

**“TAXONOMIC STUDIES ON PLANTHOPPER FAUNA  
(FULGOROIDEA: HEMIPTERA) OF ANDHRA PRADESH”**

*By*

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## **CERTIFICATE**

Mr. **K.SHIVA HARI BRAHMA** has satisfactorily prosecuted the course of research and that the thesis entitled “**TAXONOMIC STUDIES ON PLANTHOPPER FAUNA (FULGOROIDEA: HEMIPTERA) OF ANDHRA PRADESH**” submitted is the result of original research work and of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any university.

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Place:

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Place: *Bapatla*

(**K. SHIVA HARI BRAHMA**)

Date :

## DECLARATION

I, Mr. **K.SHIVA HARI BRAHMA** hereby declare that the thesis entitled “**TAXONOMIC STUDIES ON PLANTHOPPER FAUNA (FULGOROIDEA: HEMIPTERA) OF ANDHRA PRADESH**” submitted to the Acharya N.G. Ranga Agricultural University for the degree of Master of Science in Agriculture in the major field of **Entomology** is the result of original research work done by me. I also declare that the thesis or any part there of has not been published earlier in any manner.

Date:

[**K.SHIVA HARI BRAHMA**]

## ABSTRACT

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Title of the Thesis : **“Taxonomic studies on planthopper fauna (Fulgoroidea: Hemiptera) of Andhra Pradesh”**

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The investigation on Taxonomic studies on planthopper fauna (Fulgoroidea: Hemiptera) of Andhra Pradesh was undertaken during 2009-2010 at Agricultural College, Bapatla, Guntur District. The planthopper fauna associated with rice, sugarcane, maize and sorghum crop ecosystems of Andhra Pradesh were collected, described and identified during 2009-2010. Nineteen planthopper species belonging to four families (Cixiidae, Delphacidae, Meenoplidae and Lophopidae) viz., *Oliarus* sp., *Cemus* sp., *Coronacella sinhalana* (Kirkaldy), *Euidella* sp., *Harmalia anacharsis* (Fennah), *Peregrinus maidis* (Ashmead), *Perkinsiella* sp., *Perkinsiella sinensis* Kirkaldy, *Nilaparvata lugens* (Stal), *Sardia rostrata* (Melichar), *Sogatella furcifera* (Horvath), *Sogatella kolophon* (Kirkaldy), *Sogatella vibix* (Haupt), *Tagosodes pusanus* (Distant), *Terthron albovittatum* (Matsumura), *Tropidocephala serendiba* (Melichar), *Toya*

*propinqua* (Fieber), *Pyrilla perpusilla pusana* (Distant) and *Nisia nervosa* (Motschulsky) were identified. Among these, four species of viz., *Euidella* sp., *Perkinsiella* sp., *Coronacella sinhalana* and *Tropidocephala serendiba* were recorded for the first time in Andhra Pradesh. All these species were identified, illustrated and adequately described. The identification 'key' for distinguishing all these planthoppers was provided along with line drawings and the colour photographs of each specimen for easy understanding. Among the planthoppers identified, two species viz., Brown planthopper (BPH), *Nilaparvata lugens* (Stal) and white backed planthopper (WBPH), *Sogatella furcifera* (Horvath) were observed as major pests of rice. *Pyrilla perpusilla pusana* (Distant) on sugarcane; *Peregrinus maidis* (Ashmead) on sorghum and maize were observed to be in minor pest status and the remaining were only associated with different crop ecosystems.

# CHAPTER- I

## 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 Tropiduchidae (O'Brien and Wilson, 1985). The Delphacidae is the largest family of Planthoppers belonging to the super family Fulgoroidea of the order Hemiptera. The 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. The 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 oryzae* (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.,

Rice is the staple food for more than sixty per cent of the world's population and the total area under rice cultivation in India is 44.6 million hectares with a production of 90 million tonnes (Ghule *et al.*, 2008). It constitutes 52 per cent of total food grain production and 55 per cent of total cereal production (Saxena and Singh, 2003). In Andhra Pradesh, rice is grown in an area of 3.94 million hectares, with a production of 13.22 million tonnes and productivity of 3.42 tonnes per hectare (Directorate of Economics and Statistics, 2008). The overall loss due to insect pest damage in rice is estimated at 25% (Dhaliwal *et al.*, 2004). Maize is grown in an area of 7.86 lakh hectares, with a production of 8.21 lakh tonnes and productivity of 1.04 tonnes per hectare in Andhra Pradesh (Ministry of Agriculture Government of India, 2009).

Among various insect pests damaging rice, sap sucking insects *viz.*, leafhoppers and planthoppers constitute the main group. Brown planthopper, *Nilaparvata lugens* (Stal) (BPH) and White backed planthopper, *Sogatella furcifera* (Horvath) (WBPH) are very serious insect pests in several rice growing tracts of India (Krishnaiah *et al.*, 2004). Now-a-days brown planthopper has become a serious threat to rice production in Southern India. Jairaj *et al.* (1974) recorded 1.13 to 35.02 per cent reduction in grain weight on different varieties of paddy, due to the attack of BPH. The WBPH, *S. furcifera* is a serious pest of rice and under favourable conditions cause 35-95% yield loss (Siddhu, 1979).

