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Leafhopper Fauna Associated With Maize and Sorghum Crop-Ecosystems in Rayalaseema Region of Andhra Pradesh

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ABSTRACT

Leafhopper fauna associated with maize and sorghum crop ecosystems of Rayalaseema region were collected, identified and described. The leafhopper fauna viz., Aconurella prolixa (Lethierry), Amrasca biguttula biguttula (Ishida), Balclutha incisa (Matsumura), Balclutha saltuella (Kirschbaum), Balclutha thea (Kirschbaum), Batracomorphus angustatus (Osborn), *Cicadulina bipunctata (Melichar), Doratulina vertica (Pruthi), Empoascanara defecta (Dworakowska), Empoascanara indica (Datta), Empoascanara prima (Distant), Exitianus indicus (Distant), Hishimonus phycitis (Distant), Doratulina speciosum (Distant) and Nephotettix virescens (Distant) were identified from maize and sorghum crop ecosystems of Rayalaseema. An illustrated key along with key taxonomic characters was provided for easy identification of the leafhoppers.*

Key words: *Hemiptera, Leafhoppers, Cicadellidae, Maize and Sorghum crop eco-systems.*

INTRODUCTION

Leafhoppers, an economically important group of Auchenorrhynchan Hemiptera belong to the family Cicadellidae comprising about 2,445 described genera and 22,637 species in world wide and 340 genera and 1,350 species in India[10]. Leafhoppers are small wedge shaped insects of various forms, colours, sizes, and can be readily distinguished from other Auchennorrhyncha by having one or more rows of small spines extending the length of hind tibiae. Many of the members of Cicadellidae are very serious crop pests resulting in damage to leaves and stems thus producing general symptoms like curling of leaves, bronzing drying, sooty mould followed by withering and death of plants. A few groups of leafhoppers genera acts as vectors and transmit phytopathogenic organisms that causes diseases and eventual death of plants. Some of the diseases caused by phytopathogenic organisms vectored by leafhoppers include little leaf of brinjal, sesamum phyllody, purple top role of potato, yellow dwarf of rice, rice tungro[6], rice transitory yellowing, sandle spike, eastern wheat streak virus and maize streak virus, orange leaf of rice, *etc.*,[11].

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The effective management of pest species damaging any crop cannot be under taken without accurate identification. The literature dealing with the identification of leafhoppers is scattered in many journals and manuscripts published over many years and languages, most of these works are difficult to obtain. In Rayalaseema maize crop occupies an area of 0.59 lakh hectares with a production of 2.66 million tonnes and productivity of 4354 kg ha^{-}

MATERIAL AND METHODS

Leafhoppers specimens were collected from different Agro-climatic zones of Rayalaseema by sweep netting in Maize and sorghum crop eco-systems. About 10-15 to and fro net sweepings were taken each time and Leafhoppers collected were aspirated from the net into a glass tube and killed with a cotton swab wetted with a few drops of ethyl acetate. The killed specimens were transferred to homeopathic vials, labelled, brought to the laboratory and dried in a hot air oven at 45-50^{0}C, for about 5 to 6 hours. For mounting and preparing slides of genitalia the procedure suggested by Knight[5] was followed. For describing the different body parts the terminology suggested by Blocker and Triplehorn[4] was followed.

RESULTS AND DISCUSSION

In present study fifteen leafhopper species were collected, identified and described from sorghum and maize crop ecosystems of Rayalaseema region. The leafhopper species *viz.*, *Aconurella prolixa* (Lethierry), *Amrasca biguttula biguttula* (Ishida), *Balclutha incisa* (Matsumura), *Balclutha saltuella* (Kirschbaum), *Balclutha thea* (Kirschbaum), *Batracomorphus angustatus* (Osborn), *Cicadulina bipunctata* (Melichar), *Doratulina vertica* (Pruthi), *Empoascanara defecta* (Dworakowska), *Empoascanara indica* (Datta), *Empoascanara prima* (Distant), *Exitianus indicus* (Distant), *Hishimonus phycitis* (Distant), *Doratulina speciosum* (Distant) and *Nephotettix virescens* (Distant) were collected, identified and described.

