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LEAFHOPPER FAUNA ASSOCIATED WITH FINGER MILLET CROP-ECOSYSTEM IN RAYALASEEMA REGION OF ANDHRA PRADESH

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ABSTRACT

In finger millet crop ecosystem thirteen leafhopper species *viz., Balclutha incisa* (Kirschbaum), *Balclutha saltuella* (Kirschbaum), *Balclutha thea* (Kirschbaum), *Batracomorphus angustatus* ***(Osborn),*** *Chiasmus alata* (Pruthi), *Cicadulina bipunctata* (Melichar), *Cofona spectra* (Distant), *Doratulina speciosum* (Distant), *Empoascanara indica* (Datta), *Exitianus indicus* (Distant), *Maiestas acuminatus* (Dash and Viraktamath), *Maiestas dorsalis* (Motschulsky) and *Maiestas vulgaris* (Dash and Viraktamath) were collected, identified and described. An illustrated key along with key taxonomic characters were provided for easy identification of the leafhoppers associated with finger millet crop eco-systems from Rayalaseema region of Andhra Pradesh

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 (Viraktamath, 2006). 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 (Muniyappa and Veeresh, 1986), rice transitory yellowing, sandle spike, eastern wheat streak virus and maize streak virus, orange leaf of rice, *etc.,* (Wilson and Claridge, 1991).). Finger millet locally called as *Ragi,* is one of the most important staple food crop preferred in Rayalaseema region of Andhra Pradesh which occupies an area of 7000 hectares with a production of 8000 tonnes and productivity of 1640 kg ha^{-1} (Department of Agriculture, 2018). Studies on insect fauna especially leafhopper fauna associated with ragi crop ecosystems of Rayalaseema region were not attempted earlier.

MATERIALS AND METHODS

Leafhoppers specimens were collected from different Agro-climatic zones of Rayalaseema by sweep netting in rice. 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^{O}C, for about 5 to 6 hours. For mounting and preparing slides of genitalia the procedure suggested by Knight (1965) was followed. For describing the different body parts the terminology suggested by Blocker and Triplehorn (1985) was followed.

RESULTS AND DISCUSSION

In the present studies thirteen leafhoppers species *viz., Balclutha incisa* (Kirschbaum), *Balclutha saltuella* (Kirschbaum), *Balclutha thea* (Kirschbaum),

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Batracomorphus angustatus ***(Osborn)****, Chiasmus alata* (Pruthi), *Cicadulina bipunctata* (Melichar), *Cofona spectra* (Distant), *Doratulina speciosum* (Distant), *Empoascanara indica* (Datta), *Exitianus indicus* (Distant), *Maiestas acuminatus* (Dash and Viraktamath), *Maiestas dorsalis* (Motschulsky) and *Maiestas vulgaris* (Dash and Viraktamath) were collected, identified and described.

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

1. Mostly larger insects, clypeus and clypellus swollen.....2

- Mostly smaller to medium sized insects, clypeus and clypellus not swollen 3

2. Larger insects measuring more than 4 mm, colour pale whitish brown; vertex with four black spots, two central at base and the other two on lateral margins of face. The central black spot at the margin of face and vertex is distinct (Figs. 3a-b).....***Cofona spectra*** **(Distant)**

3. Vertex with a single large black spot / two black spots / conspicuous black band or with a pair of black spots on pronotum.....4

- Vertex without spots / conspicuous band.....7

4. Vertex with a 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. 1a-c)

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

- Vertex with one black spot / more than one black spot / a pair of black spots on pronotum.....5

5. Brownish insects with a pair of black spots on the pronotum near compound eyes. Connective 'Y' shaped, stem with notched apex, the arms are very close and overlapping each other. Styles with claw like apophyses. Aedeagus with a rounded apex and big apical gonopore (Figs. 2a-b)…….....***Chaismus alata*** **(Pruthi)**

