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PLANTHOPPER FAUNA ASSOCIATED WITH RICE CROP-ECOSYSTEMS FROM COSTAL ANDHRA PRADESH

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Date of Receipt: 18-02-2017

ABSTRACT

Date of Acceptance: 23-03-2017

Fourteen planthopper species viz., *Nilaparvata lugens* (Stal); *Sogatella furcifera* (Horvath); *S. kolophon* (Kirkaldy); *S. vibix* (Haupt); *Cemus* sp; *Coronacella sinhalana* (Kirkaldy); *Euidella* sp.; *Harmalia anacharsis* (Fennah); *Sardia rostrata* (Melichar); *Terthron albobittatum* (Matsumura); *Tagosodes pusanus* (Distant); *Oliarus* sp.; *Nisia nervosa* (Motschulsky); and *Toya propinqua* (Fieber) were collected, identified and described. An illustrated key along with key taxonomic characters were provided for easy identification of the planthoppers associated with rice crop eco-systems from coastal Andhra Pradesh

KEYWORDS: Hemiptera, Delphacidae, planthoppers, rice crop eco-system

INTRODUCTION

Planthoppers belong to the super family Fulgoroidea in Fulgoromorpha of Auchenorrhynchos–Hemiptera comprising 20 families. The economically important planthoppers were included in families viz., Cixiidae, Delphacidae, Derbidae, Dictyophoridae, Eurobrachidae, Flatidae, Fulgoridae, Tettigometridae, and Tropicodidae (O'Brien and Wilson, 1985). Delphacidae is the largest family of planthoppers belonging to the super family Fulgoroidea of the order Hemiptera. Family Delphacidae comprises of a number of important crop pests. Delphacids are grass feeders and devastating pests on major agricultural crops viz., rice, sugarcane, maize, sorghum and other cereals. Delphacids are the most diverse and economically important family of planthoppers, comprising about 1835 species of which 55 species are known pests on 25 crops (Wilson and O'Brien 1987). Planthoppers damage plants directly by feeding which cause a characteristic yellowing of tissue known as "hopper burn" and in addition planthoppers may also act as vectors for plant viral disease viz., rice grassy stunt virus (*Nilaparvata lugens* (Stal), *N. bakeri* (Muir) and *N. muiri* (China)) (Ou, 1985 and Hibino, 1989), rice ragged stunt virus (*N. lugens* and *N. bakeri*), rice stripe and black-streaked dwarf virus (*Laodelphax striatellus* (Fallen) and *Terthron albobittatum* (Matsumura)), hoja blanca virus (*Tagosodes oryzicolus* (Muir) (Nault and Ammar, 1989), sugarcane yellow leaf syndrome (*Saccharosydne saccharivora* (Westwood)), Fiji disease

virus (*Perkinsiella saccharicida* (Kirkaldy), *Perkinsiella sinensis* (Distant) and *P. vastatrix* (Kirkaldy)) (Wilson, 2005), maize rough dwarf virus (*Sogatella vibix* (Haupt)), maize mosaic, maize sterile stunt, maize stripe virus (*Peregrinus maidis* (Ashmead)), finger millet mosaic virus (*P. maidis*), Brazilian wheat spike disease (*Sogatella kolophon* (Kirkaldy)) (Wilson, 2005) etc.,

MATERIALS AND METHODS

Planthopper specimens were collected from different Agro-climatic zones of coastal Andhra Pradesh by sweep netting from rice crop. About 10-15 to and fro net sweepings were taken each time and planthoppers 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°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 O'Brien and Wilson (1985) was followed.

RESULTS AND DISCUSSION

In the present studies fourteen planthopper species viz., *Nilaparvata lugens* (Stal); *Sogatella furcifera* (Horvath); *S. kolophon* (Kirkaldy); *S. vibix* (Haupt); *Cemus* sp; *Coronacella sinhalana* (Kirkaldy); *Euidella* sp.; *Harmalia anacharsis* (Fennah); *Sardia rostrata*

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Planthopper fauna of rice ecosystem from coastal Andhra Pradesh