S. No.	Leafhopper species	Associated crop ecosystems	
1.	*Aconurella prolixa* (Lethierry)	Maize	-
2.	*Amrasca biguttula biguttula* (Ishida)	Maize	Sorghum
3.	*Balclutha incisa* (Matsumura)	Maize	Sorghum
4.	*Balclutha saltuella* (Kirschbaum)	Maize	Sorghum
5.	*Balclutha thea* (Kirschbaum)	Maize	Sorghum
6.	*Batracomorphus angustatus* (Osborn)	Maize	-
7.	*Cicadulina bipunctata* (Melichar)	Maize	Sorghum
8.	*Doratulina vertica* (Pruthi)	Maize	-
9.	*Empoascanara defecta* (Dworakowska)	Maize	-
10.	*Empoascanara indica* (Datta)	Maize	Sorghum
11.	*Empoascanara prima* (Distant)	Maize	
12.	*Exitianus indicus* (Distant)	Maize	Sorghum
13.	*Hishimonus phycitis* (Distant)	Maize	-
14.	*Doratulina speciosum* (Distant)	-	Sorghum
15.	*Nephotettix virescens* (Distant)	-	Sorghum

An illustrated key has been prepared to aid rapid and accurate identification of the common species of leafhoppers found associated with maize, sorghum and sugarcane crop eco-systems of Rayalaseema. For those species which were not studied here, literature or a Taxonomist working on the leafhoppers may be consulted.

1. Small to medium sized insects; forewings without anteapical cells and appendix.....2

- Medium to small sized insects forewings with anteapical cells and appendix.....4

2. Vertex with a large central black spot which is irregularly margined. Pygofer lobe with curved dorsal processes. Subgenital plates wider at middle, narrow towards apex (Figs.1a-b)

……..…….....***Empoascanara indica*** **(Datta)**

- Vertex without black spot. Aedeagus without any processes. Aedeagus articulated to connective by a membranous joint. Aedeagal shaft may be symmetrical, but definitely curved dorsad.....3

3. Aedeagal shaft without any processes, articulated in side view. Aedeagal appendages longer convergent apically with distinct transverse ledges in terminal half (Figs.2a-c)

.....***Empoascanara defecta*** **(Dworakowska)**

- Dorsal pygofer process almost triangular in profile. Aedeagus with a single dorsally curved shaft; gonopore subapical. Aedeagus bent in the form of 'C' Connective short, arms of the connective widely seperated at their base. Subgenital plates sclerotized at their margins (Figs. 3a-c)

…….……....***Empoascanara prima*** **(Distant)**

4. The head and pronotum are in lemon yellow in colour and forewings with indistinct semicircular median spot with pale reddish brown mottling. Aedeagus definitely with two shafts, short and broad apex with lateral and mesal margins curved; processes from lateral margin rounded in posterior view, with curved processes from lateral margin margins and turned ventrally (Figs. 4a-c)

…….***Hishimonus phycitis*** **(Distant)**

- The head and pronotum are not in lemon yellow in colour and forewings without semicircular median spot with pale reddish brown mottling……..…5

5. Robust wedge shaped, green coloured insects. Apophysis of style very much elongated. Aedeagus with a single shaft but terminal portion of aedeagus is forked or clefted (Figs. 5a-b)

..…….***Batracomorphus angustatus*** **(Osborn)**

- Aedeagus single shafted, not clefted apically. Apophysis of style not enlarged……...6

6. Vertex with two distinct black spots, with regular margin or with a conspicuous black/brown band.....7

- Vertex without spots / conspicuous black band.....9

7. Body 4-5 mm in length with brownish colouration, vertex with a thick black band between the compound eyes. Fore wings with four apical and three anteapical cells. Pygofer with two conspicuous spines; upper spine is longer than the lower spine, aedeagus simple and curved, apex notched (Figs. 6a-c)

……..……***Exitianus indicus*** **(Distant)**

- Vertex with a pair of spots which are either black or yellow with regular margin…....8

8. Yellowish green coloured insects. Vertex with two distinct black spots; apical portion of hemelytra with two black spots. Abdominal apodemes bulb like in shape. Subgenital plates very much elongated and narrow at apex. Aedeagus short, aedeagal shaft tube like, broader in middle and gradually narrowed to apex (Figs.7a-c)

