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Observations on the biology of *Henosepilachna ocellata* (Redtenbacher) (Coleoptera: Coccinellidae), a pest of Potato Crop in Uttarakhand

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Abstract

Biological observations on *Henosepilachna ocellata* (Redtenbacher) (Coleoptera: Coccinellidae) had been made at Mandal (Uttarakhand) and its surroundings. Here, it is an oligophagous species, extensively attacking the crops of *Solanum tuberosum* Linn. (Potato). Mating, oviposition and adult behaviour of this pest had been studied. It bred actively from March to August and it took about 34 days to develop from egg to adult. The females started egg laying after 8 to 12 days of becoming adult.

Keywords: *Henosepilachna*, potato, multivoltine, epilachnids, verrucae.

1. Introduction

Coccinellids are of great economic importance, many of them are beneficial, preying upon the pests such as aphids, chrysomelids, coccids and aleyrodidae, however, some are harmful pests of agricultural crops. These phytophagous coccinellids have been grouped in the subfamily Epilachninae. Observations on the feeding behaviour of epilachnids were made as early as 1843 by Redtenbacher [13] and in 1909, Lefroy and Howlett [9] presented brief life histories of two phytophagous coccinellids in their book "Indian Insect Life". The epilachnids, *Subcoccinella 24-punctata* (Fab.) (Schmidt, 1918 [15]; Marriner, 1937 [10]; Tanasijevic, 1958 [18]; Richards, Pope and Eastop (1976) [12]) and Mexican bean beetle, *Epilachna varivestis* (Mulsant) (Ballhorn and Lieberei, 2006 [3]; Auclair, 1959 [2]; Wilson, Stinner and Rabb, 1982; [20]), have been extensively studied abroad. In India, the dearth of such studies is clear from the fact that apart from studies made by Krishnamurti (1932) [7]; Kapur (1950) [5]; Atwal and Sethi (1977) [1]; Singh and Phaloura (1987, 1990) [16, 17]; Revathi, Kingsley, and Venkatesan (2008) [14]; Tiwari, and Yadava (2008) [19] and Ghule, Devi and Jha (2014) [4] this field has been largely left neglected. The present studies were aimed to study biology, behaviour, seasonal life history of *Henosepilachna ocellata* (Redtenbacher) in Uttarakhand, hitherto unexplored.

2. Material and Methods

Observations on *H. ocellata* were made by rearing it in the field laboratory at Mandal (altitude 2000m, latitude 30.43 N, Longitude 83.40 E, Uttarakhand) during 2010 and thereafter supplemented by field observations made in the surroundings of the selected site. Laboratory cultures were started with field collected adults. A pair each was released in 12" x 12" wire mesh cages and supplied with plentiful of the host leaves. Cages were checked frequently to record mating behaviour, egg laying, ovipositional behavior and to replenish food when needed. Eggs were immediately removed from cages and shifted to petridishes for hatching. Records of temperature and humidity were maintained during the period of observation.

3. Results and Discussion

3.1. Host plants, feeding behaviour and nature of damage

H. ocellata had been recorded feeding upon the leaves of potato and black-night shade both belonging to family Solanaceae. *Solanum tuberosum* Linn. (potato) is extensively cultivated throughout the hilly areas of Uttarakhand and the same had been found attacked by *H. ocellata*. Severe attacks had been recorded in Gobindghat, and Joshimath areas but little in the district of Chamoli. *S. nigrum* (Linn.) (Black-night shade) is a wild perennial shrub growing

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in forests as well as cultivated areas, and near Mandal, the attack had been observed solely confined to the wild host rather than the potato crop. However, in the absence of both these hosts, it fed upon *Urtica dioica*, but never had been seen breeding upon this host. Lal (1990) [8] had studied the host preferences of *H. ocellata* in Kullu valley and noted potato, tomato, brinjal, okra, cucumber, radish, capsicum, French bean, green gram and black gram as its host plants. Koshta and Dhamdhare (1981) [6] had reported it feeding on bitter gourd. But in Uttarakhand, in the areas explored, the attack was mainly confined to the potato crop and *S. nigrum*, and in the absence of these, *Urtica dioica* were attacked.