- Vertex with single large black spot with irregular margin / with a pair of black spots having regular margin.....6

6. Vertex with a large single central black spot which is irregularly margined. Pygofer lobe with curved dorsal process. Subgenital plates wider at middle, narrow towards apex. Aedeagus abruptly narrowed towards apex (Figs. 7a-b).....***Empoascanara indica*** **(Datta)**

- 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 sub apical spine is seen on pygofer. Aedeagus short and 'C' shaped (Figs. 1 2 a - b)…….....***Cicadulina bipunctata*** **(Melichar)**

7. Medium to large sized insects. Width of the vertex more than half the width of the pronotum.....8

- Small to medium sized insects; width of the vertex less than half the width of the pronotum.....12

8. Robust wedge shaped, green coloured insects. Terminal portion of aedeagus forked or clefted. Apophysis of style very much elongated (Figs. 8a-b)

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

- Brown coloured insects, not robust as above. Aedeagus tip may be blunt / spinose but never clefted.....9

9. Fore wings with distinct reddish brown zig- zag markings. Apophyses of styles finger like. Aedeagal shaft wider basally, tapering gradually with acute apex and gonopore sub apical (Figs. 5a-c)…….***Maiestas dorsalis*** **(Motschulsky)**

- Fore wings without distinct reddish brown zig-zag markings.....10

10. Brown coloured insects. Fore wings subhyaline, four apical and three anteapical cells and with narrow appendix. Aedeagus very long, wider at base, then abruptly narrowed, deeply bend dorsocephalad. Shaft with distinct sinuation, in the middle and with a pointed apex which extends upto connective arms, gonopore apical (Figs. 13a-b).....***Doratulina speciosum*** **(Distant)**

- Aedeagal shaft not as above.....11

11. Head and thorax stramineous, vertex with faint median fuscous margins. Eyes greyish black aedeagal shaft slightly curved, wider at base, gradually narrowed distally to acutely pointed spine (Figs. 4a-c)

.....***Maiestas acuminatus*** **(Dash and Viraktamath)**

- Two pale reddish brown longitudinal stripes on vertex and six on pronotum. Fore wings ochraceous with distinct greyish veins. Aedeagal shaft wider in middle, gradually narrowed and notched apically with spine like process **(Figs. 6a-c)…**……***Maiestas vulgaris*** **(Dash and Viraktamath)**

12. Yellowish to greenish yellow coloured insects. Vertex much shorter than pronotum. Aedeagus with three pairs of basal process (Figs. 9a-c)

...……..***Balclutha incisa*** **(Matsumura)**

- White / green coloured insects. Aedeagus without process or projections, simple and filamentous.....13

13. Cream to pale yellowish brown coloured insects. Aedeagus elongate simple and narrow, gonopore apical (Figs. 10a-b).....***Balclutha saltuella*** **(Kirschbaum)**

Green coloured insects. Aedeagus simple, filamentous, curved distad and aedeagal shaft evenlycurved(Figs.11a-c).....***Balclutha thea*** **(Kirschbaum)**

The most brief and important taxonomic and morphological characters of the above keyed species were provided here under for confirmation of Identifications.

Cofona spectra **(Distant):** Pale yellowish white. Vertex with a black spot towards posterior margin and a central spot at the margin of face and vertex. Two spots on the margin near eyes and located more towards the face, muscle impression on face distinct. Clypeaus and clypellus are swollen. Forewings subhyaline with four apical and three anteapical cells and appendix is present. Pygofer broader than its length in lateral view with submarginal macrosetae. Subgenital plates broader at base and gradually narrowed to an acute apex with marginal macrosetae. Connective with stem short, arms broad, strong and extended laterad. Aedeagus broad at the base gradually narrowed to a blunt apex in dorsal view. Aedeagus is 'C' shaped with the caudal end bifurcated in lateral view.

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.