.....***Amrasca biguttula biguttula*** **(Ishida)**

- Yellowish orange coloured insects; dorsal side of the abdomen black in colour. Vertex with a pair of round black spots. Pygofer with a curved, bifid process. A robust subapical spine is seen on pygofer; aedeagus short and 'C' shaped (Figs. 8a-b)

….....***Cicadulina bipunctata*** **(Melichar)**

9. Medium to large sized insects; ochraceous in colour; width of the vertex more than half the width of the pronotum.....10

- Small to medium sized insects; width of the vertex less than half the width of the pronotum.....13

10. Green to greenish yellow coloured insects with black spots on vertex / black patch on fore wing.....11
- Ochraceous coloured insects, without black spots on vertex / black patch on fore wing ……..…….....12
11. Yellowish to yellowish green coloured insects with black to brown tinges on vertex and dorsal side of abdomen. Aedeagus loosely connected with a membranous joint to connective; curved in lateral direction with apical gonopore (Figs.10a-d)…….....***Aconurella prolixa* (Lethierry)**
- Medium to large sized insects with green coloured fore wings. Fore wings with a black patch, which does not reach the claval region Aedeagus with a pair of lateral apophysis, dorsal surface elongated, sclerotised with four pairs of spines laterally (Figs. 11a-b)
.....***Nephotettix virescens* (Distant)**
12. Vertex posteriorly sulcate; forewings does not have a black spot. Connective arms 'U' shaped with a bifid stem. Aedeagus very long, wider at base the abruptly narrowed and with a pointed apex; apex extends up to the arms of the connective (Figs. 12a-c)
.....***Doratulina speciosum* (Distant)**
- Aedeagus wider at base, deeply bent dorsocephalad, with apex of the shaft curved and gonopore apical (Figs. 9a-c)
.....…….....***Doratulina vertica* (Pruthi)**
13. Yellowish to greenish yellow coloured insects. Vertex much shorter than pronotum. Aedeagus with three pairs of basal process (Figs. 13a-c)
...…….....***Balclutha incisa* (Matsumura)**
- White / green coloured insects. Aedeagus without process or projections, simple and filamentous.....14
14. Cream to pale yellowish brown coloured insects. Aedeagus elongate simple and narrow, gonopore apical (Figs. 14a-b).....***Balclutha saltuella* (Kirschbaum)**
- Green coloured insects. Aedeagus simple, filamentous, curved distad and aedeagal shaft evenly curved (Figs. 15a-c)…….....***Balclutha thea* (Kirschbaum)**

***Empoascanara indica* (Datta):** Vertex, pronotum and scutellum yellow. Vertex with a large central black spot. Abdomen black and fore wings pale grey, transparent without any markings. Pygofer lobe more or less triangular in shape, broader at base and narrowed towards apex, with its dorsomesal processess curved, rounded at base and gradually narrowed towards apex; microsetae scattered all over the apical half. Styles long, outer margin bilobed in middle, inner margin straight, apical extension broadened at apex, cephalic end of styles shorter than caudal part which is gradually narrowed. Connective more or less 'Y' shaped, arms longer than stem, joined by a membrane at base. Aedeagus with its shaft simple, tubular, without any processes, broader at base, abruptly narrowed towards apex and gonopore subapical.

***Empoascanara defecta* (Dworakowska):** Stramineous in colour. Fore wings hyaline with four apical cells, the second being quadrangular in shape. Pygofer lobe broad and long in the lateral view Styles elongated, broad at apex and narrowed towards the base. Connective very short Aedeagus very short, curved, appendages arising from aedeagus are longer and convergent apically with distinct transverse ledges in the apical portion.

***Empoascanara prima* (Distant):** Light yellow to yellowish orange in colour. Pronotum with conspicuous pit like structures Pygofer lobe rounded or angulated with a well defined sclerotised lobe like structure. Subgenital plates slightly sclerotised apically, lateral margins produced into a strong notch with micro setae. Connective loosely attached to aedeagus, inverted 'Y' shaped in structure with arms widely seperated. Aedeagus 'C'

shaped with a strong curvature towards the lateral side.

