and muslin covering of the dish in the laboratory.

**Pupa:**

The freshly formed pupa on an average measures 4.1 mm in length and 2.3 mm in breadth. The ground colour of the pupa is brownish yellow while the pronotum has black lateral margins. The wing pads are black and possess spots on sub-lateral and meso-lateral positions. With the advancement in pupal development, the eye spots begin to appear on the head region that lies ventrally in the pupal case. The head, thoracic and abdominal segments are very well distinguished. Antennae are visible on either side of the head but the differentiation in antennal segments is not clear. The
abdominal segments narrow down posteriorly. The black coloured spiracles are distinct and located on the lateral margins of abdomen. The abdominal segments have several black spots arranged symmetrically (Fig. 2). On disturbance the pupa exudes a yellow fluid which has a bad smell.

Ecllosion:

With the help of its abdomen an imago creates movements that assist in rupturing the puparium and the emergence of adult is made possible.

Adult:

The adults of H. variegata on an average measure 5.2 mm in length and 2.8 mm in breadth. Body oval with small eyes. Antenna eleven segmented which vary in shape, having a compactly jointed club. Head black and pronotum bears pale narrow border along apical and lateral margins. Lateral sides of elytra narrowly expanded and colours yellowish red. Elytra bears four black spots, first near the humeral angle, second centrally located just near the suture and the third is caudo-lateral in position while the fourth is apically located. Generally the second and the third spots were found united with the first humeral spot giving an amalgamated appearance to the spotting. Legs long and stout, middle and hind tibiae have two spurs. Claw has a median tooth (Plate 4).
LIFE CYCLE

Pre-oviposition:

In the present investigations on *H. variegata*, the pre-oviposition period on an average was found to be 6.2 days, ranging from 5.0-8.0 days.

Incubation:

In the laboratory, egg count per female ranged from 107-172 eggs. The egg number varied from 15-37 per batch. In the field, females preferred shady places during the process of egg deposition and the egg number varied from 24-31.

The incubation period has been studied in different species of the genus *Hipoodamia* by Palmer (1914). In *H. convergens* the egg stage lasted from 3-7 days, mostly 3 days. In *H. sinuata* it varied from 3-6 days while in *H. parenthesis* it was observed to be of 3.0 days duration. Gutright (1924) found the eggs of *H. tridecimpunctata* hatching in 3.0 days time at usual summer temperatures. Nielson and Currie (1960) found the incubation period in convergent ladybird beetle on an average to be 2.0 day: when fed on alfalfa aphids. Simpson and Burkhardt (1960) observed an incubation period of 3.0 days in *H. convergens*, 2-3 days in *H. glacialis* and 2-4 days in the case of
Butler and Dickerson (1972) studied the egg stage of *H. convergens* at different temperatures. At 15-20°C it took 4.5 days at 20°- 22.8°C it took 3.8 days, at 22.8°-25°C it took 3.0 days, at 25°-28.9°C it took 2.4 days, at 28.9°-30°C it took 1.8 days, at 30°-33.9°C it took 1.9 days and at 33.9°-37.2°C it took 2.0 days time. Escalante (1976) while collecting information on the bionomics of *H. convergens* recorded the egg hatching period of 12-13 days in the region of Cuzco.

In the present studies, the incubation period in *H. variegata* ranged from 4.0-5.5 days with monthwise variations. The average time duration of egg stage was calculated to be 4.9 days. During the process of hatching the chorion cracks irregularly in subapical region and the larva emerges out from the egg shell in 5-10 minutes.

**Larval duration:**

The total larval duration of *H. variegata* was recorded to vary from 12.0-17.0 days in the laboratory. The first instar larva ranged from 3.5-4.5 days with a mean of 4.5 days, the second from 3.0-4.0 days and a mean of 3.6 days, the third from 2.5-3.5 days with a mean of 3.5 days while the fourth instar lasted from 4.0-5.0 days with a mean of 4.2 days.
Palmer (1914) observed a larval duration of 10-28 days, mostly 14.0 days, in *H. convergens*. 21-23 days in *H. sinuata* and 11.0 days in case of *H. parenthesis*. Cutright (1924) while working on the biology of *H. tridecimpunctata* found the larval period ranging from 7-16 days. Nielson and Currie (1960) found the larval duration in *H. convergens* varying between 11-18 days with an average of 13.8 days when the larvae were fed with alfalfa aphids. Simpson and Burkhardt (1960) while screening certain predators of *Therioaphis maculata* observed a larval period of 8-10 days in *H. convergens*. 9-13 days in *H. glacialis* and 7-11 days in the case of *H. parenthesis*. Butler and Dickerson (1972) studying the life-history of *H. convergens* in relation to temperature, recorded a larval period of 17.2 days at 15°-12°C, 15.1 days at 20°-22.8°C, 15.2 days at 22.8°C-25°C, 11.2 days at 25°-28.9°C, 8-9 days at 28.9°C-30°C, 8-7 days at 30°-33.9°C and 7.4 days at 33.9°-37.2°C. Escalante (1976) observed five larval instars in *H. convergens* contrary to the observations of other workers who reported only four instars, the average duration of each being 5.0, 5.0, 3.0 and 8.0 days respectively.