1. Hind tibia with a movable apical spur (Delphacidae) – 2
 — Hind tibia without a movable apical spur (Cixiidae, Meenoplidae) – 14
2. Presence of one or more lateral spines on the basal segment of hind tarsus; aedeagus slender, broader medially, tapering apically and apex upturned; genital styles flattened; inner margin deeply concave in middle (Fig.1-2)
 — *Nilaparvata lugens*
 — Hind basal tarsal segment without lateral spines – 3
3. Vertex and mesonotum with a distinct pale yellow or orange or white stripe extending from the head – 4
 — Vertex and mesonotum without a distinct pale yellow or orange white stripe extending from the head – 11
4. Aedeagus twisted, tapering to apex with two rows of small teeth – 5
 — Aedeagus not twisted, tubular without two rows of small teeth – 7
5. Aedeagus twisted, tapering towards apex with two rows of small teeth; tegmina with a pterostigma; clypeus, genae and frons blackish; diaphragm 'U' shaped; genital styles strongly dilated at base, apex relatively small and almost equally bifurcated (Fig. 3-4) – *Sogatella furcifera*
 — Tegmina without pterostigma; face with frons, clypeus and genae not entirely blackish; genital styles not as above – 6
6. Face with frons, clypeus, genae entirely pale yellowish in colour; genital styles relatively short, broad, flattened, deeply bifurcated distally and anterior process of the apical bifurcation strongly produced tapering to apex, not distinctly dilated in the middle part, inner process very short; inner edge of the diaphragm rectangular (Fig. 5-6) – *Sogatella kolophon*
 — Face with frons and clypeus pale yellowish brown in colour, but genae dark brown in colour; the genital styles have the outer process of apical bifurcation dilating from the base of middle then tapering to apex with dorsal margin forming a blunt angle; diaphragm more or less 'U' shaped (Fig. 7-8) – *Sogatella vibix*
7. Aedeagus tubular with a few small teeth like projections subapically – 8
 — Aedeagus not tubular and not as above – 9
8. Aedeagus tubular and deeply curved; gonopore subapical, more or less rectangular; genital styles densely spinose distally (Fig. 9-10) – *Terthron albovittatum*
 — Aedeagus basally wider, gradually narrowed and tubular; two to three spines are there subapically, gonopore apical; genital styles relatively flattened, trapezoidal, distally and shallowly bifurcated (Fig. 11-12)
 — *Tagosodes pusanus*
9. Vertex narrow, elongated between larger compound eyes; tegmina dark brown in colour with pterostigma; aedeagus more or less straight, tubular with subapical serrations; genital styles relatively short, broader medially with a deep sinuation along the inner margin; number of spines are scattered in the middle portion of the style (Fig. 13-14) – *Sardia rostrata*
 — Vertex short, not so elongated. Anal tube process present, genital styles without serrated processes – 10

10. Frons with conspicuous raised pits on either side of the median carina; tegmina granulate along the veins and fuscus apically; aedeagus long, slightly decurved with long flagellum arising at apex, dorsal margin with one or two processes; genital styles broader basally, gradually narrowed apically with spines (Fig. 15-16)– *Cemus* sp.
 — Frons without conspicuously raised pits on either side of median carina; tegmina not granulate – 11
11. Vertex and mesonotum dark brown with characteristic cream coloured band on pronotum; anal segment collar like with a pair of slender process; aedeagus is tubular near apex (Fig. 17-18) – *Coronacella sinhalana*
 — Vertex and mesonotum dark brown without characteristic cream coloured band on pronotum – 12
12. Aedeagus flattened, curved with a pair of long unequal subapical processes; genital style L- shaped (Fig. 19-22) — *Euidella* sp.
 — Aedeagus and genital styles are not as above – 13
13. Aedeagus tubular with uniform width throughout and without any teeth; genital style bifurcated apically (Fig. 23-24) – *Harmalia anacharsis*
 — Aedeagus tubular but not with uniform width, serrated subapically, below which slightly sinuated; diaphragm Y- shaped (Fig. 25-26) – *Toya propinqua*
14. The claval vein of tegmina granulate; median ocellus pearl like; aedeagus very broad basally, gradually narrowed and slightly curved with a pair of transparent wing like structures; genital styles broad basally, elongated with claw like structures in the middle (Fig. 27-28) – *Nisia nervosa*
 — The claval vein of tegmina not granulate, median ocellus not pearl like. Vertex excavated, reddish brown in colour, mesonotum large with five carinae; aedeagus with processes (Fig. 29-30) — *Oliarus* sp.

(Melichar); *Terthron albovittatum* (Matsumura); *Tagosodes pusanus* (Distant); *Toya propinqua* (Fieber) (**Family: Delphacidae**); *Oliarus* sp. (**Family: Cixiidae**); *Nisia nervosa* (Motschulsky) (**Family: Meenoplidae**) were collected, identified and described.

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

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

***Nilaparvata lugens*:** Yellowish brown or dark brown in colour with eyes slightly bluish. Clypeus triangular, with median and lateral carina. Legs slender with tectiform post tibial spur and with teeth on margin. Number of teeth on tibial spur is 15-35. Pygofer moderately long, posterior opening slightly longer dorsoventrally than broad. Anal segments were collar like with a pair of moderately long slender spine like processes. Aedeagus slender, broader

medially, tapering apically with teeth on the caudal margin and apex upturned. Genital styles flattened, inner margin deeply concave in the middle.

***Sogatella furcifera*:** Vertex yellowish white, Frons, clypeus and genae black in colour. Pronotum is yellowish. Forewing sub-transparent with black pterostigma. The body is black dorsally, creamy white ventrally with a distinct yellowish white region in the middle of mesothorax in both males and females. Clypeus and genae blackish with whitish yellow carinae. Pronotum yellowish white and laterally darkened. Pygofer moderately long, posterior opening slightly longer dorsoventrally than broad. Anal segment collar-like with a pair of stout spine like processes, directed ventrally. Diaphragm broadly U-shaped. Aedeagus is simple, tubular usually sinuate with two rows of teeth, and with apical gonopore. Genital styles broad basally, bifurcated apically.

***Sogatella kolophon*:** Vertex, pronotum and mesonotum yellowish-white to pale stramineous. Lateral mesonotum orange brown. Face with frons, clypeus and genae entirely pale yellowish brown in colour. Clypeus and genae are light brown with yellow carinae. Post tibial spur with 19-

21 teeth. Pygofer more or less round, posterior opening slightly longer dorsoventrally than broad. Anal segment, collar like with a pair of stout spine like processes directed ventrally up to the length of anal tube. Aedeagus twisted, tubular, usually sinuate with two rows of teeth and apical gonopore. Inner edge of diaphragm rectangular. Genital styles relatively short, broad, flattened, deeply bifurcated distally and anterior process of the apical bifurcation strongly produced tapering to apex, not distinctly dilated in the middle part, inner process very short.