***Hishimonus phycitis* (Distant):** The head and pronotum are in lemon yellow in colour and forewings with indistinct semicircular median spot with pale reddish brown mottling. Subgenital plates tapering posteriorly to a membranous finger like extension with uniseriate row of stout setae laterally and becoming multiseriate basally. Aedeagus with two shafts, short and broad apex with lateral, mesal margins curved anteriorly, apex acutely rounded in posterior view, with curved processes from lateral margins and turned ventrally.

***Batracomorphus angustatus* (Osborn):** Greenish yellow in colour with small dots all over. Appendix well developed. The tip of aedeagus is clefted with two finger like projections which are widely seperated. Style linear apophysis not distinct, style ending with a small spine like structure Subgenital plates elongated linearly, abruptly narrowed towards apex ending with a sharp pointed tip.

***Exitianus indicus* (Distant):** Yellowish brown body with a black band between compound eyes. Forewings elongate subhyaline with four apical and three anteapical cells and appendix wider. Pygofer with two conspicuous dark brown or black spines along the apical margin, upper spine is longer than lower spine and is wider and short. Styles with a sharp apophysis and distinct preapical lobe Aedeagus simple, curved having an articulation between shaft and base, apex notched. Gonopore large and subapical

***Amrasca biguttula biguttula* (Ishida):** Yellowish green in colour. Vertex with two distinct black spots Tegmina light yellowish green with two prominent black spots on the apical portion Apodemes bulb like in appearance Pygofer lobe broader at base, narrower and very much elongated distally with a pair of elongated processes. Anal tube long with a pair of slender curved hooks Subgenital plates very much elongated and narrow towards apex with numerous macro, micro and hair like setae all over the surface. Aedeagus short, shaft tube like, broader in the middle, gradually narrowed towards apex and slightly curved without any processes.

***Cicadulina bipunctata* (Melichar):** Vertex with a pair of round black spots on the anterior margin. Vertex, pronotum and scutellum are yellowish orange in colour and the dorsum of abdomen is black in colour. Pygofer with an elongate dorsal process which is bifid, with curved, short and robust ventral subapical spine Connective 'Y' shaped, arms close together, approximately equal in length to the stem. Aedeagal shaft cylindrical, 'C' shaped and curved dorsally with a pair of processes basally.

***Doratulina vertica* (Pruthi):** Straw coloured species with reddish lateral patches on the frons and surrounding the eyes on vertex. Subgenital plates triangular, with a narrow apex, with marginal macrosetae Connective arms 'U' shaped and stem strongly bifid at apex. Aedeagus wider at base, deeply bent dorsocephalad with apex of the shaft curved.

***Aconurella prolixa* (Lethierry):** Yellowish to yellowish green species with black to brown tinges on vertex and dorsal side of abdomen. Pygofer lobe with a serrated, heavily sclerotised comb like structure on posteroventral margin Styles with sharp claw like apophysis Subgenital plates basally wider, gradually elongated with subacute tips, provided with micro setae and micro setae towards anterior margin. Connective 'Y' shaped with arms closely approximated together. Aedeagus loosely connected to connective with a membranous joint, curved in lateral direction.

***Nephotettix virescens* (Distant):** Yellowish green in colour. Fore wings with a black patch which does not reach the claval region, apical third black in males. Subgenital plates broader at base and gradually narrowed to an acute apex with submarginal macrosetae Styles robust, highly sclerotised with longer apophyses, apex blunt. Aedeagus with a pair of lateral paraphyses, dorsal surface elongate sclerotized with five pairs of spines laterally and directed towards apex.

***Doratulina speciosum* (Distant):** Brownish yellow. Connective arms 'U' shaped and stem

bifid at apex. Style with narrow, slender apophysis with bluntly pointed apex. Aedeagus very long, wider at base, then abruptly narrowed, deeply bent dorsocephalad and the shaft with distinct sinuation, in the middle and with a pointed apex which extends upto connective arms.

***Balclutha incisa* (Matsumura):** Yellowish to greenish yellow in colour. Styles with apophysis well developed, usually strongly arched. Connective 'Y' shaped; stem longer than arms and articulating with aedeagus. Aedeagus broad basally with 3 pairs of processes, shaft slender directed posteriorly and curved anteriorly.