Similarly the introduction of *Perkinsiella saccharicida* (Kirkaldy) resulted in 16 per cent reduction in total annual output of sugar in Hawaiian Islands (Wilson, 2005). Balikai *et al.* (2009) recorded 11.16 and 21.11 per cent reduction in sorghum grain and fodder yields, respectively due to the attack of *P. maidis*.

In the recent years there has been tremendous change in the status of several pests. Now-a-days using biological control programmes (parasites & predators), resistant plant varieties, pheromones, hormones and lethal genes are gaining importance. All these methods are highly specific and can only succeed if the identity of the pest or pests is accurately determined. Hence accurate identification of pest species affecting any crop is the first and foremost step for effective management of a particular pest. Melicher (1903) was the pioneer worker in the field of leaf and planthoppers. Distant (1906 & 1916) worked on the taxonomy of the Indian delphacidae. Mammen and Menon (1972) reported twenty nine new species of delphacids recorded for the first time from India. Asche and Wilson (1990) have redefined the genus *Sogatella* and related groups and provided a key to male planthoppers associated with rice ecosystem. Wilson and Claridge (1991) published comprehensive account of leafhoppers and planthoppers of rice in Asia.

The present taxonomic investigation was undertaken to study the economically important planthopper fauna (Fulgoroidea –Hemiptera) associated with rice, sugarcane, maize and sorghum crop-ecosystems of Andhra Pradesh with the following objectives.

1. Collection, identification and description of economically important planthopper fauna of Andhra Pradesh.
2. Preparation of taxonomic key for the identification of the collected planthopper species.

## CHAPTER - II

### REVIEW OF LITERATURE

The literature pertaining to the taxonomy of planthoppers (Fulgoroidea: Hemiptera) and their identification is very limited and scattered in many journals and monographs, published over many years in various languages in India and abroad. The broad objective of this chapter is to give a comprehensive account of the planthopper genera that were studied during the present investigations.

The planthoppers belong to the super family Fulgoroidea of Auchenorrhynchos-Hemiptera. Melichar (1903) was the pioneer worker in the field of oriental leaf and planthoppers. Distant (1906 and 1916) worked on the taxonomy of Indian Delphacidae and described 15 genera including 34 species. Distant (1908 and 1918) made more extensive study and monographed his work in 'Rhynchota' the Fauna of British India. Muir (1921) made several nomenclature changes and synonymised many genera and species erected by Distant.

Ishihara and Lowe (1969) reported *Nilaparvata lugens* (Stal), *Sogatella furcifera* (Horvath), *Unkanodes sapparonus* Matsumura, *Sardia rostrata* Melichar, *Nisia atrovenosa* Lethierry and *Eponisia guttula* Matsumura from different rice growing states in India.

Mammen and Menon (1972) for the first time in India reported 29 new species of delphacids. Mammen and Menon (1974) studied 44 species of delphacids and gave a key for separation of 25 genera of Indian delphacids.



The morphology, biology, behavior and control of four important leafhoppers viz., *Nephotettix virescens* (Distant), *Nephotettix nigropictus* (Stal), *Kolla mimica* Distant, *Typhlocyba maculifrons* Motsch and two planthoppers viz., *Sogatella furcifera* (Horvath) and *Nilaparvata lugens* (Stal) were studied by Misra (1980). The description of different immature stages, data on seasonal prevalence and abundance, fecundity, population density in relation with temperature and humidity under field conditions were also studied.

Akingbohungebe (1983) reported 27 species of planthoppers and leafhoppers on different crop plants in Nigeria. Among these five were planthoppers viz., *Hilda undata* Walker (Tettigometridae) on citrus and cotton, *Nycheuma idas* Fennah (Delphacidae); *Sogatella kolophon* (Kirkaldy) (Delphacidae) and *Sogatella cubanus* Crawford (Delphacidae) on cotton and *Perigrinus maidis* Ashmead (Delphacidae) on maize.

Chung-Lin (1983) reported 67 species of leafhoppers and 22 species of planthoppers on rice in China. The commonest planthoppers reported by him were *N. lugens*, *N. bakeri* Muir *S. furcifera* (Horvath), *S. longifurcifera* (Esaki and Ishihara) *Laodelphax striatellus* (Fallen), *U. sapporona*, *Toya propinqua* (Fiber), *Saccharosydne procerus* Matsumura and *Tropidocephala brunneipennisa* Signoret.

Ding *et al.* (1983) studied 25 delphacid species in two tribes and provided key for separation of nymphs based on the two median keels on the frons and arrangement of sensory pits on the frons, thorax and abdomen. *Perkinsiella saccharida*, *Laodelphax striatella* and *N. lugens* were among the species included in the key.

The commonly occurring Auchenorrhynchan rice fauna from India includes *N. lugens*, *S. furcifera*, *N. virescens*, *N. nigropictus*, *Recilia dorsalis*, *Cofona (Cicadella) spectra*, *C. unimaculata (Kolla mimica)*, *Nisia atrovenosa*, *Emposcanara indica*, *U. sapporonus* and *Laodelphax striatellus*. Among these three planthoppers were widely distributed in India in all rice growing states viz., Brown Planthopper (BPH), *N. lugens*; white backed planthopper (WBPH) *S. furcifera* and white winged planthopper, *Nisia atrovenosa* Lethierry. Further, other planthopper species viz., *U. sapporouns* Matsumura from Orissa, the small brown planthoppers, *L. striatellus* from Punjab and the sugarcane leaf hopper, *P. perpusilla* on rice from Uttar Pradesh were also reported (Kalode, 1983).