Chaismus alata **(Pruthi)*:*** Brownish, with black spots on the anterior margin of vertex. A pair of black spots are present on the pronotum near compound eyes. Hemelytra subhyaline with four apical and three anteapical cells and with broader appendix. Pygofer broader than height in lateral view with marginal and submarginal microsetae posteriorly. Connective 'Y' shaped, stem with notched apex, the arms are very close over lapping each other. Styles with claw like apophyses. Aedeagus with a rounded apex and big apical gonopore.

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. Forewings subhyaline with four apical cells. Anteapical cells and appendix are absent. 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.

***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. Hemelytra hyaline with three apical and two anteapical cells. 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.

***Batracomorphus angustatus (Osborn)*:** Greenish yellow in colour with small dots all over. Hemelytra subhyaline with four apical and three anteapicals. 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, devoid of marginal macro and micro setae. Gonopore apical.

***Maiestas dorsalis* (Motschulsky):** Pale yellowish brown, tegmina with distinct reddish brown zig-zag markings, hence commonly called as zig-zag leafhopper. Hemelytra subhyaline with four apical cells and three anteapical cells and with appendix. Subgenital plates wider basally, gradually narrowed towards apex, outer margins convex, with marginal macro and microsetae. Styles robust, apophyses slender and finger like. Connective longer than aedeagus and fused. Aedeagal shaft wider

***Doratulina speciosum* (Distant):** Brownish yellow. Fore wings subhyaline, four apical and three anteapical cells and with narrow appendix. 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, gonopore apical.

***Maiestas acuminatus* (Dash and Viraktamath):** Head and thorax orange yellow, vertex with faint median fuscous markings. Hemelytra long with four apical and three anteapical cells. Connective linear, fused with aedeagus, arms closely apposed and have deeper excavation at the point of junction with apophyses in the lateral aspect and longer than aedeagus. Styles with apophyses slender, narrowed distally and curved laterally, the preapical lobe angulated with few small setae. Aedeagal shaft strongly curved, wider at base, gradually narrowed distally to an acutely pointed spine, gonopore dorsoapical.

***Maiestas vulgaris* (Dash and Viraktamath):** Stramineous, vertex with an oval orange maculae on either side of medium sulcus; three pairs of spots present on its anterior margin of vertex and a pair of orange maculae at the base of scutellum. Hemelytra subhyaline with four apical and three anteapical cells, appendix present. Subgenital plates wider basally, gradually narrower towards apex with outer lateral margin convex. Connective fused with the aedeagus and longer than aedeagal shaft, wider in the middle, gradually narrower and notched apically with a spine like process ventrally which is shorter and not exceeding the apex of aedeagus. Styles robust, apophyses gradually narrower towards tip.

***Balclutha incisa* (Matsumura):** Yellowish to greenish yellow in colour. Head more or less as wide as pronotum. Fore wings long and slender with wider appendix and with four apical cells and only two anteapical cells, inner one opens basally. 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; gonopore apical.

***Balclutha saltuella* (Kirschbaum):** Cream to pale yellowish brown. Head wider than pronotum. Forewings are with three apical and two anteapical cells. Pygofer broadly rounded posteriorly, posteroventral margin slightly produced. Subgenital plates very short with fingers like

apex. Connective with arms as long as stem. Aedeagus elongate simple, shaft narrow; gonopore apical.

***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, uniseriate row of macrosetae, extending diagonally across ventral surface to medial edge of the plate. 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 ragi crop ecosystems in Rayalaseema region of Andhra Pradesh. Bindra (1973) 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. Sohi (1983) studied biosystematics leafhoppers belonging to the subfamily Typhlocybinae on cotton and rice crop ecosystems. Ahmed (1987) reported 33 Typhlocybinae leafhoppers, their host association, and associated yield loss in graminaceous crop ecosystems in Pakistan. Wilson and Claridge (1991) published a comprehensive account of leafhoppers in major rice growing areas of the world and keys for identification of leafhoppers along with colour photographs. Virakatamath (1983) emphasized the need of keys for leafhopper fauna of Karnataka and provided a key for identification economically important leafhoppers. Ramasubbarao *et al.,* (2000) 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). Giridhar *et al.,* (2008) studied leafhopper fauna associated with sugarcane ecosystems of South India and reported 22 leafhopper species.