**Pupal duration:**

The pupal duration in the present investigations was observed to range from 4.0-5.0 days with a mean of 4.2 days in *H. variegata*. 
Palmer (1914) reported a pupal period of 4-9 days in *H. convergens*, mostly 4.5 days, and the entire life cycle from egg to adult usually took 21.0 days. In *H. sinuata* the pupal period was found to be 8.0 days and from the egg to adult emergence it took 32-37 days while in *H. parenthesis* it was reported to be of 6.0 days duration with a 20.0 days life cycle from egg to adult stage. Cutright (1924) observed pupal period to be slightly over 3 days in *H. tridecim punctata*. Nielson and Currie (1960) reported the pupal stage in convergent ladybird, *H. convergens*, varying from 3-4 days when fed on a diet of alfalfa aphids. Simpson and Burkhardt (1960) studied pupal duration in three species of *Hippodamia*. In *H. convergens*, the period lasted 3-6 days, in *H. glacialis* it ranged from 4-6 days while in *H. parenthesis* it varied from 3-5 days. The total life span from egg stage to adult emergence in the aforesaid species covered 14-18 days, 16-22 days and 13-17 days respectively. Butler and Dickerson (1972) observed the life-cycle of *H. convergens* in relation to different temperatures and found the pupal stage ranging from 11.9-6.6 days at 15-20°C, 6.3-5.4 days at 20-22.8°C, 5.6-5.0 days at 22.8-25°C, 4.3-3.6 days at 25-28.9°C, 3.4-3.0 days at 28.9-30°C, 2.9-3.0 days at 30-33.9°C and 2.6-2.7 days at 33.9-37.2°C. Escalante (1976) found pupal stage of 9.0 days in *H. convergens*.

*H. variegata* in the present investigations was found
to complete its life-cycle from the egg stage to adult emergence in 23.4 days on an average, varying from 20.0–27.5 days in different seasons. In the laboratory, the longevity of the adults ranged from 15 to 42 days.
Table 5. Duration of different developmental stages in *Hippodamia variegata* (in days).

<table>
<thead>
<tr>
<th>Observation</th>
<th>Pre-oviposition period</th>
<th>Indubation period</th>
<th>1st instar larva</th>
<th>2nd instar larva</th>
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Range: 5.0-8.0 4.0-5.5 3.5-4.5 3.0-4.0 2.5-3.5 3.0-5.0 4.0-5.0 25.5-34.0
Fig. 17. Structure of first instar larva of
H. variegata.

A. Egg.
B. Head
C. Thoracic segment
D. Abdominal segment
E. Caudal segment.
Fig. 18. Structure of second instar larva of *H. variegata*.

A. Head
B. Thoracic segment.
C. Abdominal segment.
D. Caudal segment.
Fig. 19. Structure of third instar larva of *H. variegata*.

A. Head
B. Thoracic segment.
C. Abdominal segment.
D. Caudal segment.
Fig. 20. Structure of fourth instar larva of *H. variegata*.

A. Head
B. Thoracic segment.
C. Abdominal segment.
D. Caudal segment.
Fig. 21. Structure of Pupa of *H. variegata*.
Plate 4. A. *H. variegata* Adult

B. Variation in elytra pattern.
Harmonia eucharis Mulsant

The genus Harmonia belongs to the tribe Coccinellini of the subfamily Coccinellinae and family Coccinellidae. Harmonia breiti was first recorded by Mader (1931) from Kashmir. It is widely distributed in the fir forests in the Himalayas between 2100 and 2300 m and has been collected from the Galis, Marree, Beha, Otrore Shorgram, Sharan, Dalhousie, Kulu, Kotgarh and Chakrata (Rao and Ghani, 1972). Harmonia axyrdis is a commensal and uniformly distributed species in Japan (Hukusima and Ohwaki, 1972). Hukusima and Kamei (1970) studied the effects of various species of aphids as food on the development, fecundity and longevity of *H. axyrdis*. Both the larval period as well as the total developmental duration from first instar to the adult stage was observed getting extended in direct proportion to the supply of *Aphis pomi*, *Brevicoryne brassicae* and *Hyalosterus arundinis*. In marked constant to this extension, the duration shortened when *Acyrthosiphum pisum*, *Amphorophora oleracea* and *Myzus persicae* were provided. Hukusima and Ohwaki (1972) made further studies on the feeding biology of *H. axyrdis* and observed that the developmental duration of the larvae varied according to food quantity depending on the number of aphids supplied per day and tended to decrease when a greater amount of prey aphids were fed to the larvae. Okada and Matsuka (1975) could, however, rear *H. axyrdis*
artificially on pulverised drone honey bee brood. Kawai (1976) analysed the aggregation behaviour of H. axyridis larvae in relation to prey colony of Rhopalosiphum padi and found the larval movement in prey searching to be random. The author further observed that the expense of time to eat prey in its second and third instars and the change of searching movement for prey in third and fourth instar contributed in larval concentration in the prey colony inducing a trapping effect in the predators against the prey. Okamoto (1976) made some observations on food preference and the influence of different aphids as food material upon the ecological and morphological characters of H. axyridis. Kawai (1978) experimentally examined the hatching of egg batches in H. axyridis and the effect of sibling cannibalism on the survival of the first instar larvae. The author observed more than one fourth of the eggs eaten by the larvae of the same egg batch hatched a little in advance and found the life-span of the first instar larvae which ate only one egg to be twice as long as that of the unfed larvae.