Otake (1983) studied four delphacids viz., *Laodelphax striatellus* (Fallen), *Muellerianella fairmairei* (Perris), *Unkanodes albifascia* (Matsumura) and *N. lugens* as virus vectors and their vector virus-relationships from Japan.

Wilson (1983) studied, described and provided an illustrated key for identification of nymphal stages of planthoppers and leafhoppers commonly associated with rice in Asia to separate sexes and to distinguish common species at the fifth instar stage. Among them, important planthoppers studied were, *Nisia nervosa* (Motsah) (Meenoplidae), *N. lugens* (Delphacidae), *S. furcifera* (Delphacidae), *Sogatodes pusanus* (Distant) (Delphacidae) and *L. striatellus* (Delphacidae).

A comprehensive account of planthopper systematics, their external morphology and an illustrated key to the 20 planthopper families was provided by O'Brien and Wilson (1985).

An annotated list of 78 species of Auchenorrhyncha associated with rice in major rice growing regions of the world was provided by Wilson and Claridge (1985). They discussed geographical, seasonal distribution, migration and host plant specificity of Auchenorrhyncha.

Ahmed and Yunus (1986) conducted a survey of insects on grasses around Karachi, Pakistan in February to April 1983; and found twelve species of planthoppers (Delphacidae, Cixiidae and Flatidae) accounting for 10.22% of all insects collected. They reported *Toya propinqua* (Fieber) as the most common planthopper.

Wilson (1987) reviewed the leafhopper, planthopper, treehopper and Cicada species (Homoptera: Auchenorrhyncha) associated with palms (coconut, oil palm and dates). The planthoppers belonging to nine Fulgorid families were reported on palms. They are *Ormenaria rufifascia* (Walker) (Flatidae) on *Sabal palmelto* and *Latanaria lantaroides*; *Psenoflata brevis* Van Duzee (Flatidae), *Nesodryas antiope* Fennah (Delphacidae), *Sogatodes cubanus* Crawford (Delphacidae), *Sogatella kolophon* Kirkaldy (Delphacidae), *Kallitaxila apicalis* (Melichar) (Tropiduchidae) and *Tambinia verticalis* Distant (Tropiduchidae) on coconut; *Athestia chariclo* Fennah (Tropiduchidae) on *Chamaedorea* sp.; *Ommatissus binotatus* Fieber (Tropiduchidae) and *O. binotatus* Fieber (Tropiduchidae) on *Chamaerops humilis*; *Ommatissus binotatus* var *lybicus* de Bergevin (Tropiduchidae) on datepalm; *O. tumidulus* Linnovouri (Tropiduchidae) on *Phoenix* sp.; *Asarcopus palmarum* Horvath (Issidae) on datepalm; *Colpoptera elevens* Walker (Issidae), *Zophium lobulata* Ghauri (Lophopidae), *Painella simmondsi* (Lophopidae) and *Virgilia luzonensis* Muir (Lophopidae) on coconut;

*Synedoche helenae* (Van Duzee) (Achilidae) on *Washingtonia filifera*; *Myndus crudus* Van Duzee (Cixiidae) on coconut and other palms; *M. taffini* Bonfils (Cixiidae), *Proutista moesta* (West wood) (Derbidae) and *Cedusa inflata* (Derbidae) on coconut; *Recania speculum* Walker (Ricaniidae) on oil-palm and *Pochazia fasciata* (Fab.) (Ricaniidae) on oil-palm and coconut.

Wilson and O ' Brien (1987) reported 150 fulgorid species in 16 families viz., Acanaloniidae, Cixiidae, Delphacidae, Derbidae, Dictyopharidae, Eurybrachidae, Flatidae, Fulgoridae, Hypochthonellidae, Issidae, Lophopidae, Menoplidae, Nogodinidae, Ricaniidae, Tettigometridae and Tropiduchidae and listed as pests of 99 economically important plants.

Kaldandelen (1988) discussed the taxonomy and provided the keys for separation of four species in genus *Cixius* and five species in genus *Tachy* (Cixiidae) found in Turkey.

Asche and Wilson (1989a) revised the genus *Tarophagus* and recognized three species viz., *T. colocasia* (Matsamura), *T. persephone* (Kirkaldy) and *T. proserpine* (Kirkaldy) and these were separated by the male and female genitalia.

Asche and Wilson (1989b) described the genus *Ommatissus* (Tribe: Trypetimorphini) and its two subgenera and eleven species. They also provided a key for separation of these genera and all the known species of *Ommatissus*. *O. lybicus* formerly regarded as a variety of *O. binotatus* is raised to full species status.