Sogatella vibix: Vertex yellowish white and black in colour beyond mid lateral carinae. Forewings without pterostigma and are subtransparent. First segment of hind tarsus distinctly longer than the length of second and third segments put together, with thin and foliaceous tibial spur. Pygofer more or less round, posterior opening slightly longer dorsoventrally than broad. Anal segment moderately short, collar like with a pair of moderately long, slender stout spine like process directed ventrally up to the length of anal tube. Usually sinuate with two rows of teeth. Aedeagus twisted, tubular and gonopore apical. The genital plates have the outer process of the apical bifurcation dilating from base of middle then tapering to apex with dorsal margin forming a blunt angle.

Cemus sp: Vertex, pronotum reddish black with cream coloured carinae. The forewings with blackish dots all along the veins and fuscous maculae apically. Genae reddish black in colour with cream coloured pits. Tegmina with characteristic black dots along veins, fuscous streaks, apically with a distinct pterostigma. Pygofer short dorsally, long and strongly convex ventrally, posterior opening relatively small, longer than broad. Anal segment collar like with a pair of slender processes directed ventrally. Diaphragm long dorsoventrally, with dorsal margin concave, deeply incised medially, medioventral process short, broader than long, quadrate. Aedeagus long, slightly decurved, with a long flagellum arising at apex, dorsal margin with one or two processes

Coronacella sinhalana: Pronotum with cream coloured band. The central carina of the face black; lateral carina of vertex and frons, median line of pronotum and mesonotum white, second segment of antenna and legs yellowish brown, tibial spur with 18 teeth. Pygofer with posterior margin slightly incised near base, latero dorsal angle obtusely rounded, opening wider than long, lateral margins not very distinct; phallus short, tubular with several teeth dorsally near apex; orifice on lower side near apex.

Diaphragm broad, dorsal margin evenly convex medially; anal segment collar like with a pair of slender spinose processes directed ventrally.

Euidella sp. : Eyes reddish brown. Vertex, pronotum and mesonotum tinged with orange to yellowish markings; frons, genae, clypeus, antennae and legs yellowish brown. Pygofer ovoid, medioventral margin with three equally sized and long thin spines; base of paramere with a flattened part extended caudally, mid half concave latero-caudally, twisted apically and diverging, forming tip with series of minute spike-like processes. Aedeagus flattened with long unequal flagellar appendages. Genital styles long and L- shaped.

Harmalia anacharsis: Body is light brown in colour. Vertex very short, broad and excavated, triangular between eyes. Frons dark brown in colour, and carinae lighter in colour. Light brown coloured legs, first tarsal segments longer than the remaining segments, leaf like tibial spur which is broader. Anal segment collar like with a pair of spines directed ventrally. Aedeagus tubular without teeth, uniform width throughout. Genital styles bifurcated apically.

Sardia rostrata: The colouration of vertex, thorax and tegmina is dark brown with black fuscous markings. The clypeus is black in colour and gradually narrows apically. Genae black in colour. Forewings are dark brown with pterostigma and fuscous apically. Pygofer broadly rounded, posterior opening longer dorsoventrally. Aedeagus more or less straight, tubular with subapical serration, gonopore apical. Genital styles relatively short, broader medially with a deep sinuation along the inner margin and number of spines are scattered in the middle portion of the style

Terthron albovittatum : Vertex to apex of mesonotum dark brown with cream colour dorsal median stripe. Genae black in colour, Tibial spur leaf like; first segment of hind tarsus distinctly longer than the length of second and third segments put together. Pygofer dorsoventrally broad, posterior opening slightly longer. Collar like anal segment with a pair of spine like processes directed ventrally. Aedeagus simple, tubular curved deeply, gonopore sub-apical. Genital styles more or less rectangular with densely spinose distally.

Tagosodes pusanus: A white band present along the middle line from the anterior cell of vertex to the caudal tip of the mesonotum. The lateral sides of pro and mesonotum brown or black in colour. Frons and genae

