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ORIGINAL ARTICLE

Morphological Features of Life Stages of Mango Leafhopper *Amritodus atkinsoni* (Leth.) (Hemiptera: Cicadellidae)

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ABSTRACT

Mango leafhoppers are most destructive pests of mango. These cause heavy damage to mango crop. Amritodus atkinsoni (Leth.) is the most prevalent species of leaf hoppers in North India. Life history of these hoppers includes five nymphal instars. A total five moultings occur to become an adult. The first instars of Amritodus atkinsoni are 1.060 ± 0.148 mm long ranging from 0.767 mm to 1.380 mm and the width of their head across the eyes is 0.477 ± 0.077 mm ranging from 0.383 mm to 0.721 mm. The body length of second instars varied from 1.334 mm to 2.116 mm with an average of 1.492 ± 0.221 mm and the width of their head across the eyes varied from 0.521 to 0.675 mm with an average of 0.572 ± 0.055 mm. The third instars are 2.760 ± 0.096 mm long varying from 2.530 mm to 2.914 mm and the width of their head across the eyes is 1.028 ± 0.068 mm varying from 0.920 mm to 1.135 mm. The length of the fourth instars varied from 2.914 mm to 3.604 mm with an average of 3.047 ± 0.185 mm and the width of their head across the eyes varied from 1.564 mm to 1.656 mm with an average of 1.619 ± 0.025 mm. The body length of the fifth instars varied from 3.112 mm to 3.914 mm with an average of 3.430 ± 0.189 mm with the width of its head across the eyes varying from 1.698 mm to 1.864 mm with an average of 1.781 ± 0.049 mm. The body of adult hoppers is wedge shaped, with broad and rounded head, extending little between the eyes. The length of adult female varies from 4.50 mm to 5.00 mm with an average of 4.91 ± 0.107 mm. In males, it varied from 4.20 mm to 5.00 mm, with an average of 4.63 ± 0.203 mm. In females, the width of head across the compound eyes varied from 1.856 mm to 2.055 mm with an average of 1.951 ± 0.039 mm. In males, it varied from 1.733 mm to 1.840 mm with an average of 1.777 ± 0.030 mm.

Key Words: *Leafhoppers, Mango, Morphology, Nymphal instars*

INTRODUCTION

The mango, *Mangifera indica* (Linn.) is grown in as as many as 63 countries in world. India is the world's highest producer of this fruit. India accounts for 54% of world's total mango production (Chauhan and Dabas, 1997). Highest mango production in India is not due to high productivity, but it is due to large area under its cultivation. In relation to its area of cultivation, mango production is very low in India. Out of many factors responsible for its low productivity, one of the major factors is the threat of insect pests, which cause a major damage to mango production. Among the mango pests, mango hoppers are most serious and widespread pests throughout the country (Adnan *et al.* 2014, Anufriev, 1970, Rehman and Kuldeep (2007), causing 25-60% loss of yield in mango (Hiremath and Hiremath, 1994). In India mango leafhoppers were firstly reported by Lethierry (1889) from Saharanpur. Total eleven species of mango leafhoppers are reported so far. Of which *Amritodus atkinsoni*, *Idioscopus clypealis* and *Idioscopus niveosparsus* are the most important mango pests in most of the South-East Asian region. In north India *Amritodus atkinsoni* is the most prevalent species. The damage is mainly caused by the hoppers and their nymphs due to sucking of sap from tender shoots, inflorescence and leaves of mango crop. The infested flowers shrivel, turn brown and ultimately fall off, due to sucking of sap from plant parts (Kumar, 2015). As the result overall mango production reduces. Hoppers also excrete a secretion, called honey dew. In moist weather, it encourages the development of fungi like *Capnodium mangiferum* (Cooke and Brown) and *Meliola mangiferae* (Earle). Sooty mould develops on dorsal surface of leaves, branches and fruits. This black coating interferes with the normal photosynthetic activity of the plant. It results in non-setting of flowers and dropping of immature fruits. This damage is called as Honey Dew Disease (Butani, 1993). *Amritodus atkinsoni* breeds twice in a year in North India. Females

oviposite once in the month of February and March and second time in the month of July and August. It can breed both on floral parts and leaves of mango; hence it could breed both in flowering season and off-season, when new flush appeared. For the effective control of the hoppers, it is necessary to have knowledge about the various life stages of mango leaf hoppers. The present study emphasizes on morphological features of various nymphal instars and adults of the *Amritodus atkinsoni*.

