Diagnostic studies of mango leafhoppers (Hemiptera: Cicadellidae) from India.

Srinivasa N, Naresh Meshram M and PR Shashank

Abstract
Mango leafhoppers were causing main threat to yield of mangoes. Lack of sophisticated and well-illustrated photographs to identify them is creating the problems to identify a species. The study was conducted to survey and collection of mango leafhoppers from major mango growing areas in India during the period of 2013-15 to develop diagnostic keys to identify them. Twelve species of mango leafhoppers were found in survey and collection they belongs to family Cicadellidae with two subfamily Idiocerinae and Typhlocybinae were studied. The characters were studied are head, thorax and abdomen where colour, shape, spot and wing venation variations were studied along with emphasis was laid on male genitalia variation for the development of diagnostic keys with well-illustrated photographs were provided for easy identification.

Keywords: Cicadellidae, Idiocerinae, Typhlocybinae, Genitalia

1. Introduction
Mango Mangifera indica L. is the national fruit of India, infested by number of insect pests, among these leafhoppers are economically most important [1]. Adults and nymphs of mango hopper suck sap from inflorescence, young shoots and tender leaves of mango. The affected florets turn brown, become dehydrated and ultimately fruit set does not occur in heavily infested plant parts [2]. They excrete massive quantities of honeydew which imparts sugary shine to leaves and fruits and other plant parts and encourages growth of sooty mould fungi Capnodium mangiferum (Cooke & Broome) and Meliola mangiferæ Earle that reduces photosynthetic efficiency of leaves and market quality of fruits [3].

Leafhoppers belong to the family Cicadellidae of the order, Hemiptera. These are small wedge shaped insects of various form, colour and size and distinguished in having one or more rows of small spines extending the length of hind tibia. These are widely distributed and many are serious pests and vectors of diseases of many crops [4]. Recent world estimates range between 35,000–45,000 species over 22,600 species are now described [5]. The leafhopper species of the subfamily Idiocerinae feed and breed on trees and some are serious pests of mango, in the Indian subcontinent out of 10 genera and 43 species are recorded. Idiocerinae is a small subfamily of the Cicadellidae feed on mango leaves and are the most important leafhopper pests of mango [9].

There are twelve leafhopper species reported on mango. Das et al. [7] recorded Amrasca splendens Ghauri from Kerala causing severe damage to mango plantation. Viraktamath and Viraktamath [8] described three new species of mango hoppers namely, Bussonimonius manjunathi, Idioscopus anasuyaæ and I. jayashriae on mango in Karnataka. Nearly eighteen species of leafhoppers have been reported as pests of mango in the world [9]. Among these, five species belonging to the subfamily Idiocerinae; Idioscopus clypealis (Lethierry), I. nitidulus (Walker), I. nagpurenisis (Pruthi), Amritodus atkinsoni (Lethierry) and Amritodus brevistylus Viraktamath are the most important leafhopper pests of mango [9][10]. Others include, Amrasca splendens, Bussonimonius manjunathi, Idioscopus decoratus, I. dworakowskæ and I. spectabilis which have been reported to feed on mango [11]. The effective management of pest species damaging the mango, cannot be undertaken without accurate identification. Therefore the present study were undertaken to develop, descriptions and illustrated simple keys to these economically important leafhoppers for use by entomologists who are dealing with crop protection strategies.
2. Materials and methods
Mango leafhoppers were collected from mango orchards through sweep net and light trap from various parts of the country during the period of 2013-15, were processed by series of steps like sorting, cleaning, mounting, selection of specimens for study the following characters are below
II. Thorax: Pronotum, Scutellum, Proepisternum, Hind tarsi, Hind tibial spinulation, forewing appendix, venation.
2.1 Male genitalia dissection
Male genitalia dissections will be carried out as described by Oman [12] and Knight [13]. The abdomen will be removed by inserting a sharp pin between the abdomen and thorax and with gentle piercing. The abdomen will be treated in 10% KOH for 2-4 h to remove unsclerotized material by gently prodding the abdomen with the head of a pin. Afterwards, the abdomen will be rinsed thoroughly in water. The internal structures will be then removed by a hooked pin, before being stored in glycerol vials for study. The photographs of male, female (habit, lateral, face and thorax) and genitalia structures at different magnification were taken with Leica DFC 425C digital camera on the Leica 19205FA stereozoom automontage microscope. The photographs and illustrations were processed by using Adobe Photoshop CS3.