**Distribution:**

In the present survey in the valley of Kashmir, *Hamonia cuprea* was collected in the forests at Srinagar, Anantnag, Baramulla and Lolab valley areas in Kashmir (fig. 1).
Host Range:

Hukusima and Kamei (1970) studied the food consumption of *H. axyridis* on various aphid species viz. *Acyrthosiphum pisum*, *Amphorophora oleraceae*, *Aphis pomi*, *A. craccivora*, *Brevicoryne brassicae*, *Hyalopterus arundinis*, *Macrosiphum rosae*, *Myzus persicae* and *Periphyllus californensis*. The larval as well as the total developmental duration from first instar larva to adult in *H. axyridis* was observed to extend when fed on *A. pomi*, *B. brassicae* and *H. arundinis* than the other aphid species. In marked contrast, it was shortened with *A. pisum*, *A. oleraceae* and *M. persicae* regardless of far lesser food consumption than in the former cases. *A. craccivora* was observed to have a highly detrimental effect on any stage of *H. axyridis*. Kawai (1976) recorded *H. axyridis* on *R. maidis* and Okamoto (1976) made laboratory studies on the food ecology of aphidophagous Coccinellids and observed that the first instar larva of *H. axyridis* consumed first instar nymphs of unsuitable *A. craccivora* rather than the nymphs of suitable *R. padi* thereby concluding that the Coccinellid has no consistent preference for any aphid species and the suitability of food has no influence on the prey selection. During the author's studies, *R. padi* was found to be the most suitable food followed by *Macrosiphum ibaracae* and *H. pruni*. *Brevicoryne brassicae* was found less satisfactory and *Acrthosiphum marnoliae* proved harmful. Kawai (1978) while studying the choice of food by the first
instar larvae of *H. axyridis* found the larvae consuming more eggs of its own species than the *Myzus persicae* aphids.

In the present investigations, *H. eucharis* was observed feeding on the aphids of wild Rose—*Chaetosiphum glabrum*, *Macrosiphum rosae* (*Juglans regia* / *Pahaphis* sp.) and *Chromaphis* sp. in the field.

The overwintered adults resumed their activity after coming out of their hibernating quarters in the month of June when the aforesaid aphid species are common in the field. The female beetle oviposits on infested aphid plants. The young grubs were seen actively feeding in second week of June when the pest infestation was at its peak. The grubs were mostly observed on the main aphid infested stems of walnut and rose plants. The pupation occurred in the last week of June and the adults emerged in the first week of July in the field. The predator population reached its peak in early July, gradually started declining in September and the adults underwent into hibernation in early October. *H. eucharis* has two generations a year in the valley. In fields, only the adults could be seen in September, and during October/November the adults moved to cooler parts of the forests where they congregated in good numbers on the shoots of *Pinus wallichiana*.
Egg:

The eggs of *H. sucharlis* are creamy yellow in colour and on an average measure 1.4 mm in length and 0.8 mm in breadth. They are laid in batches and are spindle shaped and rounded at both the ends. The chorion is smooth and during the process of hatching a longitudinal split was observed near the upper end. In the field, eggs were collected on the undersurface of the host leaves (Fig. 22-A).

First instar larva:

The first instar larva is oblong in shape, tapering towards its posterior end. The general colour of the body is dark greyish which on maturity turns black. All along the dorsal surface of the thorax and abdomen there is a median suture of pale colouration. The head of the larva is massive and bears scattered setae. It possesses three ocelli on either side and two segmented antennae having sclerotised rings. The terminal end of the antenna bears sensory papillae. Pronotum contains bristles and small tubercles which bear spines and minute setae. The penultimate segment has two spines with irregularly arranged long and short bristles. The first instar on an average measures 1.7 mm in length and 0.6 mm in breadth (Fig. 22-A, C, D, E).

Second instar larva:

The second instar larva is slightly dark brownish in colour on the dorsal side but looks dirty brown from the
ventral side. The antenna protrudes from the concave socket and is more clearly visible. The pronotum has bristles with small spines. In the legs, the femur has a deep groove which continues onto the trochanter while as the tibia has a short groove. The pretarsal claw has a large basal tooth. The second instar larva on an average measures 3.1 mm in length and 1.5 mm in breadth (Fig. 23-A, B, C, D).

**Third instar larva:**

The third instar larva is similar to second instar except in size measuring 4.8 mm in length and 1.8 mm in breadth. The head and thorax are dark brown in colour with dirty white spots on the lateral margins of the first five abdominal segments. The head region bears scattered setae and the distal end of the antenna looks depressed. The pronotum has two median dark brown patches and possesses minute setae and spines on its lateral sides. The meso and metathorax also have small spines (Fig. 24-A, B, C, D).

