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Morphological study of second stage female larva of *Aonidiella orientalis* (Newstead) (Homoptera: Coccoidea: Diaspididae)

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Abstract
Authors have studied morphological features of scale insect second stage female larva of *Aonidiella orientalis*. It belongs to subfamily Aspidiotinae, family Diaspididae, superfamily Coccoidea, and order Homoptera. All the insects of this family are known as armored scales. Armored scales are cosmopolitan found in tropics, subtropics and warm portion of the temperate zones. It is an important pest of *Dalbergia sissoo, Mangifera indica, Cassia semia, Azadirachta indica, Musa paradisiaca, Psidium guajava* and other economical ornamental and horticultural plants which had been collected in Northern India from the leaves, twigs, barks and fruits. The body of second stage female larva of *Aonidiella orientalis* nearly rounded and divided into prosoma, postsoma and pygidium. Prosoma includes head, pro and mesothoracic segments, while postsoma is formed by metathoracic and three anterior abdominal segments. The pygidum is formed by fusion five posterior abdominal segments.

Keywords: second female larva of *Aonidiella orientalis*, morphological features

Introduction
Aonidiella orientalis belongs to subfamily Aspidiotinae, family Diaspididae, superfamily Coccoidea and order Homoptera. All the insects of this family are known as armored scales. Armored scales are cosmopolitan found in tropics, subtropics and warmer portion of the temperate zones.
Lellakova – Duskova (1963) [5] described the morphology, metamorphosis and life cycle of scale insect *Quadraspidiotus gigas*. Komosinska (1974) studied on the morphology of *Mytilaspis conchiformis* forma *conchiformis* (Gmelin). Srivastava (1975) [8] reported on occurrence of the red scale, *Aonidiella orientalis* (Newstead). Dutta (1990) [2] described on the contribution towards the study of scale insects of North India. Dutta and Baghel (1991) worked on the morphology of mature, *Aonidiella orientalis* (Newstead). Ojha (2006) [6] worked on the morphological special features of mature female insect, *Abgrallaspis katorii*. Chauhan and Ojha (2006) studied on the morphological study of adult male *Aspidiotus tamarindi* (Green). Ojha and Singh (2019) described on morphological features of first stage larva (crawler) of *Aonidiella orientalis* (Newstead).

Materials and Methods
The morphological studies were carried out in Zoology Department, Raja Balwant Singh College, Agra chiefly taken from different hosts and several localities of Shikohabad, Northern India. The collection of the material of *Aonidiella orientalis* was done from its hosts with the aid of horticultural budding knife. The specimens were preserved in dry condition and authors adopted the procedure used for mounting the insects by Williams and Kosztarab (1970). Figures and photomicrography of the mounted specimens were done with the aid of camera lucida. Measurements values in millimeters are taken with the aid of occulometer and micrometer.

Description
Scale (Fig. 1)
Scale is nearly rounded in shape and light brown in colour. The average diameter of scale of female second stage larva of *Aonidiella orientalis* (Newstead) is 0.65 mm. The scale is having nearly centrally placed exuvia which pear shaped and convex. The average diameter of the exuvia is 0.23 mm.

Body Shape (Fig.2, 3)
The shape of the body of second stage female larva of *Aonidiella orientalis* (Newstead) resembles in appearance to that of adult female, but differs in size, structure of pygidium, number of glandular ducts and the absence of vulva. Its body colour is yellowish green.