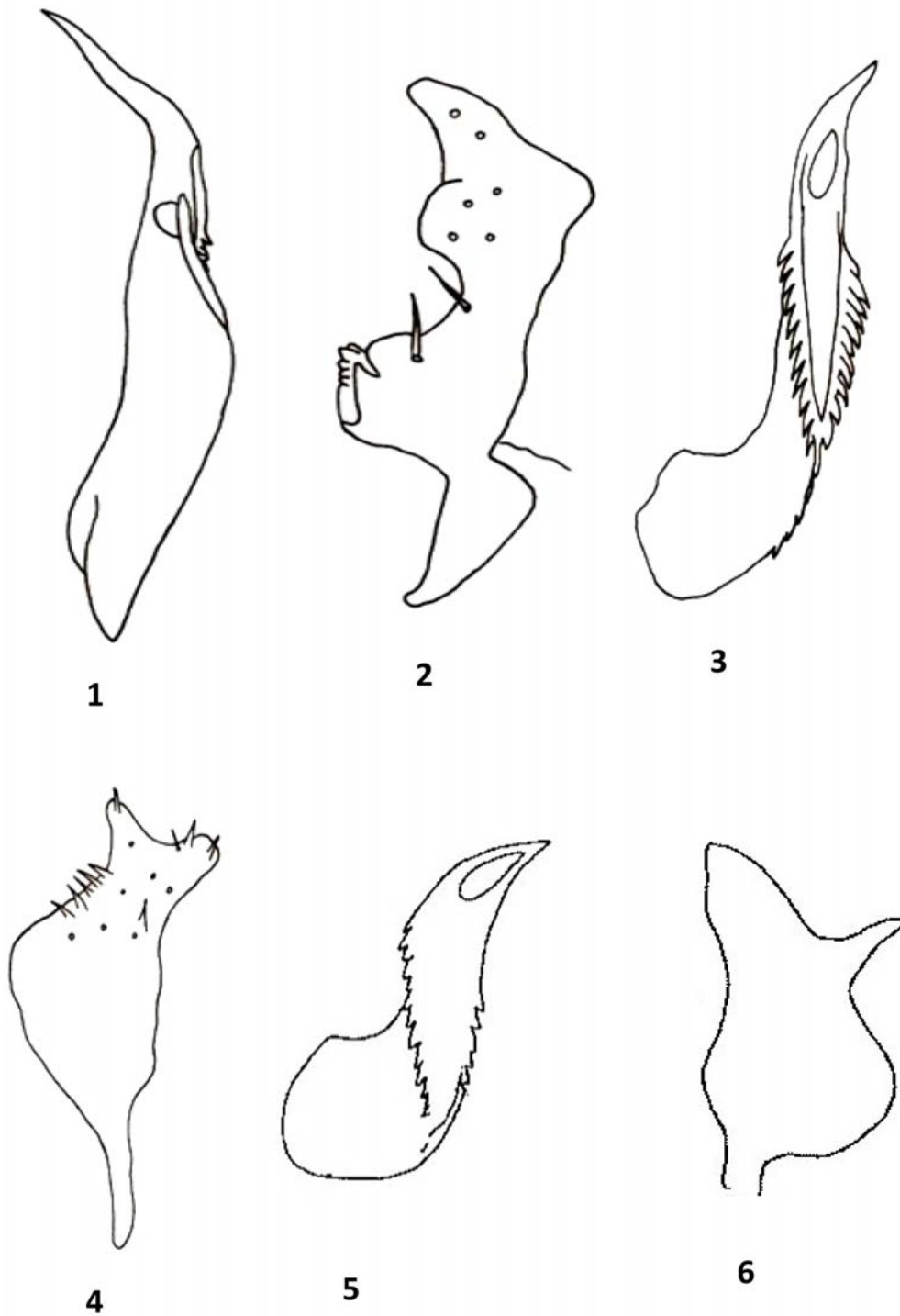


Fig. 1-2; *Nilaparvata lugens*, 1. Aedeagus, lateral view; 2. Style, lateral view; Fig. 3-4; *Sogatella furcifera*, 3. Aedeagus, lateral view; 2. Style, lateral view; Fig. 5-6; *Sogatella kolophon*, 5. Aedeagus, lateral view; 6. Style, lateral view.