**Fourth instar larva:**

The fourth and final instar larva on an average measures 6.3 mm in length and 2.0 mm in breadth. The general colour of a mature larva is black having light orange patches on its prothorax. A pair of distinct antennae are found dorso-laterally on the head. The meso and metathorax
bear spines which arise in groups of 1-3 on the tubercles. In the freshly moulted fourth instar larva, white patches were observed on the first abdominal segment while as dull yellow coloured ones were found on the fourth and fifth abdominal segments. All the eight abdominal segments bear six rows of tubercles having spines. In this instar, the legs are yellowish brown and are stouter than those in previous instars. The fourth instar larva was observed to be more voracious in feeding as compared to the other three instars (Fig. 25-A,B,C,D).

Pupation:

After enjoying voracious feeding during its larval period, the full grown fourth instar larva pupates on the upper surface of the host plant \textit{leaf} in the field while as pupation in the laboratory took place on the sides of the rearing dishes or on the upper muslin covering.

Pupa:

The pupa on an average measures 5.8 mm in length and 3.2 mm in breadth. It is oval in shape and somewhat truncate in front with tapering posterior. The exuviae of the fourth instar are pushed back towards the anal end. The pupa is light black in colour and has some irregular brown coloured patches on its dorsal surface. Ventrally eye spots are visible as faint impressions in the head region. The demarcation between the head and the abdomen is clear and
the latter bears distinct spiracles on its lateral sides. The dorsal surface of the thorax and abdomen is a bit uneven and in the intersegmental areas between 3-4; 4-5; 5-6 and 6-7 abdominal segment fissures are observed (Fig. 2).

Ecdysis:

The body movements of the imago help in the emergence of the adult from the puparium. The pupa was found ruptured at its anterior end where adult emergence had taken place.

Adult:

The newly emerged adults are light yellow in colour with translucent elytra. Body elongate, a bit convex, measuring on an average 6.1 mm in length and 3.2 mm in breadth across the elytra. Head generally pale yellow or black with yellow marking. Antenna slightly longer than head arising from oval antennarium, antennal club compact and lateral sides of pronotum strongly arcuate. Scutellum triangular and claw has a small tooth at its base. Spots on elytra are dull black and their arrangement and pattern in the laboratory reared specimens was observed to be same in every specimen viz. 2-3-3-1 on an elytra.

The individuals are widest across or slightly behind the humeral angles. The colour of the elytra in the beginning
is shining and smooth which later on gradually darkens and becomes dull yellow (Plate 5).
**LIFE CYCLE**

**Pre-oviposition:**

In the present observations on the pre-oviposition period in *H. eucharis*, the duration ranged from 8.0-12.0 days with an average of 9.9 days.

**Incubation:**

Hukusima and Kamei (1970) studied the incubation period in *H. axyridis* to be 2.4 days and 4.9 days at 25±2°C and 30±1°C temperatures respectively when fed with *M. persicae* aphids while a period of 4.5 days and 9.3 days incubation was recorded at 25±2°C and 30±1°C respectively when the aphid supplied was *Amphorophora oleracea*.

In the present observations on the incubation period in *H. eucharis*, the duration ranged from 4.0-5.0 days with an average of 4.6 days.

**Larval duration:**

Hukusima and Kamei (1970) studied the relative effects of different aphid foods on the duration of larval period. A total larval period of 9.1, 10.2 and 9.5 days was observed in *H. axyridis* in three successive generations when fed on *Myzus persicae* at 25°C. The first instar duration ranged from 2.1-2.3 days, the second instar time period
varied from 1.6-2.0 days, the third instar lasted for 1.5-2.0 days and the fourth instar enjoyed a period of 3.5 days respectively. When A. oleracea aphid was fed to H. axyridis a total larval duration of 9.9 days, 9.3 days and 9.5 days was observed in three successive generations. The first instar took 2.7 days, the second 1.9 days, the third 2.1 days while the fourth instar lasted 3.8 days at 25°C temperature. Hukusima and Ohwaki (1972) observed that with the higher density of aphid supply the average length of the larval stage shortened. When the beetles, H. axyridis, were fed with 80 aphis of M. persicae every day, the larval period lasted for 8.2 days. Similarly the duration of the larval period when supplied with 40, 20, 10 and 5 aphis per day lasted for 8.6 days, 9.5 days, 11.7 days and 15.8 days respectively.

In the present set of experiments on H. eucharis, the total larval duration was found to range from 11-16 days with an average of 12.8 days. The first instar larval period ranged from 3-4 days with an average of 3.5 days. The second instar larval duration varied from 2-3 days with an average of 2.1 days and the third instar lasted for 2-3 days with an average of 2.3 days while the fourth took 4-6 days with an average of 4.9 days.

Pupal duration:

Hukusima and Kamei (1970) recorded a pre-pupal period
of 1.0 day and a pupal period of 4.0-4.9 days in *H. axyridis* at 25°C temperature when the predator was fed on *M. persicae* aphid. The duration of pre-pupal and pupal stages ranged from 0.6-0.8 days and 4.5-5.0 days respectively in *H. axyridis*, when supplied with *A. oleracea* at 25°C. Okada and Matsuka (1972) studied the total developmental duration in *H. axyridis* on artificial food made of pulverised honey bee and found it to be ranging from 17.32 days in different months.