Both larvae and adults of *H. ocellata* fed upon the undersurface of leaves. They completely scratched away the lower epidermis and palisade tissue leaving only the upper epidermis and veins intact, thus imparting a sieve-like appearance to the leaf. While feeding upon potato leaves, the adults injured the leaves hither and thither unlike the larvae which shifted to the second leaf only after eating plentiful of the first one. However, in extensive attack the leaves were wholly skeletonised which ultimately dried and withered away.

3.2. Mating and Ovipositional behaviour

Mating behaviour of *H. ocellata* had been studied both in laboratory as well as in the field. It is of riding type, where male mounted over the back of the female. Prior to copulation, an excited male approached the female and quickly mounted over the latter's back and in case she was not receptive she either ran away quickly or jerked her body to get rid of the mounting male. If the male didn't leave the female, she stiffened her legs and stood picking her body high above the substrate and gave quick jerks or she quickly got inverted and beat her wings to free herself from the clutches of the male. For receptive female, however, the male from behind mounted, bent the tip of abdomen at about 60 ° and touched the various female external genital parts, with his parameres out, to locate the female genital aperture and on finding the latter, the male firmly held the female with the help of his fore and middle legs, deflexed the parameres and placed these beneath the last sternites of the female. The siphon was then inserted into the female genital pouch. The female remained inactive during the actual course of coition. The end was initiated by the female when she jerked her body to disengage the riding male. The copulation lasted for 1-3 mts in a pair.

Mating mostly occurred during the day time. It appeared that copulation was a matter of chance when male and female happened to meet. It is supported by the fact that male readily climbed over another male and descended only on finding that the partner is not receptive but at times male crossed the females even without touching them. Omkar and Singh (2010) [11] had presented similar views while studying the mating behaviour of *Coelophora saucia*.

Females of *H. ocellata* deposited eggs in batches. Prior to egg deposition, the female rested for about 2-5 minutes at a selected site (leaves or twigs of host) and if undisturbed started laying eggs. Abdomen was dilated and then tip of abdomen was extended so that it touched the substrate time and again. The waves of contraction passed through the abdomen and it seemed as if the female was trying to squeeze something out of her body, then the egg extruded slowly out of the ovipore, touched the substrate when half extruded and if it stuck there, the female gently pulled her abdominal tip upwards to release the egg fully. During the course of egg deposition, the female continued the up and down movements of its abdomen to facilitate the protrusion of egg. After laying an egg, she

slightly diverted and laid the second egg close to the first one and this process followed till the last egg of a batch was deposited. A female took 50-80 seconds to lay an egg. The egg batches of *H. ocellata* generally consisted of 20-29 eggs/batch, but a minimum of 15 eggs/batch and maximum of 44 eggs/batch had been recorded.

The ovipositional site was generally the undersurface of leaves or twigs of host plant. In the laboratory cages, the eggs were deposited on undersurface of leaves or walls of cages but never upon the floor of the latter, indicating their negatively geotactic behaviour and confirming that in fields, egg deposition is never done on the soil.

3.3. Immature Stages

The freshly laid eggs were bright-yellow but soon turned pale-yellow. The eggs were elliptical with their free apical end conical and basal end rounded. About a day before hatching, the colour of the eggs changed from yellow to grey and later on a bulge appeared near the apical end and ultimately the larva emerged through an apical split in the chorion. The newly hatched larva was light-yellow, but gradually turned darker with the hardening of its exocuticle.

After emerging from the egg shell, the larva descended towards the base of the former, retaining a hold at the top with its abdominal tip and sucked out any fluid remaining in the egg shells after emergence as a part of the first meal. Sometimes, the food also comprised a part of the chorion. However, in no case the egg shells were eaten up completely or the embryos which due to some reasons failed to hatch. The larvae dispersed from the egg shells after 18-24 hours of their hatching.