MATERIAL AND METHOD

Adult leafhoppers were collected from the field and reared in rearing cages, made up of plastic jars, size of which is 15x20cm. These jars had holes on both the side. Jars were covered by fine muslin cloth to provide ventilation. Hoppers were provided fresh mango spikes for feeding regularly. The development of nymphal instars were studied in rearing chambers, prepared by petriplates having a thin layer of cotton, over which a filter paper was placed. These rearing chambers were placed in rearing cages. The neonate nymphs, immediately after hatching, were transferred on to fresh mango spikes in the rearing cage. Everyday these spikes were changed to provide fresh food for nymphs. Nymphal instars and adult males and females were observed by recording length of their body and width of the head across the compound eyes as well as other morphological features was studied with the help of microscope.

RESULTS AND DISCUSSION

During the study eggs were collected from the field as well laid by female hoppers in rearing cages. The nymphal instars, hatched out from the field collected eggs and as well as from the eggs laid on the caged plants were observed. The duration of each instar, their morphology and behaviour were closely studied.

The life history of *Amritodus atkinsoni* (Leth.) included five instars; however there was no pupa stage. A total five moultings took place during the development. Last or fifth instars metamorphosed in to adults. Moulting took place by means of a median longitudinal splitting in the region of the head and the thorax. Nymphal instars were elongated, active and pale yellow coloured.

FIRST INSTAR NYMPH:

The head of first instars nymphs was relatively large, produced in front of the eyes and pale yellow coloured. They were very delicate. The body length of the first instars of varied from 0.767 mm to 1.380 mm with an average of 1.060 ± 0.148 mm and the width of its head across the eyes varied from 0.383 mm to 0.721 mm with an average of 0.477 ± 0.077 mm (Table 1, Fig. 1 & Fig. 2). One pair red coloured compound eyes were present on head. The thoracic segments were not separately demarcated from each other. Proboscis reached beyond the metasternum. The abdomen was relatively small and tapering towards the posterior end with several black and long bristles, arising especially from the posterior margin of abdominal segments. Tarsi were two jointed. After 24 hours, nymphs became elongated and turned greyish. The thoracic segments now became distinct from each other. Legs were transparent.

SECOND INSTAR NYMPH:

First moulting took place in first instars, as the result second instars were formed. These instars were yellow in colour, but after one day, they turned greyish-yellow. These were 1.492 ± 0.221 mm in length ranging from 1.334 mm to 2.116 mm and the average width of their head across the eyes was 0.572 ± 0.055 mm ranging from 0.521 to 0.675 mm (Table 1, Fig. 1 & Fig. 2).

The compound eyes of second instars were also red coloured. These instars were active. The thorax is three segmented and the thoracic segments were now quite distinct from each other. The mesothoracic segment was the widest of three. A constriction separated the thorax from abdomen. Till now wing rudiments did not appear. The lateral regions of the body were much darker than the median longitudinal area. Ventral surface was pale. The antennae were also darker than those of

first instars. The proboscis and legs were dirty white. The tarsi were still two jointed. Abdominal segments were distinct.

THIRD INSTAR NYMPH:

The body of the third instars was proportionately broader than that of second instars. The body length of third instars varied from 2.530 mm to 2.914 mm with an average of 2.760 ± 0.096 mm and the width of its head across the eyes ranged from 0.920 mm to 1.135 mm with an average of 1.028 ± 0.068 mm (Table 1, Fig. 1 & Fig. 2).

Third instars were yellow coloured; however, their ventral surface was pale. Later the lateral regions of the body became darker. Eyes were dark red. Two black spots appeared on the vertex. The pronotum begin to overlap the head. Antennae were pale. Two pair wing rudiments appeared on the thorax as blunt projections of the lateral posterior angles of mesonotum and metanotum, which were almost of equal length. Meso-scutellum was still not differentiated. Two black spots appeared on the metanotum. Abdominal segments were quite distinct. The lateral parts of the ninth abdominal segment turned black.