During present investigations, a pupal period of 5.0-6.5 days was noticed in *H. eucaharis* with an average of 5.4 days. The predator was found to complete its life-cycle from the egg stage to adult emergence in 20.0-27.5 days with an average of 22.8 days at 25±5°C and 60-70 relative humidity.
Table 6. Duration of different developmental stages in *Harmonia...* (in days).

<table>
<thead>
<tr>
<th>Observations</th>
<th>Pre-oviposition period</th>
<th>Incubation period</th>
<th>I instar period</th>
<th>II instar period</th>
<th>III instar larva</th>
<th>IV instar larva</th>
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Mean 9.9 4.6 3.5 2.1 2.3 4.9 5.4 32.8

Range 8.0-12.0 4.0-5.0 3.0-4.0 2.0-3.0 2.0-3.0 4.0-6.0 5.0-6.5 28.5-38.5
Fig. 22. Structure of first instar larva of *U. eucharis*.

A. Egg.
B. Head.
C. Thoracic segment.
D. Abdominal segment.
E. Caudal segment.
Fig. 23. Structure of second instar larva of H. eucharis.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 24. Structure of third instar larva of H. sucharis.

A. Head
B. Thoracic segment.
C. Abdominal segment.
D. Caudal segment.
Fig. 25. Structure of fourth instar larva of *H. eucharis.*

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 26. Structure of pupa of H. euchairs.
Plate 5. *H. eucharis* Adult.
**Ballia bayaderae** Mulsant

The genus *Ballia* belongs to the tribe Synonychini of the subfamily Coccinellinae and family Coccinellidae. Mulsant (1853) described *Ballia eucharis* and later the same species was redescribed by Crotch (1874) and Weise (1895). Kapur (1955) while studying the Coccinellidae of Nepal reported *Ballia gustavi* and various other species of the same genus forming a very compact group differing on the basis of their colour pattern. Gani (1962) gave a note on the identity of some species of the genus *Ballia*. Kapur (1963) recognised *B. gustavi* only provisionally as distinct and concluded by stating that it may in fact be a mere variety. Rao and Ghani (1972) studied the seasonal life-history and habits of *B. eucharis*. Ghorpade (1971) gave a brief account of *B. eucharis* while Zaka-UR-Rab (1982) recorded in a short note the predation of the plum scale - *Eulecanium coryli* by *B. bayaderae* from Kashmir.

**Distribution:**

Genus *Ballia* is a polymorphic ladybird beetle.

Kapur (1955 & 1963) recorded *B. gustavi* from the Himalayas of North India, Nepal and Sikkim. Gani (1962) recorded *B. eucharis* all along the Himalayas in Assam and on the Khansi hills.

During present survey *B. bayaderae* was found in the fields at Srinagar and Anantnag areas in the valley (Fig. 1).
Host Range:

Gani (1962) found four species of Ballia viz. eucharis, dianae, christophori and bayaderae on silver fir - *Abies pindrow* and blue pine - *Pinus excelsa* in the Murree cantonment forests and collected very few grubs from the aforesaid host plants. Ghorpade (1979) bred *B. eucharis* on Cicadellidae at Shillong.

In the present observations, *B. bayaderae* was observed feeding on plum scale - *Eulecanium coryli* and *Brachycadus helichrysi* in the field.

The overwintering adults resume activity in late may or early June and lay eggs on infested plants. The grubs were found on scale infested plum and aphid infested *Berberis vulgaris* plants. Feeding activity of grubs was observed to be maximum during ending June/July. The food searching movements of the larvae is rather slow but with slight disturbance it became very quick and the grubs moved fast to safer places for shelter. The number of adults declines in August and the beetle starts hibernating in this stage in the month of September. The predator in the valley is univoltine. Adults collected in the field from mid July onwards remained in reproductive dormancy during the rest of the season and were found in small numbers.
**Egg**

The eggs are spindle shaped and measure 1.2 mm in length and 0.8 mm in breadth on an average. They are deposited in batches and colour pale yellow when freshly laid, turning darker as the development proceeds. The chorion is smooth and egg shell is colourless. Before the onset of hatching the colour of the egg changes to somewhat greyish (Fig. 27-A).

**First instar larva**

The first instar larva is oblong, somewhat tapering posteriorly with longitudinal folds. On an average it measures 1.6 mm in length and 0.7 mm in breadth. The head, thoracic plates and spines are black in colour. The general colour of the body and legs is dark brown. A white line, median in position, extends from the prothorax to the seventh abdominal segment. The head is slightly bent downwards and the fronto - clypeal region has a 'V' shaped suture. Three ocelli are found on each side of the head and it bears scattered setae. The antenna is three segmented having sclerotised rings. The terminal segment of the antenna possesses sensory papillae. The pronotum bears bristles on its anterior margin and is highly sclerotised. Small spines are uniformly scattered all over the body (Fig. 27-B,C,D,E).
Second instar larva:

The second instar larva resembles the first instar except in size which on an average measures 4.1 mm in length and 1.0 mm in breadth. The antenna is bulging and the pronotum has uneven median area. The posterior spines are stumpy and the meso and metanotum have four tubercles, the break up being two median and two lateral in position. The two median tubercles have two spines while the two lateral ones have three spines each (Fig. 28-A, B, C, D).

