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Taxonomic studies of subfamily Idiocerinae BAKER, 1915 (Hemiptera: Cicadellidae) two species *Amritodus atkinsoni* and *Idioscopus clypeus* with taxonomic key from district Faisalabad Punjab Pakistan based on morphological characters

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Abstract
Amritodus atkinsoni and *Idioscopus clypeus* are the two species belong to subfamily Idiocerinae BAKER, 1915 (Hemiptera: Cicadellidae). These are the most destructive pests of Mango fruit orchards in District Faisalabad. The research work for purpose of species identification was conducted In Taxonomic lab, Department of Entomology, University of Agriculture, Faisalabad during year 2018-2019. The Mango Leafhopper specimens were collected with the help of sweep netting from mango orchards. The specimens after collection were killed by placing them in poison bottle. Stereo light microscope digital camera fitted B41 Olympus was used with magnification power Omax 3.5X- 90X USB3 18 MP and variable magnification to identify key characters of leafhoppers from District Faisalabad. Taxonomic keys and checklist of subfamily Idiocerinae were provided for further description.

Keywords: *Amritodus*, *Clypeus*, Idiocerinae, morphology, leafhoppers, mango orchard, specimens, diagnostic characters

Introduction
Cicadellidae is the most important family of leafhoppers in the world. It consists of 22,000 described species and 36 described subspecies (Zahniser and Dietrich, 2008) [14]. Most of these subfamilies are not properly categorized (Oman *et al*., 1990; Dietrich *et al*., 2001; Dietrich & Rakitov, 2002) [3, 5, 11] Cicadellidae considered as 10th biggest groups of insects in the world and the samples from Amazon rainforest shows that leafhoppers consist of almost 100,000 species (Dietrich, 2006) [6]. Cicadellidae is the largest subfamily with 50 subfamilies (Muhlethaler, 2008) [10]. Subfamily Idiocerinae is most important family consist of destructive pests. As for the Pakistan fauna, documented 6 species from the district including three innovative species by (Ahmed *et al.* 1980) [1] *Amritodus saeedi*, *Idioscopus karachiensis* and *I. freytagi*, all reproducing on Mango from Karachi.
The Idiocerinae leafhoppers are conspicuous by the blend of characters; the body slim and wedge-formed; head more extensive than pronotum; ocelli on face, reference section substantial. The subfamily Idiocerinae species mostly feed and breed on trees and it is the serious pest of Mango fruit (*Mangifera indica*) in the region of Indian subcontinent from 43 species and 10 genera have been recorded (Viraktamath, 2007) [13]. These leafhoppers can be perceived by their wedge-moulded appearance with short and expansive head, ocelli on the face, facial sutures stretching out past the antennal pits nearly to the ocelli, forewing with wide index and male genitalia with the style prolong and the connective rather T-formed. Up to the here and now fifteen genera of Idiocerinae have been portrayed from the Indian subcontinent see key by (Viraktamath, 2007) [13]. In this paper, described two species of mango leafhoppers *Amritodus atkinsoni* and *Idioscopus clypeus* from District Faisalabad based on their morphological characters. Mango leafhopper *Amritodus atkinsoni* is the most destructive pest of Mango in Asia (Kumar, 2015) [9].

Materials and Methods

Study site. The research work for the purpose of species identification was conducted In Taxonomic lab, Department of Entomology, University of Agriculture, Faisalabad during year 2018-2019.

Collection of Specimens: The Leafhopper specimens were collected with the help of sweep netting from different locations on fruits. The specimens after collection were killed by placing them in poison bottle. Poison bottle was made by Potassium cyanide which is used for killing specimens. For the preservation of specimen's entomological pins were used and had placed them in wooden box. To protect specimens from other insects like ants were used naphthalene bolls. Stereo light microscope digital camera fitted B41 Olympus was used with magnification power Omax 3.5X- 90X USB3 18 MP and variable magnification to identify key characters of leafhoppers from District Faisalabad. A comprehensive survey and field visits were conducted throughout the District during the whole year 2019. During field surveys mostly, fruit orchards were visited. The specimens were identified with help of Taxonomic keys of different researchers. Faisalabad district is agriculture-based area and fruit orchards are present. So, collection was very easy. Mostly collection was done from University mango orchard.