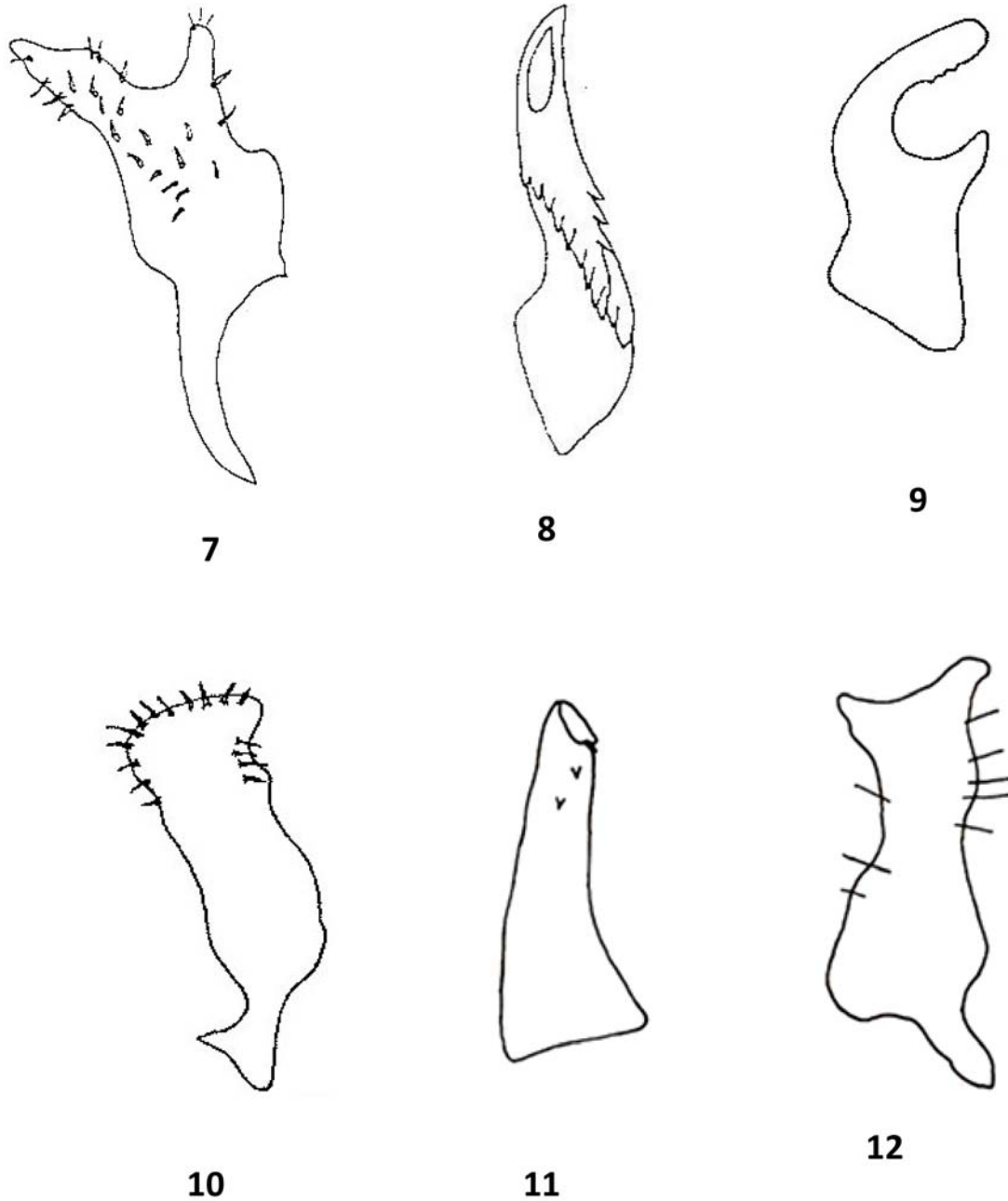


Fig. 7-8; *Sogatella vibix*, 7. Style, lateral view; 8. Aedeagus, lateral view; Fig. 9-10; *Terthron albovittatum*, 9. Aedeagus, lateral view; 10. Style, lateral view; Fig. 11-12; *Tagosodes pusanus*, 11. Aedeagus, lateral view; 12. Style, lateral view.