Third instar larva:

The third instar larva is stouter than the first and the second instars and on an average measures 6.2 mm in length and 2.4 mm in breadth. The pronotum has rough surface and bears longer spines on its lateral and posterior margins. The spines bear setae at their basal segments. The first to eighth abdominal segments have six tubercles in a row - the position being two median, two pleural and two marginal. The abdominal sternites have long bristles in transverse rows (Fig. 29-A, B, C, D).

Fourth instar larva:

The fourth instar larva is stouter of all the instars and on an average measures 12.0 mm in length and
3.5 in breadth. The head is light orange - yellow in colour. The dorsal side of the larva possesses prominent patches of orange - yellow and white. The prothoracic shield is orange and bears setae of the same colour on its side. The meso and metathorax have light greyish streaks on the dorsal sides. The chalazae on first to fifth abdominal segments are orange brown, each bearing stout branched setae. The chalazae on the fifth abdominal segment are almost dull white but the setae are orange brown in colour. The chalazae on the second and third abdominal segments are not so prominent but the white coloured setae are prominently visible. On the sixth abdominal segment, which is black in colour, a pair of white tubercles bearing white setae are present. Next three abdominal segments are black. The legs are long and brownish yellow in colour (Fig. 30, A, B, C, D).

**Pupation:**

The full grown fourth instar larva stops feeding in this phase of life-cycle and remains inactive for about 24 hours after attaching itself to some substrate, generally a leaf surface, with the help of its anal disc. It remains in this condition till the pupa is formed.

**Pupa:**

The freshly formed pupa is greyish in colour, later
on turning dull black with prominent black markings on its dorsal side. In early pupal condition eye spots can be located near the head region. The head, thoracic and abdominal segmentation is quite distinct in the pupal stage also. The abdominal segments narrow down gradually from the first to last segments. Each abdominal segment bears a pair of spiracles on its lateral sides (Fig. 31). On an average, the pupa measures 6.7 mm in length and 5.4 mm in breadth. The remnants of the last larval moult remain adhered to the posterior end of the pupae.

**Eclosion:**

The abdominal movements created within the puparium exert pressure on its outer covering and result in its rupture in the antero-ventral position allowing the adult beetle to come out from its shell.

**Adult:**

The adult is larger than any of the other Coccinellids except *Aiolocaria* species which sometimes is slightly larger than *Ballia bayadera*. It is sub-spherical and on an average measures 10.3 mm in length and 7.5 mm in breadth across the elytra. The elytra on adult emergence is pale yellowish brown in colour and after a couple of hours shining black spots appear which become prominent in half.
an hours time. Scutellum black and pronotum slightly
paler than the elytra and finely punctated. Head pale
yellowish - brown bearing a pair of large black compound
eyes. Antennae, mouth parts, labrum and legs are brown
in colour (Plate 6).
Life Cycle

Pre-oviposition:

During present studies, the pre-oviposition period was found ranging from 3.0 to 4.0 days with a mean of 3.6 days in *B. bayaderae* in the laboratory.

Incubation:

The egg number in the laboratory during present observations varied from 12 to 28. The incubation period of *B. bayaderae* eggs was found to range from 3.0 to 4.0 days with an average of 3.5 days at 25±5°C.

Rao and Ghani (1972) recorded the incubation in *B. eucharis* varying from 3 to 6 days with an average of 4.8 days at 16 ±5°C.

Larval duration:

Under present investigations, the duration of first instar *B. bayaderae* larva was found to vary from 3.0 to 3.5 days, the second instar took 1.5 to 2.0 days to undergo second moult, the third instar lasted for 2.0 to 2.5 days while the fourth instar larva enjoyed a period of 4.0 to 5.5 days. On an average, the first, second, third and fourth instar larva took 3.2, 1.7, 2.2 and 4.8 days respectively. The total larval span from first instar larva to fourth instar was found to be 10.5 to 13.5 days.
Rao and Ghani (1972) recorded the larval duration in *B. eucharis*, the first instar larva ranged from 1.2-3.0 days, the second from 1.0-2.0 days, the third from 1.9-2.0 days and the fourth and final instar from 5.0-5.2 days.

**Pupal duration:**

During present studies, the pupal period was found ranging from 6.0-8.0 days with a mean of 6.8 days in *B. bayaderae* in the laboratory.

Rao and Ghani (1972) found the pupal period in *B. eucharis* ranging from 5.0-6.0 days.

*B. bayaderae* in the present observations was found to complete its whole life-cycle from egg stage to the adult emergence in 19.5-25.5 days with a mean of 22.2 days time duration.
Table 7. Duration of different developmental stages in *Ballia bayadera* (in days).

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<th>Observations</th>
<th>Pre-oviposition period</th>
<th>Incubation period</th>
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Mean: 3.5  3.5  3.2  1.7  2.2  4.8  6.8  25.9

Range: 3.0-4.0  3.0-4.0  3.0-3.5  1.5-2.0  2.0-2.5  4.0-5.5  6.0-8.0  24.0-29.0
Fig. 27. Structure of first instar larva of B. bayaderae.