Results and Discussion

Genus: *Amritodus atkinsoni* (Leth): 1889

Diagnostic characters. Vertex is anteriorly rounded, and colour is smoky. The shape of clypeus is flattened and highly modified with black stripes. The colour of Pronotal is brown anterior margin contains two spots and dark brown stripe and scutellum consist of dark brown streak. Two black spots are present on Prosternal disk.

Head: The adults of *Amritodus Atkinson* are mostly dark brown in colour. Head in dorsal perspective consists of vertex with eyes situated at sideways of it. Head is most extensive then pronotum and vertex might be characterized as the whole dorsal surface of the head bearing the eyes. A sulcus is a middle line or notch present on vertex. Leafhoppers mostly consist of two ocelli that are found either on the vertex might be near eyes. The face is characterized as the whole cephalic part of the head. It is separated by parallel frontal sutures into the basal focal region. Clypeus which is isolated by transverse suture into a little apical region clypeus. The semi-circular plates adjoining clypellus are known as Lora and the staying parallel regions are considered as Genae. The clypeus and clypellus furthermore referred as front. The antennae emerge anterior to the eyes close to the frontal sutures and comprise of a basal scape and pedicel with a long string-like flagellum that may show characteristics of division basally. Mouthparts are mostly hemipteran types and piercing-sucking.

Thorax: Thorax like every other insect comprises of three. Thorax like every other insect comprises of three portions pro meso and metathorax and contain two pairs of wings and three pairs of legs. The scutellum, scutal and pronotum suture of the 35 mesonota can viewed from dorsal side. The shape of scutellum is triangularly associated with transverse suture in the centre with and pointed normally with a straight extension posteriorly. Wings might be brachypterous not completely developed. Forewings are thicker then hind wings and are dark in nature consistently shaded. The longitudinal veins present in the wings are considered as median, radial, cubital and venal veins. Every leg comprises of typical parts yet hind pair is distinctive having femora and tibiae stretched which empower the leafhopper to jump.

Abdomen: The abdomen consists of eleven fragments. In male mango hoppers eight pregenital segments 9th, 10th and 11th segments from anal tube which might be decreased in size and variously sclerotized.

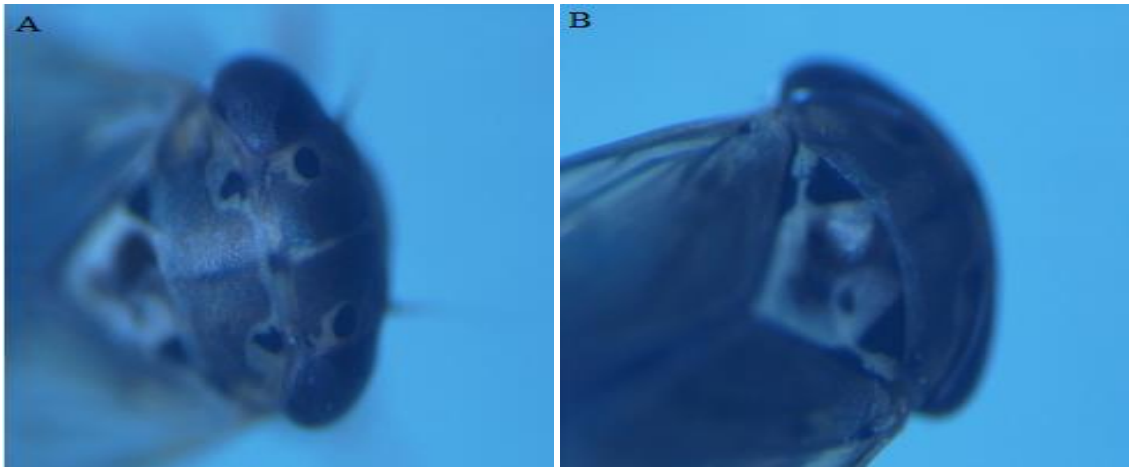
Measurements: Body length: 5.166 mm long: Length of vertex 0.278 mm, width across eyes 2.003 mm; length of pronotum 0.697 mm. width 1.735 mm; length of scutellum 0.933 mm, width 1.422 mm.