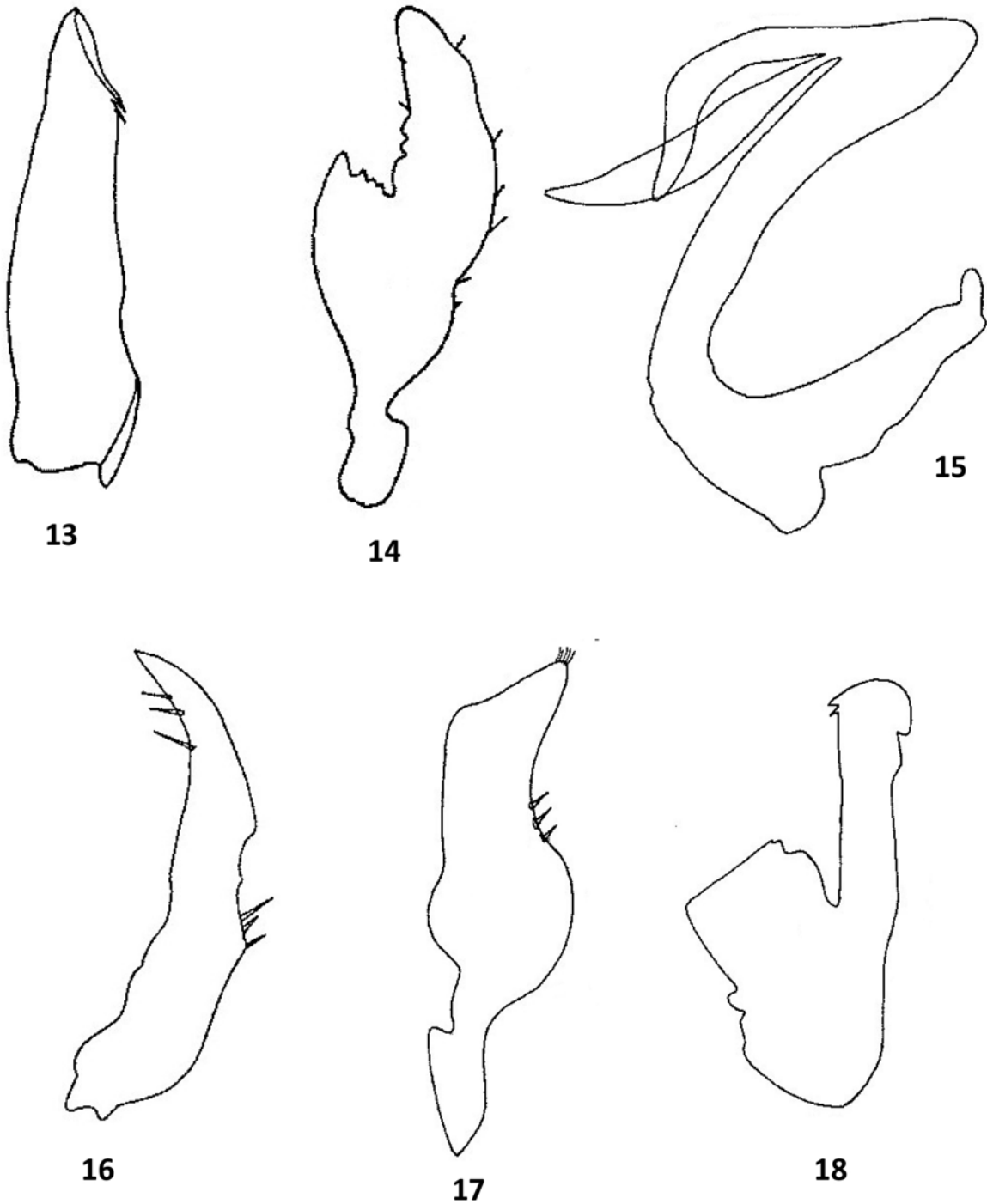


Fig. 13-14; *Sardia rostrata*, 13. Style, lateral view; 14. Aedeagus, lateral view; Fig. 15-16; *Cemus* sp., 15. Aedeagus, lateral view; 16. Style, lateral view; Fig. 17-18; *Coranacella sinhalana*, 17. Style, lateral view; 18. Aedeagus, lateral view

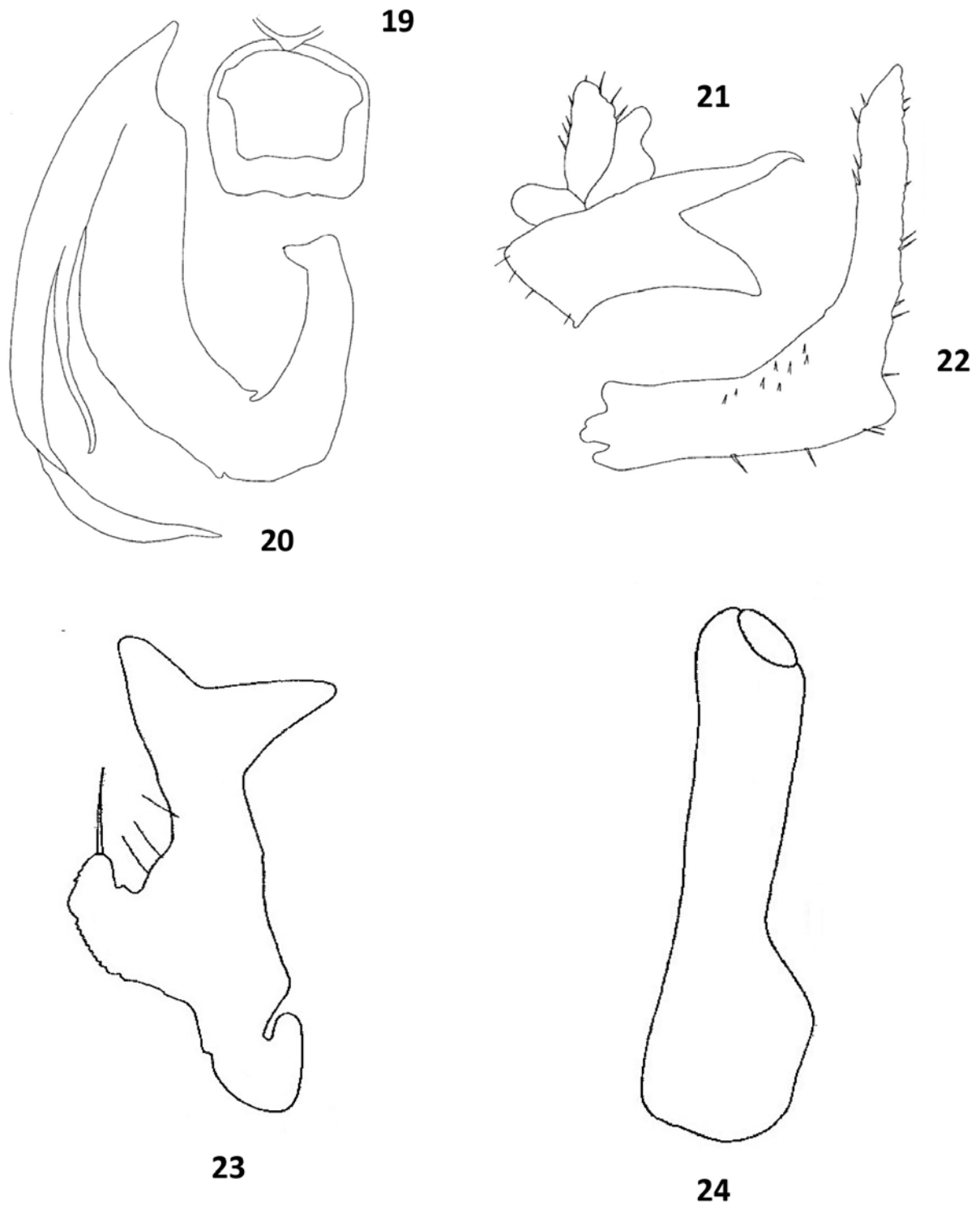


Fig. 19-22; *Euidella* sp., 19. Diaphragm; 20. Style, lateral view; 21. Anal tube; 22. Style, lateral view
Fig. 23-24; *Harmalia anacharsis*, 23. Style, lateral view; 24. Aedeagus, lateral view