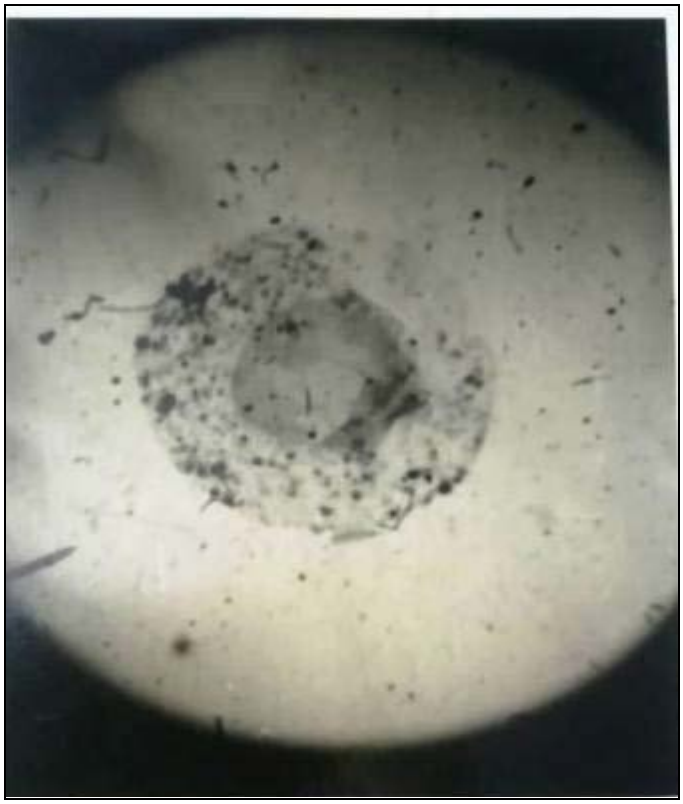

Fig 1: Microphotograph of the scale of second stage female larva of *Aonidiella orientalls* (Newstead)

Fig 2: Microphotograph of second stage female larva of *Aonidiella orientalls* (Newstead)

Segmentation of the body (Fig 2, 3, 4)
The body of the second female larva of *Aonidiella orientalis* into prosoma, postsoma and pygidium. The prosoma includes head, pro and mesothoracic segments, while postsoma is formed by metathoracic and three anterior abdominal segments. The pygidium is formed by fusion of five posterior abdominal segments. The prosoma consists of a pair of antennae, mouth parts, and two pair spiracles.

Eyes: The eyes are absent in the second stage of female larva.

Antennae: The antennae are reduced in second female larval stage. Each antenna is small single lobed protuberance provided with only one long sensory seta.

Mouth Parts: The mouth parts are piercing and sucking type. Its labium is conical, one segmented bearing four setae, two long anterior and two small posterior.
Legs: The legs are absent in the second stage larva.

Spiracles: There are two pair spiracles present on ventral side. The average length of each anterior and posterior spiracle is 0.02625 mm and 0.020 mm. The anterior spiracle is associated with a trilocular pore having average diameter 0.00275 mm. but trilocular pore is absent near the posterior spiracle.

Tubular Glandular Ducts of the body: There are three types of glandular ducts in the second stage female larva of *Aonidiella orientalis*: macroducts, mesoducts and microducts. In addition to this glandular tubercles and glandular plates are also found.

Glandular Ducts Situated on Dorsal Side: The glandular ducts on right and left dorsal side are absent on head and prothorax region. The mesothorax and metathorax each consists of two mesoducts and the abdominal mesoducts occur on first to fourth abdominal segments. Their average numbers on subsequent segments are two, three and six respectively. Values obtained from 15 measurements. The macroducts are present only in the V to VIII abdominal segments and arranged in four groups. The average numbers of first group are four whose opening are present in series, starts from crypts of L_1 and L_2 lobes. The second group consists of four whose openings start from the intrasegmental crypts of L_2 and L_3 lobes. The third group of macroducts consists of six whose opening begins from the third pygidial segment. The fourth group includes two macroducts whose opening begins from the intrasegmental crypts of the second pygidial segment.

Glandular Ducts Situated on Ventral Side: On the ventral side of the body only microducts and glandular tubercles are present. The microducts are absent in head region but two microducts are present on metathorax. Three glandular tubercles are present on metathorax and arranged transversely below the posterior spiracle. III to VII abdominal segments having the microducts in following subsequent number: two, three, four, two and one. The glandular tubercles are two on first and one on second abdominal segments.

Abdominal glandular plates (Fig 2, 3, 4): The glandular plates are present in four groups. The plates are fringed, finger –like structure and sometime branched on the top. The arrangement of the plates are as follows : two glandular plates between L_1 lobes, two between L_1 and L_2 lobes, two between L_2 and L_3 lobes and three anterior to the L_3 lobe.