There are four larval instars in the life cycle of *H. ocellata* followed by prepupa, pupa and adult. The newly hatched larva of *H. ocellata* was very delicate and light-yellow but gradually turned darker during its stay at the egg shells acquiring slightly dark-yellowish hue but head and scoli, including their pinaculi, turned brownish. Just after dispersal the larvae fed close to one another, however, as they grew old they dispersed to different leaves. When full grown, it attached itself to the substrate with the help of a sticky secretion given out at its anal end. After the attachment, its body started shrinking, scoli started degenerating from apices towards bases and head and legs were drawn under the body. The larva remained motionless in this state and prepared for moulting. After some time, the old larval skin ruptured at the ecdysial cleavage line and mid-dorsal line up to the mesonotum, and the second instar larva wriggled out.

Subsequent larval instars varied slightly in color and in the number of scoli but considerably in body dimensions. The second instar larva resembled the first instar in colour. The third instar larva was comparatively dark-yellow with head blackish-brown. The fourth instar larva was broad anteriorly but broadest at its second abdominal segment and narrow posteriorly. Dorsally, it was covered by the branched scoli and was dark-yellow with dark brown pinaculi and head. The scoli were dark brown to light-yellow in colour. The venter of larva was yellowish and it possessed clearly defined brownish verrucae.

Fourth instar larva after actively feeding for 5-6 days spent an inactive period of 1-2 days, the prepupal stage, when it attached itself to the undersurface of a leaf or a twig and stopped feeding. Its size started decreasing and when disturbed showed no activity. The scoli started degenerating from apices towards bases. The fourth instar larval skin was gradually pushed backward by the growing pupal skin which ultimately developed sclerotisations at specified areas, and thus pre-pupa

changed to an exarate pupa.

The pupa of *H. ocellata* was found attached to under-surface of leaves and also at the basal portion of the stem of its host plant. The head of pupa was opisthognathous and marked with yellow and brownish-yellow areas. Pronotum was rectangular with lateral margins gradually curved. Discal area of pronotum was largely yellowish-brown except at antero-lateral margins and mid-line. Mesonotum bore a dark-brown patch on either side of the mid-dorsal line. Metanotum bore similar brown patches as on mesonotum but almost of the double size. Each elytron was elongate, oval, bending ventrally to cover most of

the hind legs and abdominal sternites. Its basal area was acutely rounded, median area yellowish-brown but epipleura and scutellar areas were yellowish. Abdominal terga were without any inter-segmental conjunctivae and bore a pair of dorsal tubercles arranged medially. Colour of terga was mainly yellow with irregularly distributed brownish-yellow patches.

If pupa was disturbed it showed characteristic oscillatory movements by repeatedly throwing its anterior end up and down and posterior end fixed to the substratum. Often a number of larvae of about the same age pupated side by side.

Table 1: Dimensions of various instars and their duration
Food plant : *Solanum nigrum* Linn.(Solanaceae)

	Egg	First Instar	Second Instar	Third Instar	Fourth Instar	Prepupa	Pupa	Adult Male	Adult Female
Length (Av. \pm S.D.) mm.	1.749 \pm 0.032	2.699 \pm 0.073	4.930 \pm 0.139	6.350 \pm 0.211	10.220 \pm 0.221	--	7.210 \pm 0.161	6.687 \pm 0.286	6.256 \pm 0.443
Breadth (Av. \pm S.D.) mm.	0.581 \pm 0.016	0.731 \pm 0.027	1.386 \pm 0.057	1.413 \pm 0.060	3.080 \pm 0.122	--	4.778 \pm 0.085	5.966 \pm 0.128	5.667 \pm 0.067
Duration (Av. \pm S.D.) Days	7.000 \pm 0.000	4.350 \pm 0.490	3.842 \pm 0.375	4.526 \pm 0.772	5.167 \pm 0.383	2.944 \pm 0.235	6.167 \pm 0.383	Egg to Adult 33.944 \pm 0.640	
Temperature (Av. \pm S.D.) $^{\circ}$ C	21.604 \pm 1.456	21.236 \pm 0.929	20.000 \pm 0.500	20.119 \pm 0.540	20.488 \pm 0.739	20.375 \pm 0.626	20.048 \pm 0.406	--	--
Relative Humidity (Av. \pm S.D.) %	66.500 \pm 9.017	69.563 \pm 4.366	72.071 \pm 2.046	73.632 \pm 3.651	71.789 \pm 5.051	73.071 \pm 4.122	75.846 \pm 2.664	--	--