2. Results
3.1 Check list for leafhopper species associated with mango from India

<table>
<thead>
<tr>
<th>Species</th>
<th>Type- species</th>
<th>Karnataka</th>
<th>Major/Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Amrasca</em> Ghauri, 1967: 159.</td>
<td><em>Amrasca splendens</em> Hycrinal by original designation</td>
<td>Karnataka</td>
<td>Major/Minor</td>
</tr>
<tr>
<td><em>Amritodus</em> Anufriev 1970: 376.</td>
<td><em>Idiocerus atkinsoni</em> Lethierry, by original designation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. <em>splendens</em> Ghauri, 1967: 161</td>
<td><em>Idiocerus atkinsoni</em> (Lethierry), 1889:252</td>
<td>Karnataka, Maharashtra, Orissa, Punjab, Uttaranchal, Uttar Pradesh, West Bengal</td>
<td>Major/Minor</td>
</tr>
<tr>
<td>2. <em>atkinsoni</em> (Lethierry), 1889:252</td>
<td><em>I. quinquepunctatus</em> (Melichar) 1903: 146</td>
<td>Karnataka, Tamil Nadu</td>
<td>Major/Minor</td>
</tr>
<tr>
<td>4. <em>manjunathi</em> Viraktamath and Viraktamath 1985: 305</td>
<td><em>Idiocerus minor</em> Bierman, by original designation</td>
<td>Karnataka, Kerala</td>
<td>Major/Minor</td>
</tr>
<tr>
<td>5. <em>anasuyae</em> Viraktamath and Viraktamath 1985: 307</td>
<td><em>Idiocerus clypealis</em> Lethierry, by original designation</td>
<td>Karnataka</td>
<td>Major/Minor</td>
</tr>
<tr>
<td>6. <em>clypealis</em> (Lethierry) 1903: 48</td>
<td><em>I. nigroclypeatus</em> (Melichar) 1903: 48</td>
<td>Wide spread in India</td>
<td>Major/Minor</td>
</tr>
<tr>
<td>7. <em>decoratus</em> Viraktamath 1976:236</td>
<td><em>I. scutellatus</em> (Distant) 1908</td>
<td>Karnataka</td>
<td>Major/Minor</td>
</tr>
<tr>
<td>10. <em>nitidulus</em> (Walker) 1870: 252</td>
<td><em>I. niveosparsus</em> (Lethierry) 1889: 252</td>
<td>throught India</td>
<td>Major/Minor</td>
</tr>
</tbody>
</table>
### 3.2 Diagnostic keys for mango leafoppers

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hind tarsomere I acuminate. <em>Amrasca splendens</em></td>
</tr>
<tr>
<td>2.</td>
<td>Hind tarsomere I truncate.</td>
</tr>
<tr>
<td>3.</td>
<td>Male pygofer with triangular projections on ventral margins. <em>Busoniomimus manjunathi</em></td>
</tr>
<tr>
<td>4.</td>
<td>Male pygofer not as above.</td>
</tr>
<tr>
<td>5.</td>
<td>Aedeagus with elongated preatrium, shaft comparatively short.</td>
</tr>
<tr>
<td>6.</td>
<td>Aedeagus without preatrium, shaft elongate.</td>
</tr>
<tr>
<td>7.</td>
<td>Aedeagus with basal pair of spine like processes. <em>Amritodas brevistylus</em></td>
</tr>
</tbody>
</table>
- Aedeagus without basal pair of spine like processes. *Amritus atkinsonii*

5. Third apical cell of fore wing with black spot, clavus yellowish green, pygofer with ventral processes, aedeagal shaft sinuate. *Idioscopus decoratus*

- Third apical cell of fore wing without black spot. 6

6. Face and vertex uniformly ochraceous or lemon yellow, without black irregular spots. 7

- Face and vertex with round black spots. 8

7. Head, pronotum and scutellum, yellowish green, a large discal spot on pronotum and basal half of scutellum black. *Idioscopus spectabilis*

- Head pronotum immaculate, lemon yellow or shahgreen, scutellum with two dark brown basal triangular spots, anal collar processes broad, almost straight. *Idioscopus dworakowskii*
8. Face irregularly marked with brown or black patches without well-defined black spots, style with anterior portion longer than the posterior

\[ \text{Idioscopus nitidulus} \]

- Face with one or more small round black spots near upper margin

\[ \text{9} \]

9. Clypellus entirely or partially black

\[ \text{10} \]

- Clypellus without any black marking

\[ \text{11} \]

11. Aedeagus strongly sinuate, shaft broad at base narrowed and strongly curved apical hook and has pair lateral sinuate curved processes arising mid length

\[ \text{Idioscopus anassyae} \]