Wilson and Claridge (1991) provided diagnosis, distribution and illustrations for the identification of *Cemus* sp., *T. pusanus*, *T. oryzicolous* (Muir), *T. cubanus* (Crowford), *Harmalia anacharsis* Fennah, *Terthron albovittatum* Matsumura, *S. rostrata* Melihar, *T. propinqua* and *N. nervosa*.

Two species of *Pelitropis rotulata* and *Tangia breviceps* comb. Nov. (moved from *Neurotmeta*) was reported by O'Brien (1992) from U.S.A and a key was also provided to distinguish the Tropiciduchid species of USA.

Wilson *et al.* (1993) surveyed the planthopper fauna of Missouri tall grass prairie during 1986-1990. They collected 47 species representing 22 genera and 7 families and reported one species of Achilidae, 5 species of Cixiidae, 27 species of Delphaciade, 2 species of Derbidae, 5 species of Dictyopharidae, one species of Fulgoridae and 7 species of Issidae.

Fatima *et al.* (1996) conducted a survey to determine the abundance of leafhoppers and planthoppers on different crops like rice, wheat, maize and grasses in Sindhu, Pakistan. The results showed that among planthoppers, *T. propinqua* and *S. furcifera* and among leafhoppers *Exitianus* sp. and *Chiasmus* sp. were the dominant species.

The planthoppers associated with rice were revised by Gunathilagaraj (1999) and reported 10 species viz., *N. lugens*, *N. bakeri*, *S. furcifera*, *S. vibix*, *T. pusanus*, *L. striatellus*, *U. sapporonus*, *Eudellana celadon* Fennah, *N. nervosa* and *P. perpusilla* in India. He also provided synonyms, distribution, host plants, symptoms of damage, factors responsible for losses, biology and management for major pests viz., *N. lugens* and *S. furcifera*. The small brown plant hopper *L. striatellus* and sugarcane leaf hopper *Pyrilla perpusilla* were reported as occasional pests.

The New Zealand Cixiidae fauna was reviewed by Larivieri (1999) and illustrated 11 genera and 25 species along with identification key.

### **2.1 GENUS, CEMUS FENNAH**

Wilson and Claridge (1991) studied *Cemus* sp and provided diagnosis, distribution and illustrations for identification. Bonfils (1993) described two new species viz., *Cemus quilicii* and *Thriambus reynaudi* from *Pennisetum clandestinum* and sugarcane respectively. Narayana *et al.*, (2005) reported *Cemus* sp. for the first time on rice from Andhra Pradesh and provided identification key. Rao and Chalam (2007) reported *Cemus* sp. from rice eco-systems of South India. Shashank (2009) reported *Cemus* sp. associated with different rice eco-systems of Karnataka and provided key for identification.

### **2.2 GENUS, CORONACELLA METCALF**

Wilson and Claridge (1991) described genus *Coronacella* and provided the key for identification of *Coronacella sinhalana* (Kirkaldy). Rao and Chalam (2007) reported *C. sinhalana* sp. for the first time in India from different rice eco-systems of Karnataka and provided key for identification.

### **2.3 GENUS, EUIDELLA METCALF**

Rao and Chalam (2007) reported *Euidella* sp. for the first time in India from different rice eco-systems of Karnataka and provided key for identification.

## 2.4 GENUS, HARMALIA FENNAH

Wilson and Claridge (1991) described *Harmalia* and provided the key for identification of *Harmalia anacharsis*. Narayana *et al.*, (2005) reported *H. anacharsia* for the first time from Andhra Pradesh and provided identification key. Rao and Chalam (2007) reported *Harmalia* sp. from different rice eco-systems of South India.

## 2.5 GENUS, NILAPARVATA DISTANT

Okada (1977) reported 14 species under this genus which were recorded from tropical and temperate zones throughout the world. Out of 14 species under this genus *Nilaparvata*, he described 7 species *viz.*, *N. lugens*, *N. albostrigata*, *N. bakeri*, *N. muii*, *N. myersi* (Muir), *N. seminula* (Melichar) and *Nilaparvata* sp. He provided a key for identification of six *Nilaparvata* species of Asia and Pacific region. They are *viz.*, *N. bakeri*, *N. albostrigata*, *N. muii*, *N. myerisi*, *N. lugens* and one unknown species in the genus.

Mochida and Okada (1979) reported that there are fourteen determined and two undetermined species as members of the genus *Nilaparvata* so far in the world. Wilson and Claridge (1991) described *Nilaparvata* on the basis of the possession of small spines on the first tarsal segments of the hind leg and also provided the key for identification of male and females of *N. lugens*, *N. bakeri*, and *N. muii*.

Narayana *et al.* (2005) reported *N. lugens* (Stal) associated with different rice eco-systems from Andhra Pradesh. An illustrated key is provided to identify 10 known planthoppers from Andhra Pradesh. Rao and Chalam (2007) reported

that species belonging to *Nilaparvata* were predominantly found in association with rice ecosystem of South India. They also provided key for identifying the species.