Table 1: Morphological features of different life stages of *Amritodus atkinsoni*

Life Stages	Length (in mm)			Width of Head (in mm)		
	Min.	Max.	Ave.	Min.	Max.	Ave.
I instar	0.767	1.380	1.060±0.148	0.383	0.721	0.477±0.077
II instar	1.334	2.116	1.492±0.221	0.521	0.675	0.572±0.055
III instar	2.530	2.914	2.760±0.096	0.920	1.135	1.028±0.068
IV instar	2.914	3.604	3.047±0.185	1.564	1.656	1.619±0.025
V instar	3.112	3.914	3.430±0.189	1.698	1.864	1.781±0.049
Adult Male	4.200	5.000	4.630±0.203	1.733	1.840	1.777±0.030
Adult Female	4.500	5.000	4.910±0.107	1.856	2.055	1.951±0.039

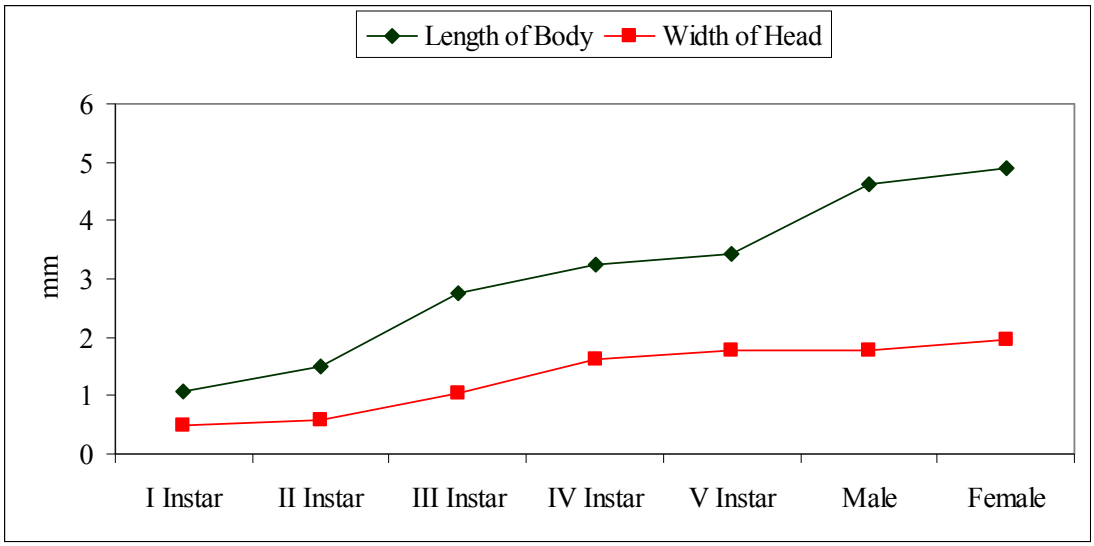

Fig.1: Measurement of Length and Width of different life stages of *Amritodus atkinsoni*

FOURTH INSTAR NYMPH:

The average length of the fourth instars were 3.047 ± 0.185 mm ranging from 2.914 mm to 3.604 mm and the average width of their head was 1.619 ± 0.025 mm ranging from 1.564 mm to 1.656 mm (Table 1, Fig. 1 & Fig. 2).

As this stage proceeds, the nymphs became elongated very much and show much activeness. The wing pads were quite distinct. The nymphs started leaping from place to place by the movement of their flexible abdomen. The body was dull yellow coloured. The compound eyes were dark red. There were prominent black spots on the vertex, metanotum and ninth abdominal segment.

Slightly dark patches were also seen on pronotum. The prothorax was distinct. The meso-scutellum was distinct from its adjacent parts and can be easily recognized by its dark lateral margins. The abdomen was very much elongated. At this stage, the male and female nymphs were distinguishable from each other.

Fig. 2: Different life stages of *Amritodus atkinsoni*

FIFTH INSTAR NYMPH:

The body length of the fifth instars varied from 3.112 mm to 3.914 mm with an average of 3.430 ± 0.189 mm and the width of its head across the eyes varied from 1.698 mm to 1.864 mm with an average of 1.781 ± 0.049 mm (Table 1, Fig. 1 & Fig. 2).