Distribution: India: Chhattisgarh: (Bastar); West Bengal; Delhi; Maharashtra. Sri Lanka. Pakistan: Punjab, Sindh.

Material Examined: UAF Mango orchards, 20, 26 – ii- 2019, Shah Kot, 15, 17- iii- 2019, Toba Tek Singh, 12, 14- iv, 2019.

Remarks: Most common species found on Mango orchards and serious pest.

Habitat: These species mostly found in mango fruit orchards.



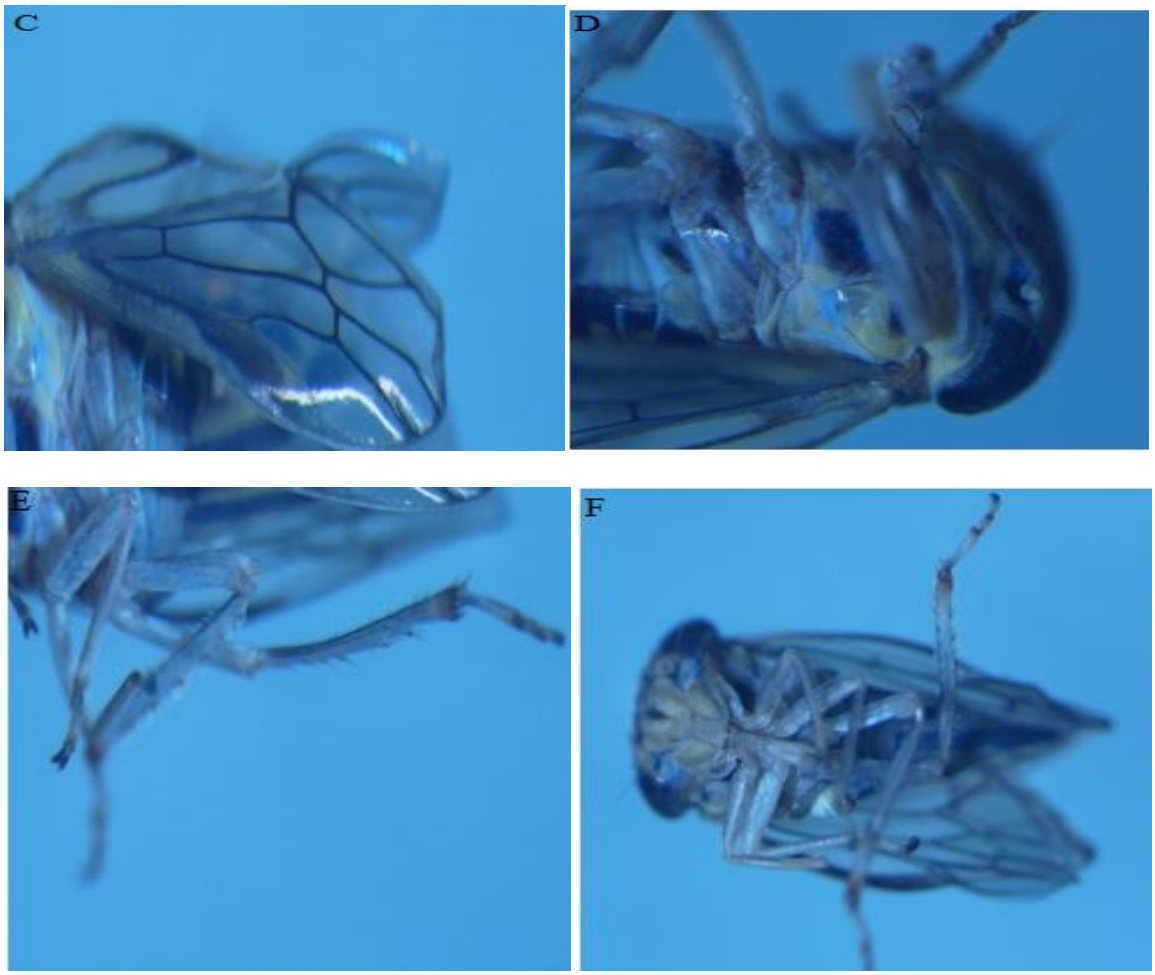


Fig 1: A Head view *Amritodus atkinsoni* (Leth) 1889. **B** Eyes view *Amritodus atkinsoni* (Leth) 1889. **C** Wing venation forewing *Amritodus atkinsoni* (Leth) 1889 Figure. **D** Mouthparts view *Amritodus atkinsoni* (Leth) 1889. **E** Legs view *Amritodus atkinsoni* (Leth) 1889. **F** Ventral view *Amritodus atkinsoni* (Leth) 1889.

Genus *Idioscopus clypealis* (Lethierry 1889:252: *Idioceris*)
Diagnostic Characters
Pale darker and with ivory and green coloured eyes. The colour of the face is dark focus disappearing to ivory along the side and dark towards ante clypeus. Female contain dual pointed dark spots among simple eyes dual dark coloured spots are present on apex and eyes are closed to head. These kinds of spots absent from males. Tegmen dull brown translucent with the ivory coastal edge.

Head: The head, pronotum and scutellum of *Idioscopus clypeus* is yellowish and two black spots on anterior margin of vertex but theses spots are absent in male. Two black spots on the base of ocelli.

Thorax: The colour of Scutellum present on thorax is yellowish with triangular black spots. Scutellum short. The forewings are pale ochraceous. Hind tibiae are strongly spined.

Abdomen: The genitalia contain an aedeagus with two pairs of long appendages. Pygofer short and hooked and pointed.

Distribution: It is mostly distributed from Pakistan, India, Philippines, Australia, Belgium, China, Japan, Sri Lanka and the Philippines.

Measurements: Length (F) 3.5- 4mm; (M) 3-3.5mm

Material Examined: Mango orchards, UAF, 3♂□ 27.vii.23, 2019, Asad; Mango orchards, 2 ♀□ Jaranwalla, 15. vii.17 2019, Asad.

Remarks: This species is a serious pest of Mango in all over the world. This species can be differentiated as lighter colour and two spots on scutellum and dark spot on vertex.

Habitat: These insects are mostly found in mango fruit orchards and cause serious losses.