Suri *et al.* (2008) studied for taxonomic and genetic variability of brown planthoppers which were collected from rice fields of Nellore, Bapatla, Warangal, Maruteru and Srikakulam. The male genital structures of brown and black forms of planthoppers were studied and collected planthopper specimens were further subjected to molecular analysis for their genomic DNA by using Random amplified Polymeric DNA Polymeric Chain Reaction (RAPD-PCR) technique and also in DNA fingerprinting method. They found no variation in male genital structures and reported colour variants in brown planthopper *N. lugens* (Stal) and ruled out the presence of different species or subspecies or biotypes in five geographical regions of Andhra Pradesh. Shashank (2009) reported *N. lugens* (Stal) associated with different rice eco-systems of Karnataka and provided key for identification.

## **2.6 GENUS, NISIA MELICHAR**

Shun-Cheran-Tsaur (1989) described two new species of *Nisia* (Meenoplidae) and provided keys to Taiwanese *Nisia* and *Eponisia* species.

Wilson and Claridge (1991) studied *N. nervosa* and provided diagnosis, distribution and also key for identification.

Narayana *et al.* (2005) reported *N. nervosa* from different rice ecosystems of Andhra Pradesh. Shashank (2009) reported *N. nervosa* associated with different rice eco-systems of Karnataka and provided key for identification.



## **2.7 GENUS, OLIARUS STAL**

Mead and Kramer (1982) revised the *Oliarus* species in North America (North of Mexico) and recognized 51 species. Over 20 *Oliarus* species have been recorded from Central and South America and from Galapagos Islands.

Tsaur *et al.* (1988) revised the Cixiidae of Taiwan. They described four new species of *Oliarus* and proposed one new combination. They also provided a key to the two species of *Oliarus*. Stalle and Stalle (1989) studied the three species of the genus *Oliarus* from Papua New Guinea and Mysol and also described and illustrated five new species of *Oliarus* from Paw paws.

The Oriental *Pentastirini* (Cixiidae) was revised by Stalle and Stalle (1991) and they described 25 new species. A key was also provided to the species including *Oliarus caudatus* and *O. morobensis*. Wilson *et al.* (1994) reported only one species of Cixiid, (*Oliarus*) *Pentastiridius apicalis* (Uhler) on rice. Bourgoin *et al.* (1998) described two new species of *Oliarus viz.*, *O. oryzicola* from Peru and *O. kindli* from French Guiana. They also studied the biology of *O. oryzicola* on rice. Lakshminarayana *et al.* (2003) reported *Oliarus* sp. (Cixiidae) for the first time from rice-ecosystems of Andhra Pradesh, India. The brief male genitalia descriptions and diagnosis of this species was given.

## **2.8 GENUS, PEREGRINUS (ASHMEAD)**

The genus *Peregrinus* (Ashmead) was studied and reviewed briefly by Wilson and Claridge (1991). Rao and Chalam (2007) reported *P. maidis* associated with rice and sugarcane ecosystems and a key for the identification of South Indian Delphacidae was also provided.

## 2.9 GENUS, PERKINSIELLA KIRKALDY

The genus *Perkinsiella* Kirkaldy was studied and reviewed briefly by Wilson and Claridge (1991). Rao and Chalam (2007) reported *P. sinensis* for the first time in India from different rice eco-systems of South India.

## 2.10 GENUS, PYRILLA STAL

Distant (1906) described three species of *Pyrilla* viz., *lycoides* (Walk), *aberrans* (Kby) and *perpusilla* (Walk). Distant 1906 and 1916 described the Indian forms of *Pyrilla* in the Fauna of British India-Homoptera, vols. 3 and 6. He reported three species of *Pyrilla* viz., *P. aberrans*, *P. perpusilla* and *P. pusana*

Pruthi (1937) reviewed the Indian species *P. aberrans*, *P. perpusilla* and *P. pusana* and found no evidence of the occurrence of *P. aberrans* in India. He also recognized that *P. perpusilla* and *P. pusana* may be conspecific but the relationship was unsettled because of insufficient knowledge on *P. perpusilla*.

Qadri and Aziz (1943) studied the Indian species of sugarcane leafhopper *P. perpusilla* Walker. They described external morphology and various distinguishing features of well distributed Indian species of *Pyrilla* viz., *P. perpusilla* Walker, *P. pusana* Distant and *P. aberrans* Kirby.

Based on morphology and breeding experiments conducted in the laboratory and also observation made in the field it has been concluded that there is only one typical species in existence, viz., *P. perpusilla*. The other two so called species viz., *aberrans* and *pusana* are being only seasonal colour variation or phases and it was reported three Indian forms viz., 1. Winter-spring– summer from – *Pyrilla perpusilla* Walker; 2. Monsoon-autumn form -*P. perpusilla* var. *aberrans*

Kirby and 3. Autumn- winter form-*P. perpusilla* var . *pusana* Distant (Mukerji and Prasad 1954). Fennah (1963a) reviewed the species of the genus *Pyrilla* found in India and Ceylone on the basis of population samples from different localities. He described 10 geographical sub-species of *P. perpusilla* viz., *perpusilla*, *pusana*, *coimbatorensis*, *chikkarallapurana*, *thekkadiana*, *naraikkaduana*, *bhimbami*, *pirmedana*, *lycoides* and *singhalensis* and 5 sub-species under *P. aberrans* viz., *aberrans*, *palghati*, *consors*, and *achates*. He also reported that *P. perpusilla* was wide spread in India, Ceylone, Thailand and *P. aberrans* previously confined to Ceylone but also found to occur in South India.