A. Egg.

B. Head

C. Thoracic segment.

D. Abdominal segment

E. Caudal segment.
Fig. 28. Structure of second instar larva of *B. bayadera*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 29. Structure of third instar larva of *B. bayadera*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 30. Structure of fourth instar larva of B. bayaderae.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 31. Structure of pupa of B. bayaderae.
Plate 6. *B. bayadera* Adult
Oenopia conglobata Linnaeus

The genus Oenopia belongs to the tribe Synonychini of the subfamily Coccinellinae and family Coccinellidae. Oenopia conglobata was for the first time recorded by Linnaeus in 1758. Mulsant (1850) reported O. luteopustulata and O. sauzetic. Kapur (1955, 1963 and 1973) reported O. luteopustulata from India and giving the geographical distribution of O. luteopustulata, the author reported it to be widely spread throughout the sub-continent occurring in Simla, Uttar Pradesh, Nepal, Sikkim, North Bengal, Assam, Andaman islands, Burma and Tibet. O. sauzeti was recorded from Muree and Dalhousie hills, Punjab, Kumaun hills, Chota Nagpur, Bihar, Nepal, Burma, Sikkim and Rajasthan. O. quadrupunctata too was reported from Sikkim, Darjeeling and also from the higher and less explored parts of Himalayas in Tibet.

Distribution:

During the present survey in the valley of Kashmir, O. conglobata was found at Srinagar, Badgam, Anantnag, Pulwama, Kupwara and Baramulla (Fig. 1).

Host Range:

Very scanty record on the host range of O. conglobata is available. In the present investigations on the host range, the predator was observed feeding on Lipaphis erysimi
(Brassica compestris), Aphis pomi (Malus sylvestris), Rhopalosiphum sp. (Prunus communis), Microsiphum rosae (Rosa sp.), Aphis craccivora (Robinia pseudoacacia) and Cavariella aegopodii (Salix sp.).

The overwintered adults resume their activity in the month of April depending upon the climatic conditions in the valley. The predator starts ovipositing on sunny days on aphid infested plants in the last week of April or early May. The activity of the grubs was noticed to be maximum during ending May and early June when the aphid infestation on host plants is maximum and the predator seems to do a great deal of damage at this stage. The pupation takes place in June and the adults emerge out in the same month. The peak population of the predator starts declining in July and continues upto September. The predator hibernates in the adult stage in the month of September and there seem to be three overlapping generations a year in the valley.

**Egg:**

The eggs of C. conglobata are elongated, cigar shaped and almost rounded at both the ends. They are yellow in colour when freshly laid and turn darker as the development proceeds. The chorion is sculptured with extremely minute tubercles all over the surface (Fig. 2-a). Each egg on an average measures 1.2 mm in length and 0.5 mm in breadth.
First instar larva:

Egg hatching was indicated by the change in colouration from pale to darkish grey. The newly emerged larvae were dirty cream coloured when they came out from the egg shell. The first instar larva has a clear demarcation between head, thorax and abdomen. Dorso-laterally a pair of three segmented antennae are located. The terminal segment of the antennae is longer than the other two. The antenna has sclerotized rings and two papillae - one being long and the other short. The larva is fusiform and the head is bent downwards having a vase shaped suture. There are three Ocelli on each side of the head that bears scattered setae. The tergal plates of the pronotum possess bristles and spines. The first to eighth abdominal segments bear six pairs of scoli on each. The legs are black and the claw is dark brown (Fig. 3A-B, C, D, E). On an average, the first instar larva measures 1.3 mm in length and 0.5 mm in breadth.

Second instar larva:

The second instar larva is similar to first except in length which on an average measures 3.3 mm and in breadth measures 0.9 mm. The pronotum bears more bristles and spines. It is almost black in colour and the mouth parts are well developed and more sclerotised. The abdominal tubercles have
many spines. On the ventral side of the larva the protuberances develop into bristles (Fig. 33-A, B, C, D).

Third instar larva

The third instar larva is stout and light black in colour with well developed mouth parts. On an average, each larva measures 5.2 mm in length and 1.3 mm in breadth. The mandibles are stout, bearing two blunt teeth. The pronotum is heavily covered with bristles and spines. The abdominal tubercles are covered with more spines. Warts are present on the ventral side of the abdominal segments and bristles are similar to that of the previous instar (Fig. 33-A, B, C, D).

Fourth instar larva:

The fourth and the final instar is stouter and on an average measures 5.9 mm in length and 2.8 mm in breadth. It colours almost black and the lateral sides of head carry dull orange coloured dots. Dorso-laterally, a pair of distinct antennae are present. The body of the larva is fusiform, widest at metathorax and it gradually narrows down posteriorly. From first to eighth abdominal segments, six pairs of scoli are present. The position of the six tubercles on each segment is - two median, two pleural and two marginal. Each tubercle has two spines. A row of small spines is present between each median and pleural row of tubercles. The spines of
median and pleural rows are unequal and progressively increase in size from first to eighth segment. The penultimate segment has long bristles at its segmental surface and the caudal margin. The legs are black and the claws colour dark brown. The marginal spines on first to eighth abdominal segments are pinkish orange in colour (Fig. 35-A,B,C,D).