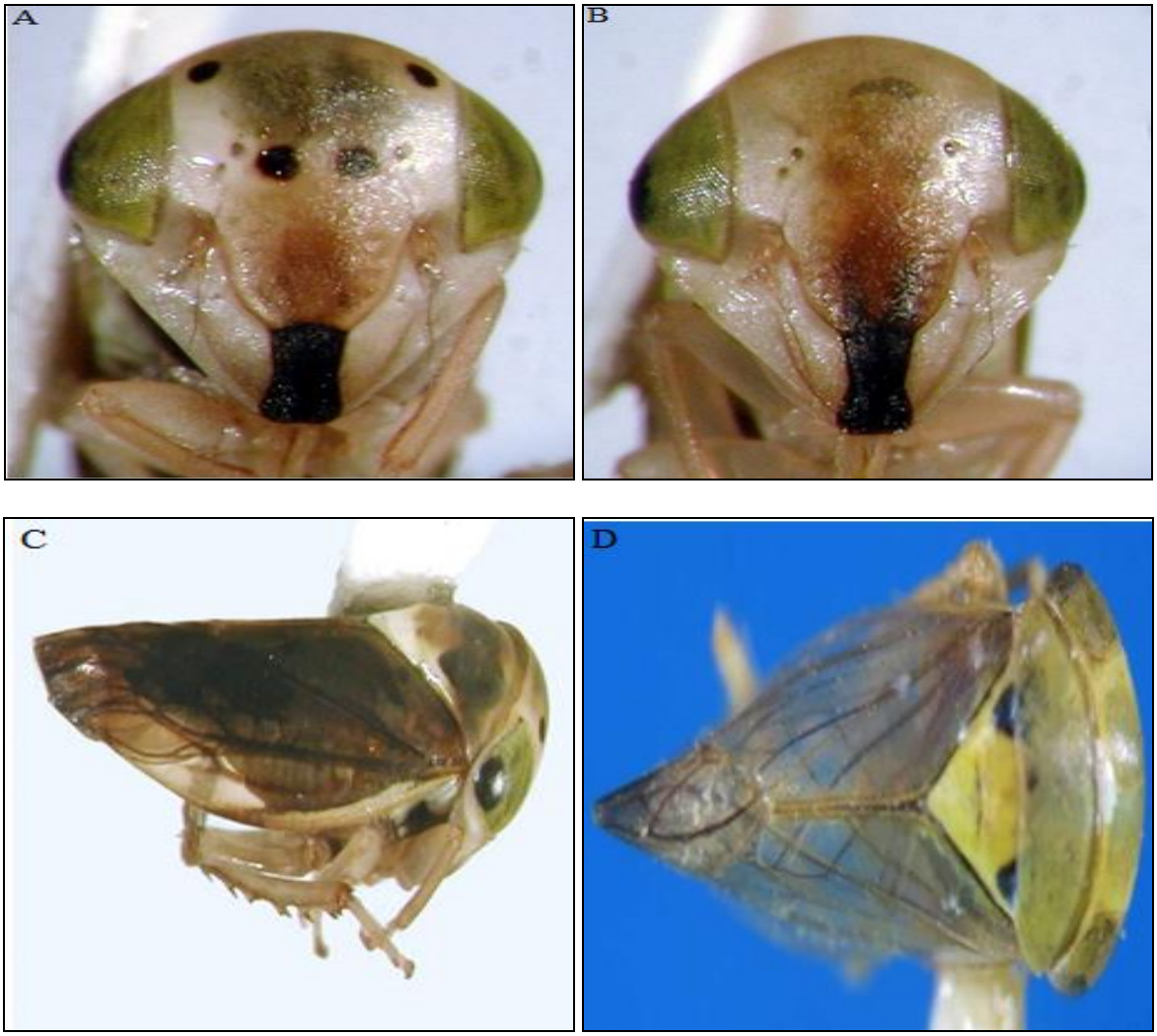


Fig 2: A Frontal view of female *Idioscopus clypeus* (Lethierry 1889) Figure. **B** Frontal view of male *Idiocerus Clypeus* (Lethierry 1889). **C** Side view *Idiocerus clypeus* (Lethierry 1889). **D** Complete body view *Idiocerus Clypeus* (Lethierry 1889).

Taxonomic keys to the species and genera of Idiocerinae from Pakistan

1. A plate-like structure is crosswise wrinkled form and teeth like processes are present on male pygofer lobe……*Tasnimoserous sindhesis* Sp. Nov
   Plate like structure (Pronotum) are crosswise wrinkled form and structure of male pygofer is pointed…..……2
2. The 3rd apical cell of the front wing is stretched, and lack of black spots and style of male is branched……*Balocha Palleda*
3. The 3rd apical cell of the front wing is not stretched, and style of male is not branched…….....3
4. The ingrowths present on the male reproductive organ are fully developed and long cylindrical processes are present nearby apex……..…… *Idioscopus*
   Male reproductive organ lack of advanced ingrowths and no cylindrical processes nearby apex and plate-like structure consist of black colour spots……*Amritodus*……..5
5. The plate-like structure (Pronotum) are completely clean and front wing base lack of white band……...*Idioscopus clypeus*
   Plate like structure (Pronotum) consist of brown colour areas and white bands present on base of front wing and shaft present on aedeagal are smooth-edged……*Idioscopus intidolus*
6. The style of the male is rounded very powerfully, and setae are very fat on lateral side and female posterior margin is curved…….…… *Amritodus atkinsoni*
   The style of male is not in rounded form lack of fat setae on lateral side and 7th sternite of female are square……..……*Amritodus saeede*