Sukhani (1971) reported the breeding and egg laying of *P. perpusilla* on paddy during September – October, 1970. Garg and Sethi (1983) reported the incidence of *P. perpusilla* on paddy crop and found that moderate temperature, adequate relative humidity, dry spells coupled with cloudy days together with the total absence or traces of rainfall which prevailed during kharif are the most conducive climatic conditions and were responsible for highest incidence on kharif rice.

Prasad (1992) collected *P. perpusilla* from sugarcane at several locations in Haryana, Bihar and Uttar Pradesh in India. The morphology of forms in different areas of India was described. The rainy season form viz., *Pyrilla perpusilla* var. *negriventris* nov. a new form was proposed. Liang and Liang (1996) reported the occurrence of *P. perpusilla* on rice for the first time from Southern China.

Mustaque and Akbar (1998) reported 5 species of *Pyrilla* from different localities of Pakistan. They were *P. punjabensis* sp. nov. from sugarcane, maize and grasses and *P. rahimyarnesis* sp. nov. from sugarcane, rice and maize in

Punjab, *P. pusana* mainly on rice, but some specimens were also collected from sugarcane, millets and maize, *P. perpusilla* on sugarcane and millets and *P. aberrans* was found on sugarcane, lucerne, rice, maize and sorghum. A key to these species was provided and the phonetics affinities of these species were discussed.

Lakshminarayana *et al.* (2003) reported *P. pusana* (Lophopidae) for the first time from rice-ecosystems of Andhra Pradesh, India. The brief male genitalia description and diagnosis of these species was given.

## **2.11 GENUS, SARDIA MELICHAR**

Wilson and Claridge (1991) studied *S. rostrata* Melichar and provided diagnosis, distribution and key for identification.

Shakila (1997) described five species of genus *Sardia*. Of these, four species, *Sardia balakotiensis* sp. nov., *Sardia campusii* sp. nov., *Sardia sialkotensis* sp. nov. and *Sardia gilgitensis* sp. nov. are treated as new, while *Sardia rostrata* is treated as a new record from Pakistan. A key to Pakistani species of genus *Sardia* has also been prepared to accommodate all the species recorded from Pakistan.

Narayana *et al.* (2005) reported *S. rostrata* from Andhra Pradesh and provided key for identification. Rao and Chalam (2007) reported *Sardia* sp. from rice ecosystems of South India. Shashank (2009) reported *S. rostrata* associated with different rice eco-systems of Karnataka and provided key for identification.

## 2.12 GENUS, SOGATELLA FENNAH

Horvath (1899) first described the species *furcifera* under *Delphax* on the basis of male specimens collected from Japan. Fennah (1963b) subsequently changed the genus name *Delphax* to *Sogatella* and he also described and provided a key for the separation of sixteen species in this group viz., *Sogatella furcifera*, *S. vibix*, *S. longifurcifera*, *S. catopteran*, *S. nigrigenis*, *S. capensis*, *S. kolophon*, *S. nigriensis*, *S. derelicta*, *S. colorata*, *S. balteata*, *S. gemina*, *S. mehetho*, *S. nebris*, *S. petax* and *S. camptistylis*. Uhm *et al.*, (1982) described species specific difference in both males and females of *S. furcifera*, *S. vibix* and *S. kolophon*.

Asche and Wilson (1990) have redefined the genus *Sogatella* and related groups and provided a key to males of the 14 included species. According to them *Sogatella* species are found throughout the subtropical and tropical regions of the world. A key is provided to distinguish the four genera viz., *Sogatella*, *Tagosodes*, *Latistria* and *Sogatellana*. A check list of specimens in each genus was also given.

Narayana *et al.* (2005) reported two species viz., *S. kolophon*, and *S. vibix* associated with different rice ecosystems for the first time from Andhra Pradesh. An illustrated key is provided to identify 10 known planthoppers from Andhra Pradesh. Rao and Chalam (2007) reported the dominance of *Sogatella* over *Nilaparvata* in rice ecosystem of South India and they provided key for the separation of *S. furcifera*, *S. kolophon* and *S. vibix*.

Suri *et al.* (2008) studied for taxonomic and genetic variability of White backed planthoppers which were collected from rice fields of Nellore, Bapatla, Warangal, Maruteru and Srikakulam. The male genital structures of White backed planthoppers were studied and collected planthopper specimens were further subjected to molecular analysis for their genomic DNA by using Random amplified Polymeric DNA Polymeric Chain Reaction (RAPD-PCR) technique and also in DNA fingerprinting method. They found no variation in male genital structures and reported non-significant minor differences in the DNA fingerprinting of White backed planthopper *S. furcifera*. They ruled out the presence of biotypes in five geographical regions of Andhra Pradesh.

Shashank (2009) reported *S. furcifera* associated with different rice eco-systems of Karnataka and provided key for identification.

### **2.13 GENUS, TAGOSODES ASCHE & WILSON**

The genus *Tagosodes* was described to accommodate the majority of the species in the genus *Sogatodes*, now synonymised with *Sogatella* and the species *T. cubanus*, *T. orizicolus* and *T. pusanus* were studied and reviewed briefly by Wilson and Claridge (1991).