***Balclutha saltuella* (Kirschbaum):** Cream to pale yellowish brown. Head wider than pronotum Subgenital plates very short with fingers like apex Connective with arms as long as stem Aedeagus elongate simple, shaft narrow.

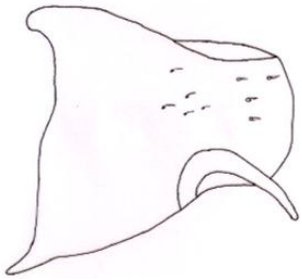
***Balclutha thea* (Kirschbaum):** Green in colour, sometimes with darker green spots on vertex posteriorly and pronotum anteriorly. Subgenital plates with pronounced tooth laterally at midlength Connective 'Y' shaped, stem very much longer than arms. Apophyses of style well developed with sharp ending and strongly arched. Aedeagus simple, filamentous, curved distad and aedeagal shaft evenly curved.

This is the first study of leafhopper fauna associated with maize and sorghum crop ecosystems in Rayalaseema region of Andhra Pradesh. Bindra[3] studied the host range, description and biology of 61 leafhoppers and stressed the need for identification of leafhopper species occurring in different crop ecosystems for the benefit of farmers, economic entomologists and extension workers. Virakatamath[9] emphasized the need of keys for leafhopper fauna of Karnataka and provided a key for identification economically important leafhoppers. Ahmed[1] reported 33 Typhlocybinae leafhoppers, their host association, and associated yield loss in graminaceous crop ecosystems in Pakistan. Wilson and Claridge[11] published a comprehensive account of leafhoppers in major rice growing areas of the world and keys for identification of leafhoppers along with colour photographs. Rao *et al.*,[7] reported 26 leafhoppers belonging to 12 genera associated with rice and sugarcane crop ecosystems along with keys for distinguishing these leafhoppers from Telangana (erstwhile Andhra Pradesh). Shashank[8] reported 20 leafhopper species associated with rice crop ecosystems of coastal and central Karnataka.

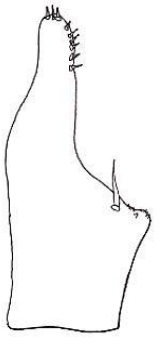
Table 1: Morphometric details of leafhopper fauna identified from maize and sorghum crop ecosystems of Rayalaseema region (in – millimetres) (average of 10 specimens)

S. No.	Leafhopper species	Total body length	Width of the body	Length of the head	Inter-occular distance	Length of the pronotum	Length of the scutellum	Length of the wing	Width of the wing	Length of the male genitalia	Width of the male genitalia	Length of the aedeagus
1.	*E. indicus*	3.45	1.24	0.28	0.53	0.38	0.33	2.42	0.65	0.30	0.24	0.18
2.	*N. viriscens*	3.23	1.02	0.25	0.40	0.39	0.38	2.54	0.74	0.56	0.38	0.29
3.	*A. prolixa*	1.87	0.60	0.20	0.22	0.25	0.16	1.45	0.42	0.30	0.27	0.20
4.	*A. biguttula biguttula*	2.28	0.63	0.20	0.23	0.21	0.27	1.80	0.45	0.62	0.17	0.14
5.	*E. defecta*	1.86	0.50	0.13	0.24	0.22	0.21	1.48	0.31	0.15	0.12	0.11
6.	*E. indica*	1.71	0.45	0.12	0.31	0.37	0.14	1.99	0.33	0.27	0.20	0.15
7.	*E. Prima*	1.59	0.49	0.12	0.27	0.15	0.20	1.21	0.32	0.19	0.11	0.11
8.	*B. angustatus*	3.57	1.38	0.13	0.75	0.54	0.61	2.82	0.91	0.50	0.26	0.13
9.	*B. incisa*	1.77	0.50	0.07	0.26	0.24	0.11	1.04	0.28	0.23	0.20	0.16
10.	*B. saltuella*	1.97	0.47	0.07	0.26	0.25	0.11	1.68	0.32	0.16	0.12	0.09
11.	*B. thea*	2.37	0.47	0.12	0.31	0.37	0.14	1.99	0.33	0.27	0.20	0.15
12.	*C. bipunctata*	2.08	0.59	0.16	0.26	0.24	0.18	1.62	0.34	0.27	0.23	0.13
13.	*H. Phycitis*	3.00	1.13	0.27	0.53	0.49	0.37	2.16	0.72	0.47	0.42	0.12
14.	*D. speciosum*	2.37	0.75	0.34	0.25	0.28	0.23	1.74	0.59	0.27	0.22	0.39
15.	*D. vertica*	2.70	0.78	0.25	0.26	0.30	0.19	2.02	0.46	0.34	0.24	0.42