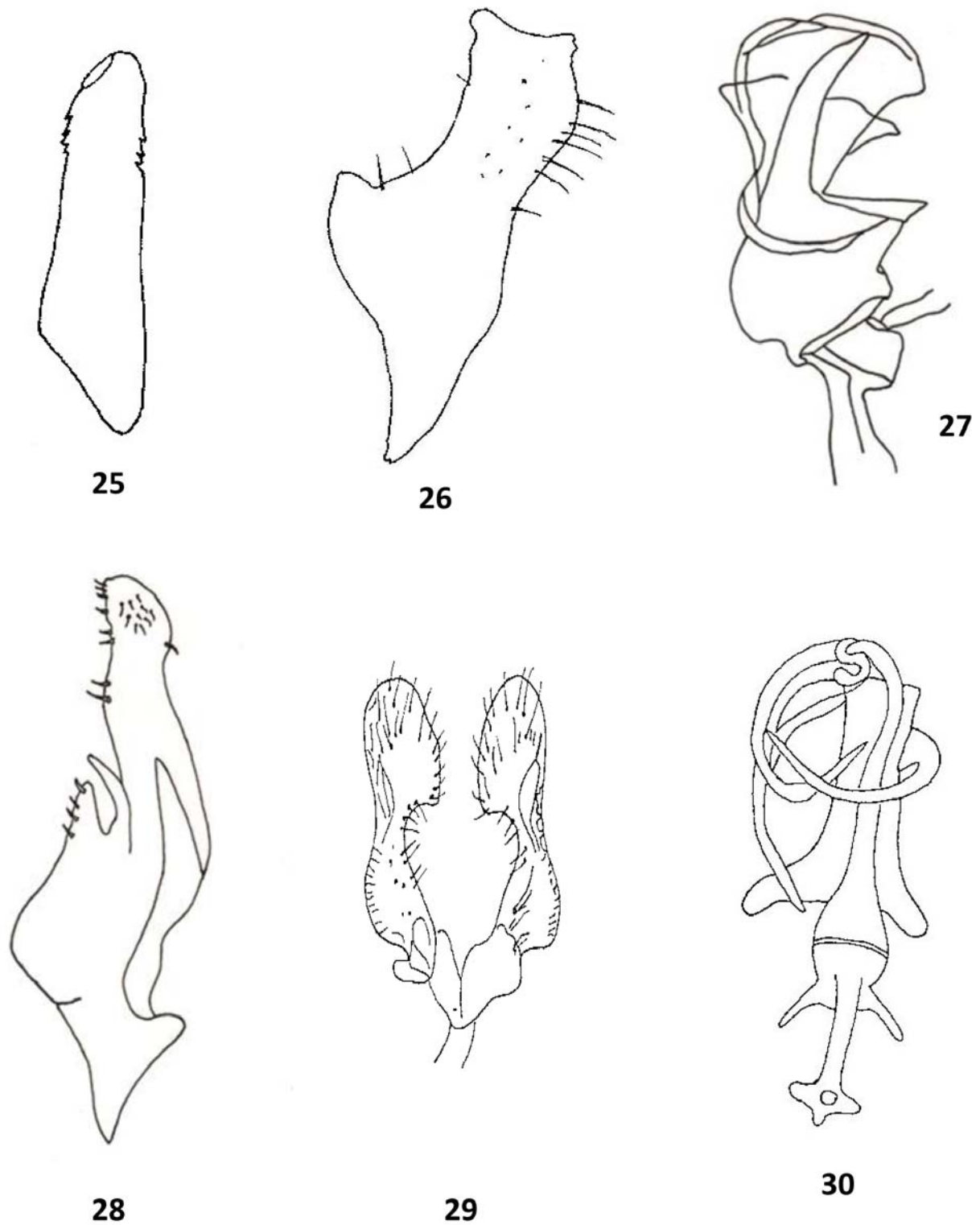


Fig. 25-26; *Toya propinqua*., 25. Aedeagus, lateral view; 26. Style, lateral view, Fig. 27-28; *Nisia nervosa* , 27. Aedeagus, lateral view; 28. Style, lateral view, Fig. 29-30; *Oliarus* , 29. Aedeagus, lateral view; 30. Style, lateral view

are black in colour. Clypeus light brown in colour. Tegmina subtransparent, longer than wide with a pattern of dark markings and pterostigma. Post tibial spur thin, foliaceous and with minute teeth marginally. Pygofer moderately long, posterior opening slightly longer dorsoventrally than broad. A pair of short spine like processes directed ventrally on the collar like anal segment. Aedeagus tubular wider basally, gradually narrowed and tubular, 2-3 spines are there sub-apically, gonopore apical. Genital styles relatively flattened, trapezoidal distally and shallowly bifurcated.

Oliarus sp.: Frons with intercarinal areas dark in colour. Tegmina with black dots all along over the veins. Legs yellowish, with 4 tibial spines; two small basal ones, and others longer. Pygofer with medioventral process which are conical and triangular. Lateral lobes well produced, symmetrical, diverging distally in ventral aspect. Aedeagus more or less tubular with curved elongated flagellum like processes. Genital styles broader apically, deeply sinuated along the mesal margin in the middle with spines densely scattered.