- Aedeagus shaft with caudal denticate slightly before gonopore

\[ \text{Idioscopus jayashriae} \]
4. Discussion
The present investigation will support the existing literature for easy identification of mango leafhopper complex of India. Leafhoppers associated with mango belong to two subfamily Typhlocybinae and Idiocerinae of Cicadellidae. Since Lewis [14] described the genus Idiocerus, about 13 species described under this genus from Indian subcontinent by Lethierry [15], Melichar [16] Distant [17], Baker [18] and Pruthi [19]. Now position of these species changed to genera other than Idiocerus namely, Amritodus Anufriev, Balocha Distant, Idiocerus Baker and Idioscopus Kirkaldy. Most commonly found genus is Idioscopus, most of the species of which breeds on the plants of the family Anacardiaceae and most of them posing serious threat to mango Mungifera indica L. [9]. Amritodus atinosoni (Lethierry) was described under, Idiocerus atkinsoni by Lethierry [15], later Malnado- capriles replaced to Idioscopus atkinsoni. Anufriev in 1970 changed it to Amritodus atkinsoni (Lethierry) stand as valid name. Species Idioscopus nagpurensis (Pruthi) was described by Pruthi [19]. Under the genus Idiocerus Malnado – capriles has, shifted to genus Idioscopus. Idioscopus nitidulus (Walker) was earlier described by Lethierry as I. niveosparsus in 1889, later on Baker [22] described as I. incertus. In 1980 as I. freytagyi by Ahmed et al., and as I. karachiensis by Ahmed et al. [20]. Idioscopus clypealis (Lethierry), is described in 1903 under the genus Idiocerus. Again in the same year melchar described Idiocerus nigrolyceopus Later on Distant described the same species as Idiocerus scutellatus. All these species were synonymised by Baker [19] as Idioscopus clypealis, now stand as valid name. Species like Idioscopus decoratus Viraktamath [22], Idioscopus dworakowskiae, Viraktamath [23], I. spectabilis Viraktamath [23], I. jayashriae Viraktamath and Viraktamath, [24] was reported to breed on mango. Busonimimus manjunathi was described by Vitaktamath and Viraktamath [24]. Typhlocybinae leafhopper Amrasca splendens was described by Ghauri [25] stand as valid name. Amrasca splendens species can be easily distinguished from other mango leafhopper species by the presence of acuminate first hind tarsomere along with bright coloured, brown deep red, face reddish anteriorly and rest yellow including genae and lora. Two round spots anteriorly with reddish margin, where has in other species hind tarsomere I truncate. Pygofer in male genitalia of Busonimimus manjunathi triangular with projections on ventral side distinguish from other species pygofer with aedeagus Y shaped basal strut, dorsal apodeme stout on the middle of Aedeagus. Amritodes brevistylus more are less similar to A. atkinsoni in morphology and coloration except Aedeagus with elongated preapream, shaft comparatively short and a pair of basal spine which absent in A. atkinsoni. Aedeagus without preapream with elongated shaft, third apical cell of the fore wing with black spot, clavus yellowish green, aedeagal shaft sinuate and and pygofer with ventral processes, pronum parrot green without black spot and two black basal triangle is the character of Idioscopus decoratus. Third apical cell of the forewing without black spot, face and vertex is uniformly ochraceous without irregular black spots is common in both I. spectabilis and I. dworakowskiae but differ in pronotum with large discal spot and basal half of the scutellum is black in I. spectabilis as compare to pronotum immaculate, scutellum with two triangular basal brown spots in I. dworakowskiae. Face irregularly marked with brown patches, pronotum with brown patches, style anterior portion longer than the posterior and the aedeagus with 2 pair of processes and one pair reaching 1/3rd of the Aedeagus is the characters of I. nitidulus. Face and vertex with two round spots in apex, face lemon yellow, pronotum yellowish green without black spots and scutellum with two basal black triangle spot and two small dots in between them are common in both I. clypealis and I. nagpurensis but differ in cypellus full black, Aedeagus with two process reaching full length and apex of style pointed in I. clypealis but cypellus half basal black. Aedeagus with two pair of processes not reaching the full length, apex of aedeagal shaft knob like and apex of style with small round lobe in I. nagpurensis, Cypellus without any black spot, face and vertex lemon yellow, pronotum with brown patches is common in I. anasuyae and I. jayashriae but differ in aedeagal shaft broad at base narrowed and strongly curved apical hook has a pair lateral curved processes in mid length in I. anasuyae where has in I. jayashriae Aedeagus shaft with caudal denticle slightly before gonopore differs.

5. Conclusion
With the above key characters and well-illustrated photographs one can easily identify mango leafhopper species complex found in India.

6. Acknowledgement
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7. Reference