3.4. The Adult

Pupal skin ruptured at the ecdysial cleavage line and the teneral adult made its way out. It was very soft and brownish-yellow, and it took several hours to hardening, developing the spots and attaining species specific colouration. Body of the adult is oval and convex. Head is reddish-brown which is more than half the pronotal width. Antennae are eleven-segmented and the last three segments form a distinct club. Pronotum is half of body width, emarginated anteriorly, lateral margins widely rounded and slightly elevated. It is dark-brown coloured except reddish brown at lateral margins. Elytra are dark-brown to piceous with six black spots. Each spot is surrounded by light-brown ring of moderate width. Sexual dimorphism is exhibited by the *H. ocellata* adults. Apart from comparatively larger size of female, its last abdominal sternite bears a longitudinal slit, which is entire in male.

Adults were very active, they moved quickly over the host plant and usually rested on undersurface of leaves. If disturbed they quickly folded their legs and antennae and fell down feigning death. They also showed reflex bleeding, when handled roughly, by exuding a yellow coloured fluid at the joints. The females of *H. ocellata* had been observed feeding upon their own eggs. Mostly the freshly laid eggs were attacked and eaten up. The adult beetle had been seen pressing the egg in-between their mandibles from base towards tip, puncturing it and then sucking the yolk, so that only the chorion remained which was also nibbled later on. Larvae had never been observed feeding upon the eggs or their fellow beings.

3.5. Seasonal life-history

H. ocellata is an oligophagous and multivoltine insect. As observed in the hilly areas of Uttarakhand, it remained active from April to August and its maximum infestation was in the months of May to July. During this period all the stages in its life-cycle could be collected in good number in the fields. With the start of monsoons in mid-July, in spite of the availability of food during this period, the population started

diminishing and only scattered adults were available by the start of August. In the months of May/June, when the day temperature ranged from 18 to 25 $^{\circ}$ C, it took about 34 days to complete its life-cycle from the egg to adult. The newly emerged adult was ready to mate within 3-5 days of its emergence and egg laying occurred after a gap of 5-7 days of mating. So, it can be expected that it passed through about three generations in the active period of the year. The population seemed to be affected by the temperature and rainfall and the food factor didn't appear to limit it. It attacked *S. tuberosum*, a cultivated crop, and *S. nigrum*, a wild host. Potato is cultivated throughout the hilly regions of Uttarakhand and near Mandal area generally two crops are obtained in a year i.e. during the period from March to June and September to December, while *S. nigrum* is a wild perennial shrub. So, there was an uninterrupted supply of food throughout the year. During the months from March to July, usually the temperature varied from 18 $^{\circ}$ C to 25 $^{\circ}$ C and relative humidity from 65% to 90%. However, with the onset of monsoons in mid-July, the temperature started decreasing with a considerable rise in humidity and during this period, a few larval instars, mostly the third or the fourth, and the adults could be collected from the fields. By the start of September, the day temperature fell below 19 $^{\circ}$ C and generally ranged from 14 $^{\circ}$ C to 19 $^{\circ}$ C, and during this period, the insect was no more available in the fields and thus not even a single specimen could be collected in the months from October to March next suggesting that they underwent a phase of dormancy or migration. However, no hibernating or migrating individuals of *H. ocellata* had been encountered in and about the area under observation during this period.

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