1a



1b



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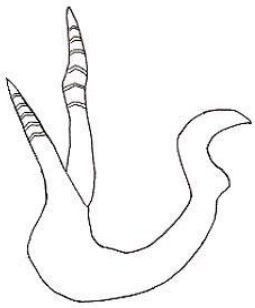
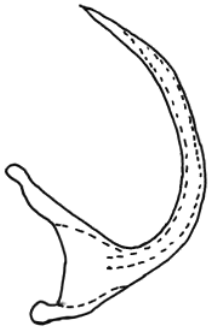


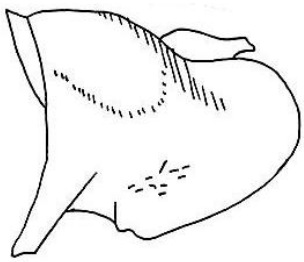
2b

2c



3a

3b



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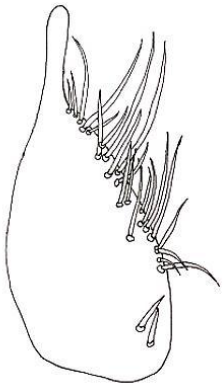

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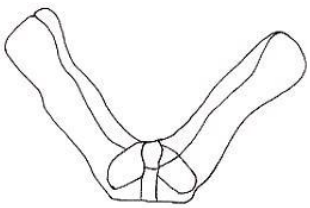
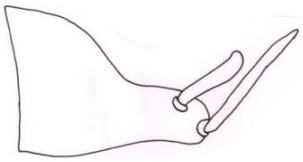


4b

Figs. 1a-b *Empoascanara indica* (Datta): 1a. Aedeagus, lateral view; 2b Pygofer Figs. 2a-c *Empoascanara defecta* (Dworakowska): 2a. Subgenital plate; 2b Aedeagus, lateral view; 2c Style Figs. 3a-c *Empoascanara prima (Osborn)*: 3a. Aedeagus; 3b.Connective; 3c Pygofer Figs. 4a-c *Hishimonus phycitis* (Distant): 4a. Subgenital plate; 4b Aedeagus

5a

5b



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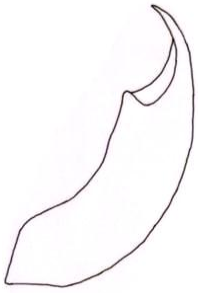

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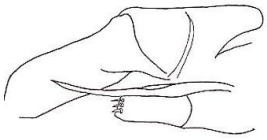
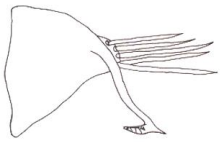
6c



7a

7b

7c



8a

8b

9a

9b

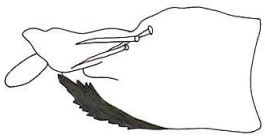
9c

Figs. 5a-b *Batracomorphus angustatus* (Osborn): 5a. Aedeagus, lateral view; 5b Subgenital plate Figs. 6a-c *Exitianus indicus* (Distant): 6a. Pygofer lobe, lateral view; 6b Aedeagus, lateral view; 6c Style Figs. 7a-c *Amrasca biguttula biguttula* (Ishida): 7a. Pygofer with anal tube; 7b Aedeagus, dorsal view; 7c Connective *8a-b Cicadulina bipunctata* (Melichar): *8*a. Pygofer, lateral view; 8b Aedeagus, lateral view Figs 9a-c *Doratulina vertica* (Pruthi): 9a. Aedeagus, dorsal view; 9b Style; 9c Subgenital plate