Pupation:

After the completion of the feeding period by the fourth instar larva, the mature ones stop feeding and start the development for pre-pupal stage by attaching to some substratum with the help of caudal segment. In this phase it remains inactive till it gets transformed into pupa. Both in the pre-pupal and pupal condition, it is capable of producing a defensive, bad smelling secretion when either of the stages are disturbed.

Pupa:

The pupa remains enclosed in the exuvae of the fourth instar and on an average measures 5.7 mm in length and 3.0 mm in breadth. The freshly formed pupa is light yellow in colour which changes to light brown with further development. The pupa is oval and dorsally convex, the anterior portion being truncate while the posterior is tapering. The head is brownish while the thorax and abdomen possess pale yellow
markings on brownish areas. The elytral folds are dark brown in colour. In the pupal stage, the body segmentation of head, thorax and abdomen is quite clear but the antennae are not so distinct. The spiracles are clearly visible (Fig. 3).

Eclosion:

The movements in the abdomen are responsible for rupturing the puparium. The phenomenon of eclosion takes place in the apical position anterodorsally and the process was observed to take about 12-15 minutes time duration.

Adult:

The newly emerged adult on emergence from the pupa colours yellow and has no spotting pattern on its elytra. After one and a half hours, however, full spotting pattern with faint impression was discernible. After attainment of adult-hood, the beetles were found to start feeding and mating.

Adults ovoid with moderately convex dorsum. Head light orange bearing three small black coloured dots. Antenna eleven segmented arising from antennarium located in between compound eye and labrum. The antenna is light brown while mouth parts vary from brown to black. Spotting pattern on elytra varies and each elytron bears; one round apical, one
large oval humeral, one large median towards inner side, one small median towards outer side and two posteriorly located spots. One of the outer posteriorly located spots generally fused with large medially located spot. Elytra colours light orange and the spots black. Scutellum regular, small, triangular with very fine punctation. The head and elytra finely and shallowly punctated. Legs black in colour (Plate 7). On an average, the adult measures 4.3 mm in length and 3.0 mm in breadth.
LIFE CYCLE

Almost negligible work on the life-cycle of *Oenopia conglobata* has been done in India as well as abroad. After scanning the literature on the said genus and species, it was found that very scanty reports on the distribution and host range were available.

Under present studies the adults started laying eggs, 4-8 days after their emergence. The eggs were laid in batches on the stems and on the under surface of the leaves in close vicinity of the aphids. They were laid in captivity also and the egg number varied from 9-18 in the laboratory. The incubation period ranged from 4-5 days with a mean of 4-5 days.

The wriggling movements of the larva help it to come out from the egg shell. The remaining yolk traces in the egg shell form the first food of the newly hatched larva which in the beginning shows little crawling movements. The larvae passed through four instars. The first instar ranged from 3.0-4.5 days, the first moult was observed to occur after 2.0-3.5 days, the second moult took place after 2.5-3.0 days while the third moult forming the fourth and the final instar was observed after 4.0-5.0 days. On an average, the mean time duration for the first, second, third
and fourth instar larva was found to be 3.9 days, 2.8 days, 2.6 days and 4.4 days respectively and the total larval duration from first instar to fourth instar larva ranged from 11.5–16.0 days with a mean of 13.7 days.

The pupal period ranged from 4.5–5.5 days and on an average it was found to be of 4.8 days duration. The total developmental period from egg to adult emergence ranged from 15.5–21.0 days with an average of 18.2 days. The adult longevity in the laboratory was found to be ranging from 21 to 29 days having a mean of 26.0 days.
Table 8. Duration of different developmental stages in *Oenopia conglobata* (in days).

<table>
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<tr>
<th>Observation number</th>
<th>Pre-oviposition period</th>
<th>Incubation period</th>
<th>1st larval period</th>
<th>IIInd larval period</th>
<th>IIIId larval period</th>
<th>IVth larval period</th>
<th>Pupal period</th>
<th>Total</th>
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Mean: 6.2, 4.5, 3.9, 2.8, 2.6, 4.4, 4.8, 29.3

Range: 4.0-8.0, 4.0-5.0, 3.0-4.5, 2.0-3.5, 2.5-3.0, 4.0-5.0, 4.5-5.5, 25.5-34.0
Fig. 32. Structure of first instar larva of *O. conglobata*.

A. Egg
B. Head
C. Thoracic segment
D. Abdominal segment
E. Caudal segment.
Fig. 33. Structure of second instar larva of *O. conglobata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 34: Structure of third instar larva of *O. conglobata*.

A. Head
B. Thoracic segment.
C. Abdominal segment
D. Caudal segment.
Fig. 35. Structure of fourth instar larva of *O. conglobata*.

A. Head
B. Thoracic segment
C. Abdominal segment
D. Caudal segment.
Fig. 36. Structure of pupa of O. conglobata.
Plate 7:  
A. O. conglobata Adult  
B. Variation in elytra pattern.