Toya propinqua: Stramineous in colour. Vertex very short and shallowly excavated. Tegmina without pterostigma and is light stramineous in colour. Legs normal, tibiae foliaceous. Pygofer dorsoventrally elongated with an elongated ventral opening. A pair of moderately long slender spine like processes on collar like anal segment. Aedeagus tubular, serrated sub-apically below which slightly sinuated, gonopore apical. Genital styles flattened, broader, concave and wider in the middle with number of spines apically.

Nisia nervosa : Stramineous to whitish in colour. Vertex deeply excavated and is not demarcated from the frons. Frons very much elongated, excavated and curved along the eyes. Clypeus shorter and triangular in shape. Tegmina light straw coloured, veins darker, claval vein granulate or tuberculate. Legs slender, mobile spur absent, first two tarsal segments with a row of spines. Pygofer dorsoventrally long, posterior opening slightly longer. Pygofer is shoe shaped laterally. Anal segment without a pair of spines. Aedeagus very broad basally, gradually narrowed and slightly curved with a pair of transparent wing like structures. Genital styles broader basally, elongated and with claw like structures in the middle and broader.

Okada (1977) reported 20 species of delphacid planthoppers as rice pests in Japan, of these only three

species, *Nilaparvata lugens* (Stal), *Sogatella furcifera* (Horvath) and *Laodelphax striatellus* (Fallen) were considered as major rice pests. Wilson and Claridge (1991) published a comprehensive account of leafhopper and planthoppers found on rice in the major rice growing areas of world. They described 28 species of planthoppers belonging to the families of Delphacidae, Lophopidae, Meenoplidae and Cixiidae of Fulgoroidea on rice. Lakshminarayana *et al.* (2005) reported seven planthoppers species associated with different rice ecosystems of Andhra Pradesh. Rao and Chalam (2007) reported 23 delphacid planthoppers in India from rice and sugarcane ecosystems. Shashank (2009) reported five delphacid planthoppers *viz.*, *Cemus sp.*, *Nilaparvata lugens*, *Sogatella furcifera*, *Sardia rostrata*, and *Tagosodes pusanus* found associated with different rice eco-systems from Karnataka. In the present studies fourteen planthopper species belonging to three different families were collected, identified, described and illustrated for easy and quick identification. An attempt has been made in this paper to describe the planthopper fauna associated with rice crop ecosystems of coastal Andhra Pradesh, and an identification key well supported with illustrations was also provided which will be useful aid to identify the planthoppers by research and extension workers. The accurate identification of planthopper fauna associated with a particular agro-ecosystem is very much needed along with their identification key to formulate integrated management strategies whenever they attain pest status.

LITERATURE CITED

- Hibino, H. 1989. Insect-borne viruses of rice. In, K F Harris (Ed.) *Advances in Disease Vector Research*, 6: 209-241, Springer-verlag, New York.
- Knight, W.J. 1965. Techniques for use in the identification of leafhoppers (Homoptera: Cicadellidae). *Entomologist's Gazette*. 16: 129-136.
- Lakshminarayana, N., Rao, V.R.S. and Rajasekhar, G.P. 2003. New records of planthoppers belonging to Cixiidae and Lophopidae (Fulgoroidea: Homoptera) from rice ecosystems of Andhra Pradesh. *Journal of Applied Zoological Researches*. 14(2): 169-171.

- Nault, L.R and Ammar, E.D. 1989. Leafhopper and planthopper transmission of plant viruses. *Annual Review of Entomology*. 34: 503-527.
- O'Brien, L.B and Wilson, S.W 1985. Planthopper systematics and external morphology. In, Nault L R and Rodriguez J G (eds.) *The leafhoppers and planthoppers*. John Wiley and sons , New York 61-102.
- Okada, T. 1977. Taxonomic characters for identification of the rice brown planthopper (*Nilaparvata lugens*) and its related species in the Asian and Pacific Region. The Rice Brown Planthopper. In: *Food and Fertiliser Technology Centre for the Asian and Pacific Region* (ed.).1-26. Proceedings of the International Seminar. Taipei, Taiwan.
- Ou, S.H. 1985. *Rice Diseases*. 2nd ed. CAB International Mycological Institute, UK 1-380.
- Rao, V.R.S and Chalam, M.S.V. 2007. Biodiversity of planthopper fauna (Delphacidae: Hemiptera) associated with rice and sugarcane crop-ecosystems in South India. *Hexapoda*. 14(2): 129-141.
- Shashank, P.R. 2009. Taxonomic studies on leafhopper and planthopper fauna associated with rice ecosystem and their management. *M.Sc. (Ag) Thesis*, submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.
- Wilson, S.W and O'Brien, L. B. 1987. A survey of planthopper pests of economically important plants (Homoptera: Fulgoroidea). In: *Proceedings of the IInd International workshop on leafhoppers and planthoppers of economic importance*.343-360. Wilson M R and Nault L R (Eds.). 23rd July – 1st August 1987, Commonwealth Institute of Entomology, 56 Queen's Gate, London. pp. 368.
- Wilson, S.W. 2005. Keys to the families of Fulgoromorpha with emphasis on planthoppers of potential economic importance in the Southeastern United States (Hemiptera: Auchenorrhyncha). Department of Biology, Central Missouri State University, Warrensburg. *Florida Entomologist*. 88(4): 464-481.
- Wilson, M.R and Claridge, M.F. 1991. *Hand book for the identification of leafhoppers and planthoppers of rice*. Commonwealth Agricultural Bureaux International, London, UK. 142.