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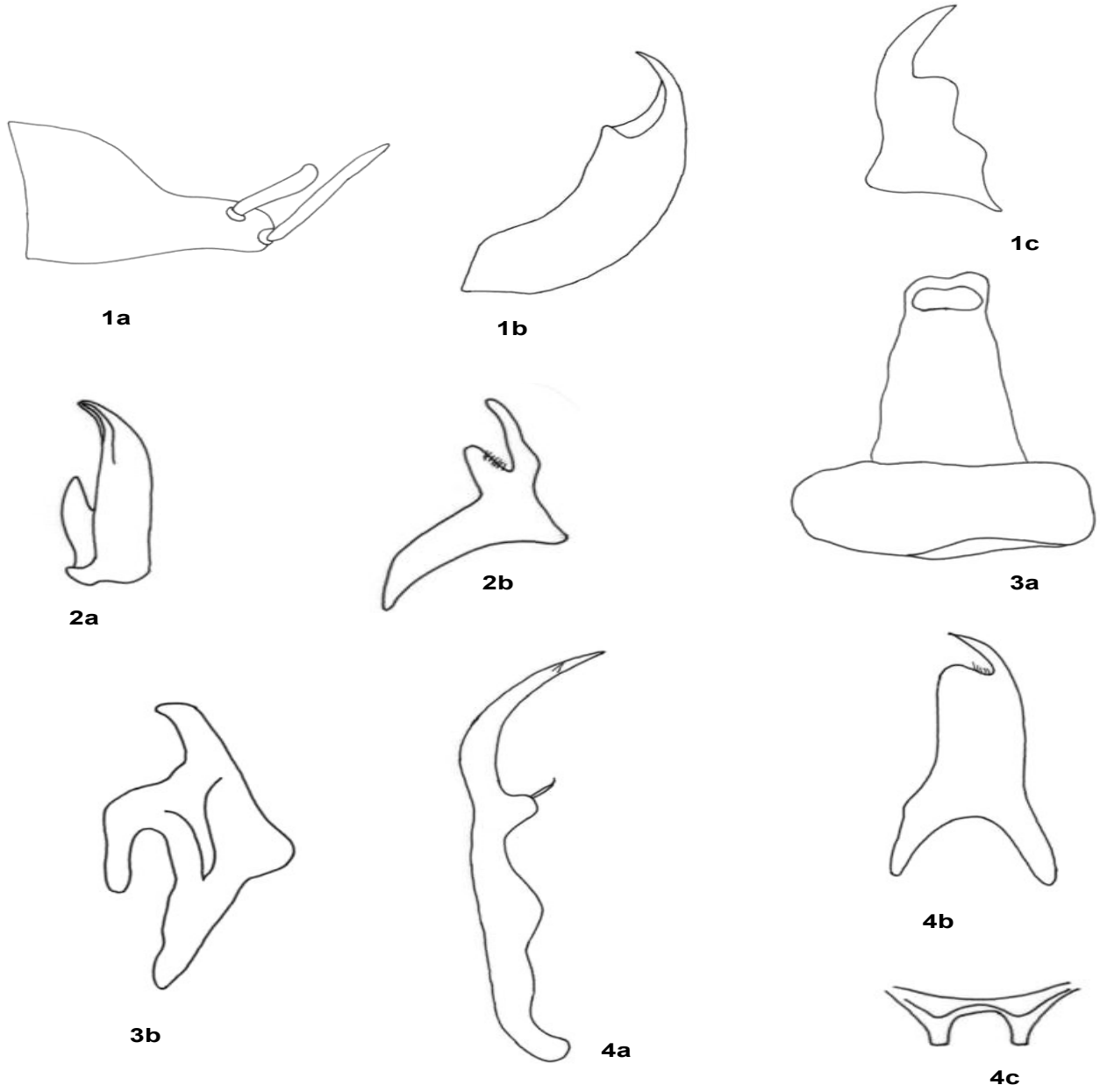
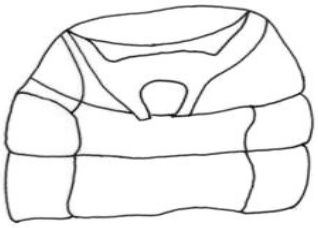