Narayana *et al.* (2005) reported *Tagosodes pusanus* for the first time from Andhra Pradesh and provided identification key. Rao and Chalam (2007) reported *T. pusanus* from different rice eco-systems of South India. Shashank (2009) reported *T. pusanus* associated with different rice eco-systems of Karnataka and provided key for identification.

## **2.14 GENUS, TERTHRON FENNAH**

The genus *Terthron* Fennah was studied and reviewed briefly and also a key for identification of *Terthron albovittatum* was provided by Wilson and Claridge (1991).

Narayana *et al.* (2005) reported *T. albovittatum* for the first time from Andhra Pradesh and provided identification key. Rao and Chalam (2007) reported *T. albovittatum* from different rice eco-systems of South India and provided identification key.

## **2.15 GENUS, TOYA DISTANT**

Wilson and Claridge (1991) described *Toya* on the basis of vertex and coloration of carinae and also provided the key for identification of *Toya propinqua*.

Narayana *et al.* (2005) reported *T. propinqua* for the first time from Andhra Pradesh and provided identification key. Rao and Chalam (2007) reported *T. propinqua* and *T. bridwelli* for the first time in India from different rice eco-systems and provided identification key.

## **2.16 GENUS, TROPIDOCEPHALA STAL**

Rao and Chalam (2007) reported *Tropidocephala* sp. and *Tropidocephala serendiba* (Melichar) for the first time in India from different rice eco-systems and provided a key for identification.

## CHAPTER - III

### MATERIALS AND METHODS

The present investigation on “Taxonomic studies on planthopper fauna (Fulgoroidea: Hemiptera) of Andhra Pradesh” was conducted at Agricultural College, Bapatla, Guntur district during 2009-2010. The details of materials used and methods employed during the present investigation are given in this chapter.

#### 3.1 SOURCES OF MATERIAL STUDIED

Planthopper specimens were collected from different Agro-climatic zones of Andhra Pradesh by sweep netting in rice, sugarcane, maize and sorghum crop ecosystems apart from grass and light attracted insects (Fig.1 & Table.1).

**Table1: Districts surveyed for collection of planthopper fauna of Andhra Pradesh**

SI. NO	District	Places visited
1.	Srikakulam	1. Ragolu 2. Naira 3. Narasannapeta 4. Gara
2.	Vizianagram	5. P. S. puram 6. Vasadi 7. Jami
3.	Vishakapatnam	8. Anakapalli 9. Sitanagram
4.	West Godavari	10. Polla 11. Bhimadolu



		12. Maruteru
5.	East Godavari	13. Ravulapalem
6.	Krishna	14. Gudivada
7.	Guntur	15. Bapatla
		16. Ponnur
		17. Lam
8.	Nellore	18. Nellore
		19. Kavali
9.	Prakasam	20. Darsi
		21. Kandukuru
10.	Khammam	22. Madira
11.	Kurnool	23. Nandyal
		24. Konejedu
		25. Sarvaipalli
12.	Chittoore	26. Tirupathi
13.	Cuddapha	27. Badvel
14.	Adilabad	28. Ichhada
15.	Hyderabad	29. Rajendranagar
16.	Rangareddy	30. Tandur

## **3.2 METHODS OF STUDY**

### **3.2.1 Collection, Killing, Drying and Preservation of the Specimens**

Planthoppers were collected by sweep netting with the help of an insect collection net and trapped in aspirator. The killed specimens were dried in hot air oven at 45-50<sup>0</sup>C for about 4 to 5 hours. The dried specimens were preserved in glass vials and labelled carefully. A narrow strip of filter paper with its tip dipped in formaldehyde was placed in each vial, held hanging with the cork not touching the specimens to prevent the fungal infection during long storage.

### 3.2.2 Processing of Material for Study

The procedure advocated by Knight (1965) was followed for mounting and preparation of genitalia for planthoppers.

#### A. Mounting of specimens

Planthoppers were mounted on white triangular thick paper points on the right hand side of the thorax by using the gum prepared by diluting quick fix in amyl acetate. This facilitates the examination of head, wings, legs and abdomen from all desired angles on which identification was based and also useful for easy detaching of the abdomen for the study of male genitalia. The label with information regarding host plant, locality, date of collection and name of the collector was transfixed to each specimen. The sex of the respective specimen was indicated on the right side of the label by using standard notations '♀' for female and '♂' for male.

#### B. Preparation of male genitalia

To study the male genitalia, the specimen was gently supported on a cork piece on its back and the abdomen was removed from the thorax with the help of sharp needle by pressing down at the junction of the thorax and abdomen. The detached abdomen was transferred into a cavity dish containing few milliliters of 10 per cent potassium hydroxide and kept for overnight at room temperature. Abdomen was then transferred to another small petridish containing water. The digested soft tissues or internal body contents were pressed out by means of a pair of fine needles or forceps. Then the abdomen is rinsed twice or thrice in water to remove the potassium hydroxide remnants.