Check List for Subfamily Idiocerinae of Pakistan

Amritodus Saeede, Ahmad and Naheed: 1980: 222
Idioscopus clypeuas Leth, 1889: 252: Idiocerus
Amritodus atkinsonii, Leth, 1889:252: Idiocerus
Idioscopus Karachinesis, Ahmad and Naheed
Balcha Palida Maldonado, 1961:304-305
Idioscopus nititodus, Walker, 1870:322: Iassus
Idioscopus fretagii, Naheed and Ahmad
Tasnimocerus sindehensis sp.nov

Leafhoppers belong to family Cicadellidae which are second largest vector of transmitting plant diseases. Leafhoppers are the important pests of agriculturally important crops and their ability to transfer plant pathogens like phytoplasmas (Bedford *et al.* 1998) [2]. Leafhoppers are also found on different grasses like lawns etc. So, to control leafhoppers identification of their species are very important because without identification of their species you cannot apply any control measures. The study was conducted in District Faisalabad Punjab Pakistan in 2018-2019. Mango leafhoppers

belong to subfamily Idiocerinae collected from mango orchards of District Faisalabad and two species found *Amritodus atkinsoni* and *Idiocerus clypeus*. Specimens were identified at the species level by using keys of Khatri (2010) [8] Dietrich (2005) [4] and British Museum of Natural History. Taxonomic work performed with the help of Camera fitted compound and stereo Microscope. Specimens were killed by using Potassium cyanide killing jar and preserved in wooden boxes. Leafhoppers are very minute insects, so species are glued on cardboard. To protect specimens from other insects used phenolphthalein bolls were used.

Srinivasa *et al.* (2017) [12] recently worked on diagnostic characters of mango leafhoppers from different regions of India and identified 12 species belongs to subfamily Idiocerinae and Typhlocybinae. They studied different characters like head thorax and abdomen colour shape and size. And studied male genitalia variation. I have worked on Mango leafhoppers and identified two species using similar characters studied in this paper.

Khatri and Webb (2014) [7] reviewed subfamily Idiocerinae and described newly identified species *Tasnimoserous sindhesis* from important region Pakistan Tando jam Sindh. They also described junior synonyms of *Idioscopus nitidulus* and *I. freytagi*. Genus *Idioscopus nagpurensis* is recorded the first time in Pakistan. Taxonomic key and checklist of Idiocerinae from Pakistan are also given related to genera and species. The leafhoppers belonging with subfamily Idiocerinae feed on trees and cause huge losses in Mango in Indian subcontinent. Now in present time 15 genera of Idiocerinae have been explained in Indian subcontinent.

4. Conclusion

Leafhoppers belong to subfamily Idiocerinae collected from different locations of District Faisalabad Toba Tek Singh, Shah Kot, and Jaranwalla during the year of 2018-2019. Specimens collected from fruit orchards, Agronomic fields and grasses. The collected specimens were identified at genera, species and subfamilies level. Two genera and two species of mango leafhoppers were identified *Amritodus atkinsoni* and *Idiocerus clypeus* from subfamily Idiocerinae. Mango leafhoppers are the major pests of mango orchards and belong to subfamily Idiocerinae and they cause serious losses. So, identification is very important to control these pests. The results of this study show that *Amritodus atkinsoni* is totally different species then *Idioscopus clypeus.* Because the colour *Amritodus atkinsoni* is smoky and vertex are interiorly rounded. The colour of pronotal is brown anterior margin contains two spots and dark brown stripe and scutellum consist of dark brown streak. Two black spots are present on prosternal disk. Idioscopus clypeus is pale darker with ivory and green coloured eyes. Female contain dual pointed dark spots among simple eyes and these spots are absent in male. The conclusion is that identification of specimens is very important to control these species.

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