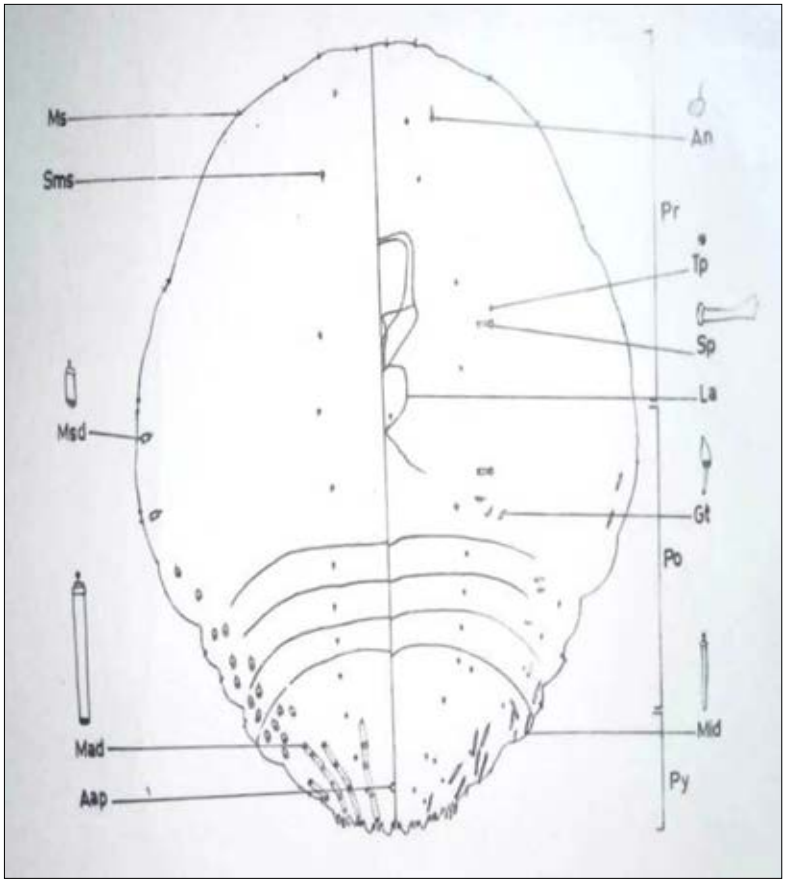

Fig 3: Photograph of a diagram showing left dorsal and right ventral side along with magnified view of various parts of the body of second stage female larva of *Aonidiella orientalls* (Newstead)

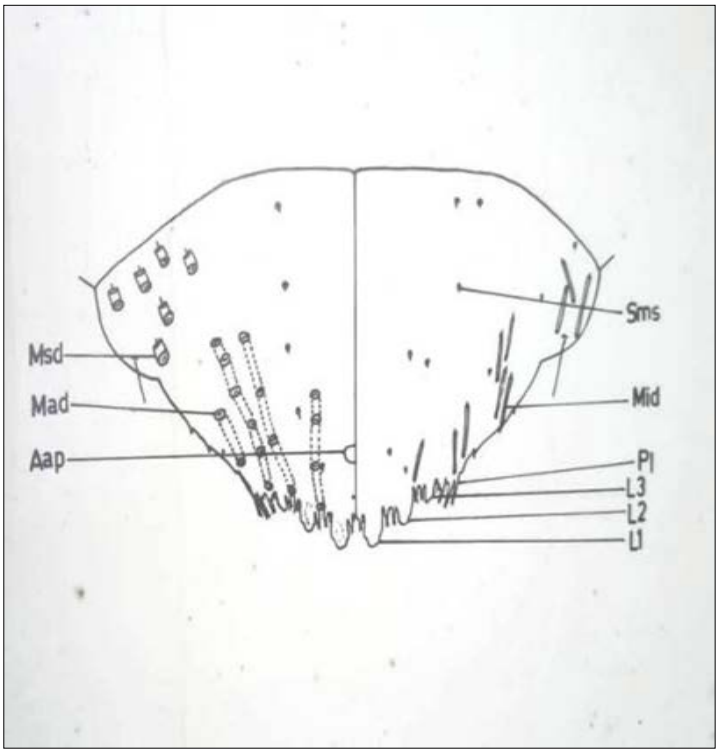

Fig 4: Photograph of a diagram showing left dorsal and right ventral side of the second stage female larva of *Aonidiella orientalls* (Newstead)