Figs. 1a-c. *Exitianus indicus* (Distant): 1a. Pygofer lobe, lateral view; 1b. Aedeagus, lateral view; 1c. Style. Figs. 2a-b. *Chiasmus alata* (Pruthi): 2a. Aedeagus, lateral view; 2b. Style. Figs. 3a-b. *Cofona spectra* (Distant): 3a. Aedeagus, dorsal view; 3b. Style. Figs. 4a-c. *Maiestas acuminatus* (Dash and Viraktamath): 4a. Fused connective and aedeagus, lateral view; 4b. Style; 4c. Abdominal sternal apodemes.



5a

5b

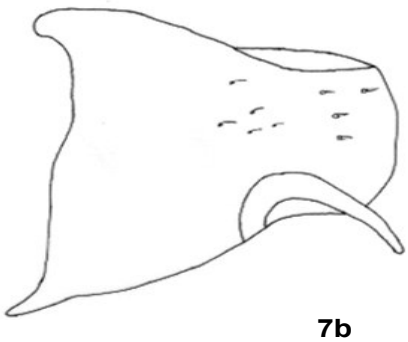
5c

6a

6b

6c

7a

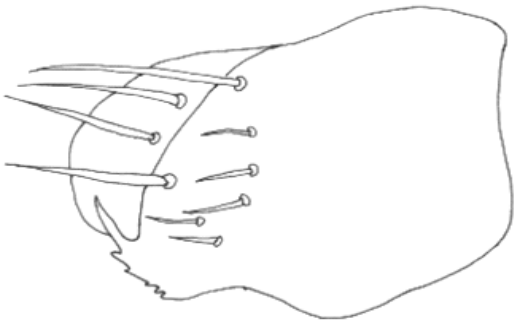


7b

Figs. 5a-c. *Maiestas dorsalis* (Motschulsky): 5a. Abdominal apodemes lateral view; 5b. Style; 5c. Aedeagus. Figs. 6a-c. *Maiestas vulgaris* (Dash and Viraktamath): 6a. Fused connective and aedeagus, lateral view; 6b. Style; 6c. Style lateral view. Figs. 7a-b. *Empoascanara indica* (Datta): 7a. Aedeagus, lateral view; 7b. Pygofer.

8a

8b



9a

9b

9c

10a

10b

Figs. 8a-b. *Batracomorphus angustatus* (Osborn): 8a. Aedeagus, lateral view; 8b. Subgenital plate. Figs. 9a-c. *Balclutha incisa* (Matsumura): 9a. Pygofer, lateral view; 9b. Aedeagus, lateral view; 9c. Style. Figs. 10a-b. *Balclutha saltuella* (Kirschbaum): 10a. Style; 10b. Aedeagus, lateral view.

11a

11b

11c

12a

12b

13a

13b

Figs. 11a-c. *Balclutha thea* (Kirschbaum): 11a. Aedeagus in lateral view; 11b. Style; 11c. Subgenital plate. Figs. 12a-b. *Cicadulina bipunctata* (Melichar): 12a. Pygofer, lateral view; 12b. Aedeagus, lateral view. Figs. 13a-b. *Doratulina speciosum* (Distant): 13a. Aedeagus, lateral view; 13b. Style