At this stage, the nymphs resemble the adults except their body size and the wings. Initially, these nymphs were pale yellow, but then they rapidly turned light grey and ultimately dark grey. The two spots on the vertex, areas of the metanotum and 9th abdominal segments were distinctly black. Distinct black patches were also present on pronotum, vertex and face. The meso-scutellum was quite prominent. The dorsum of the abdomen was dark, except the intersegmental areas. The ventral surface of the body was pale. The wing pads became very large.

ADULT:

The newly formed adults were cream coloured and after one hour, they became brown dorsally and pale yellow ventrally. Mango leafhoppers are wedge shaped having a broad, rounded head, extending little between the eyes. The length of female varied from 4.50 mm to 5.00 mm with an average of 4.91 ± 0.107 mm. In males, it varied from 4.20 mm to 5.00 mm, with an average of 4.63 ± 0.203 mm. In females the width of head across the compound eyes varied from 1.856 mm to 2.055 mm with an average of 1.951 ± 0.039 mm. In males, it varied from 1.733 mm to 1.840 mm with an average of 1.777 ± 0.030 mm (Table 1, Fig. 1 & Fig. 2). Thus, the females were slightly bigger than the male adults.

Head was wider than pronotum and yellowish. Vertex was infuscate except along posterior and lateral margins. One median, basal, elongate and small spot and two circular spots were present on vertex. These spots were also visible in facial view. Clypeus was yellow with a small, median and black longitudinal line and with minute, fuscous striae. Face was flat and shorter than the width including eyes and immaculate. Ocelli were paired and closer to adjacent compound eye than to the median line. Antennae were shorter and five segmented. Antennal filaments were hair like. In males, disc like swellings were present near the tip of antennae. Mouth parts were adapted for piercing and sucking. The mandibles and maxillae were modified and formed slender, bristle like stylets, which were found resting in groove like labium. Stylets were hollow, seta like structure, capable of limited protrusion and retraction. Labium was four segmented. Maxillary and labial palps were absent.

The thorax consists of three segments, the prothorax, mesothorax and metathorax. Mesothorax was the largest thoracic segment and subdivided in to prescutum, scutum, scutellum and postnotum. A triangular, black spot was present near each basal angle on scutellum. Along with these spots, a central, narrow, fuscous streak was present, which was dilated anteriorly and posteriorly and appeared as an arrow like marking on scutellum. Pronotum was yellowish, two black spots and a narrow median longitudinal line were present on pronotum. Hindwings were membranous and concealed under the forewings. Forewings or tegmina were slightly harder and of uniform texture. Tegmina were longer than abdomen and their colour was ochraceous, while, their costal margins were yellowish. In tegmina, four apical cells and one anteapical cell were present, veins were fuscous. In legs, tarsi were three segmented. Hindcoxae were elongated and highly mobile. Hind legs were saltatorial, in which tibiae were ridged lingtudinally and had longitudinal rows of spines on lateral margins.

Abdomen was eleven segmented. Its eighth and ninth segments were modified to form external genitalia; whereas, thenth and eleventh segments were small annuli, at the end of these annuli, anal orifice was present. The male genitalia was very distinctive. Its pygofer lobes were long and narrow, with rounded caudal margins. A long, thin process was present on inner surface of pygofer lobes. Styles were curved with prominent macrosetae on the outer margin. Aedeagus was S-shaped, without the appendages at the apex.

These findings are in conformity with Patel, *et al.* (1975) and Mishra and Chaudhary (1994). However, Hiremath and Thontadarya (1991) reported that the newly emerged adults were yellow and later turned dull black. The general morphology of these hoppers is also in conformity with Distant (1908) and Srinivasa *et al.* (2017a). Srinivasa *et al.* (2017b) also reported that aedagus is without basal pair of spine like process. Patel *et al.* (1975), Sohi and Sohi Sr. (1990) and Mishra and Chaudhary (1994) also reported five nymphal instars during the life history of these hoppers but Hiremath and Thontadarya (1991) and Babu *et al.* (2002) recorded only four nymphal instars during the life history. These contradictions in the results may be due to the different ecological conditions of the areas, studied by these researchers.

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