Pygidium (Fig. 2, 3, 4)

The pygidium consists of IV to VIII abdominal segments and is very well sclerotized. The average length and width of the pygidium are 0.20 and 0.240 mm. It consists of three pair lobes (L_1, L_2 and L_3) which fairly well sclerotized with apophyses directed to the ventral side of the pygidium. The L_1 largest with rounded apex and having two equal outer and inner notches. The average length and width of each L_1 is 0.0075 mm and 0.00655 mm. The L_2 is rounded apex and having two equal outer and inner notches. The average length and width of each of the L_2 is 0.0065 mm and 0.0050 mm. The L_3 is bilobed having one outer deep notch and its apex rounded. Its average length and width of each is 0.00525 mm and 0.0025 mm. The anus is located at the antero-posterior axis on the dorsal side of the pygidium. Its diameter is roughly the same as that of spiracular pore. The distance between anus and the pygidial margin is 0.0255 mm.

Distribution of Setae (Fig 2, 3, 4): In the second stage of female larva of *Aonidiella orientalis* (Newstead) the setae are distributed on dorsal as well as on ventral side. Dorsally each right and left side there are two longitudinal rows: marginal and submedian one.The marginal row consists of four setae in head part, six setae in thoracic part and nine setae in abdominal part, one on each of I to VIII segments and one between L_1 lobe. Submedian row consists of two setae in cephalic part three in thoracic and seven setae in abdominal part, one on each of I to VII segments. On ventral side setae present in three rows: marginal, submarginal and submedian. The marginal area consists of four setae in head part, three in thorax and eight setae in abdominal part, one on each of II to VIII segments, and one between L_1 lobe. Submarginal area of abdomen with seven setae, one on each of I to VII segments, submedial area with two setae on head part, three on thoracic part and nine setae in abdominal part, one on each of I to III segments, two on each of IV and VI segments, and V and VII segments each with only one seta.

Results and Discussion

In *Aonidiella orientalis* (Newstead) like that of *Quadraspidiotus gigas* (Lellakova -Duskova, 1963) [5]. *Mytilaspis conchiformis* forma *conchiformis* (Komosinska, 1974) the length of the pygidium of second instar male larva is always more than that of the pygidium of second female instar. Lellakova-Duskova (1963) [5] reported in *Quadraspidiotus gigas* female second larva of 9-18 macroducts. He also recorded in second male instar average 10-15 macroducts more than in the second female larva, while Komosinska (1974) described the average number of the macroducts in *Mytilaspis conchiformis* forma *chonchiformis* female second stage instar 1.2 and in male second stage instar 2.2. However in *Aonidiella orientalis* (Newstead) each side of the pygidium of second instar of female consists 16 in female second stage instar and 18 in male second stage instar. In *Quadraspidiotus gigas* (Lellakova-Duskova, 1963) [5] like that of Aonidiella *orientalis* (Newstead) there is no vast difference in the shape of L_1 lobe in first and second instars of male and female. However *Mytilaspis conchiformis* forma *conchiformis* (Komosinska, 1974) the L_1 lobe in male second instar in spatular in shape.

Abbreviations

Aap - Anal Aperture ; An – Antenna ; Gt - Glandular tubercle ; La - Labium ; L_1, L_2, L_3 – Lobes; Mad - Macroduct; Mid - Microduct; Msd - Mesoduct; Pl - Plates; Po - Postsoma; Pr - Prosoma; Py - Pygidium; Sms - Submedian seta; Sp - Spiracle; Tp - Trilocular pore.

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