10a

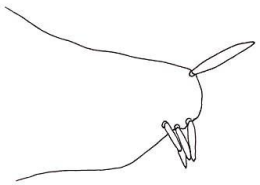
10b

10c



10d

11a



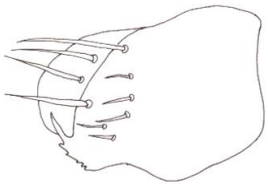
11b

12a

12b

12c

Figs.10a-d. *Aconurella prolixa* (Lethierry): 10a. Aedeagus, lateral view; 10b Connective; 10c Style; 10d. Pygofer. Figs. 11a-b *Nephotettix virescens* (Distant): 11a. Aedeagus, lateral view (with four spines); 11b Pygofer lobe, lateral view (with five spines) Figs. 12a-c *Doratulina speciosum* (Distant): 12a. Aedeagus, lateral view; 12b Style: 12c. Subgenital plate



13a

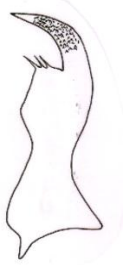
13b

13c

14a

14b

15a



15b

15c

Figs. 13a-c *Balclutha incisa* (Matsumura): 13a. Pygofer, lateral view; 13b Aedeagus, lateral view; 13c Style Figs. 14a-b *Balclutha saltuella* (Kirschbaum): 14a. Style; 14b Aedeagus, lateral view Figs. 15a-c *Balclutha thea* (Kirschbaum): 15a. Aedeagus in lateral view; 15b Style; 15c Subgenital plate

REFERENCES

1. Ahmed, M., Host associations and losses to growth and yield to some vegetable plants caused by Typhlocybine leafhoppers (Cicadellidae) in Pakistan. *Proceedings of 2nd International Workshop on leafhoppers and plant hoppers of economic importance*, 28th July-1st August 1986, Eds Wilson, M. R. and Nault, L. R., CIE, provo, Utah, USA. 243-250 (1987).
2. Andhra Pradesh agricultural officers association, *Department of Agriculture Plant doctors dairy*. 4-7 (2018).
3. Bindra, O. S., Cicadellid vectors of plant pathogens. *Final report of the PL-480 Project No.A7-ENT-22 Grant No.FG-IM-300 completed on October 13, 1971. Department of Entomology, Punjab Agricultural University*, Ludhiana, India. 1-56 (1973).
4. Blocker, H. D. and Triplehorn, B. W., *External morphology of leafhoppers. In, the leafhoppers and planthoppers (eds Nault, L.R and Rodriguez, J.G). John Wiley and Sons*, New York. 4-60 (1985).
5. Knight, W. J., Techniques for use in the identification of leafhoppers (Homoptera: Cicadellidae). *Entomologist's Gazette.* **16(4):** 129-136 (1965).
6. Muniyappa, V. and Veeresh, G. K., Arthropod vectors of virus and mycoplasma diseases of plants in India. *Colemania*. **2:** 19-38 (1986).
7. Rao, V. R. S., Singh, J. P. and Sudhakar, T. R., Leafhoppers fauna associated with rice and sugarcane crop ecosystems of Telangana region in Andhra Pradesh. *Indian Journal of Entomology*. **62(1):** 43-52 (2000).
8. Shashank, P. R., Taxonomic studies on leafhopper and planthopper fauna associated with rice ecosystem and their management. *M.Sc. (Ag.) thesis Acharya N G Ranga Agricultural University*, Lam, Guntur (2009).
9. Viraktamath, C. A., Genera to be revised on a priority basis. In *proceedings of the first international workshop on leafhoppers and plant hoppers of economic importance, Knight, W. J., Pant, N. C., Robertson, T. S. and Wilson, M. R., (Eds.). Common Wealth Institute of Entomology*, London. 471-492 (1983).
10. Viraktamath, C. A., Final report of emeritus scientist project on taxonomic studies on the economically important leafhoppers (Hemiptera: Cicadellidae) of the Indian subcontinent. Department of Entomology, *University of Agricultural Sciences*, GKVK, Bangalore. 65-70 (2006).
11. Wilson, M. R. and Claridge, M. F., Handbook for identification of leafhopper and palnthoppers of rice. *CAB International, Wallingford. Oxon, U.K.*142 (1991).