The abdomen was then transferred to a glycerin drop on the glass slide. The treatment renders the entire abdomen completely transparent which was sufficient in many cases to permit the study of genitalia. The male genitalia was dissected out under Binocular Stereo Zoom Microscope following the technique given by Knight (1965) for detailed examination and for illustrations. After the identification and illustrations, the dissected parts of genitalia were placed inside the abdomen, which was finally stored in a micro vial in a drop of glycerin. The vial was stoppered with a cork and transfixed to the same pin, which was holding the rest of the specimen.

### **3.2.3 Illustrations**

Illustrations of genital parts were made by keeping genitalia in position by applying a very small quantity of fevi stick gum at the bottom of the cavity slide before placing a glycerin drop on it. The genital structures were gently pressed after arranging them in desired orientation. The dissected male genital structures were further studied in detail with Olympus Trinocular Research Microscope and illustrations were made with the same microscope using drawing apparatus. Using DPX mountant, wing mounts were prepared for studying wing venation, and all drawings were made with pencil and inked later. The scales of magnification were indicated on right side of the paper which equals to 0.001/0.0025 mm and indicated at right hand side of particular structure.

### **3.2.4 Measurements**

Measurements of the specimens were made by standardized ocular micrometer placed in one eyepiece of the stereoscopic binocular microscope. The

measurements of width of the planthopper were taken across the compound eyes. The total length of the planthopper including the folded forewings was also taken.

### **3.2.5 General structure of planthopper and terminology adopted**

For describing the different body parts the terminology suggested by O'Brien and Wilson (1985) was followed.

#### **3.2.5. 1 Head**

Head in dorsal aspect consists of vertex with eyes located at laterad of it. Most fulgorids have no strong demarcation of the anterior margin of the vertex which is continuous with frons. The frons is bordered laterally by carinae and is separated from the clypeus by the frontoclypeal suture. The frons may bear a median ocellus in those planthoppers that have three ocelli. A longitudinal carina (median carina) or a pair of carinae (inner carinae) may also be present on the frons. All planthoppers bear rows of pits on the frons. The region between the lateral border of the frons and the compound eye is referred as gena, it contains a lateral ocellus. The clypeus consists of a proximal postclypeus and distal anteclypeus which is separated by partial transclypeal suture. The labrum is a small piece distal to the anteclypeus. The beak is three segmented; visible externally are three segments of the labium. The first labial segment is partially obscured by the overlapping anteclypeus. The apex of the labium bears numerous sensilla. In almost all planthoppers the compound eyes are large. The antennae are situated ventral to the compound eyes and surrounded by an

anterior cup-like extension of the gena and the lateral carina of the frons. Each antenna consists of three segments; a basal ring-like scape, an elongated cylindrical pedicel, and a whip-like flagellum. The pedicel bears ring-like sensoria. The head may be variously modified. The cephalic extension is due to the elongation of the vertex and frons or may be an extension of the frons and clypeus. In some, the genae may have lateral shelf-like extensions beneath the antennae.

#### **3.2.5.2 Thorax**

The thorax is composed of three segments, the pro, meso and meta thorax and bears two pairs of wings and three pairs of legs. The pronotum is generally collar-like and extends laterally overlapping the reduced plural sclerites. Pronotum bears dorsal longitudinal carinae and one or two pairs of variously shaped lateral longitudinal carinae. Mesonotum in its dorsal view is subpentagonal with a posteriorly directed triangular scutellum. A median longitudinal carina and one or two pairs of lateral carinae may also be present. The metanotum is obscured by the overlapping mesonotum and wings.

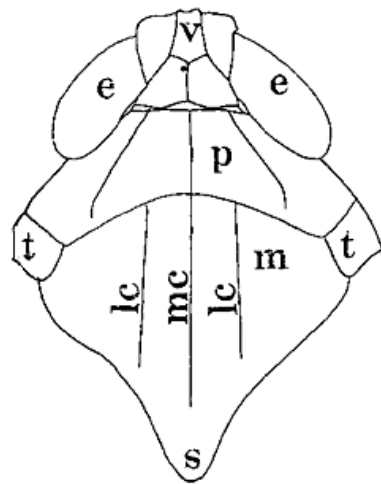
#### **3.2.5.3 Wings**

The fore wings bear a pad-like tegula at the base. In delphacids venation is reduced to some extent. Major features in wing venation are whether the claval suture extends to the wing margin or ends before the wing margin and whether or not the apices of the fore wings overlap. The veins in wings include Cubitus (Cu), Media (M), Radial sector (R-Sc) and the Costa which arises before the basal cell.

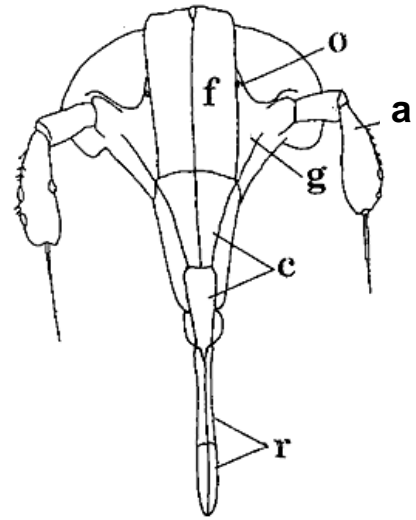
If the Costa (C) is not marginal, there is a precostal area. A nodal line connects the stigma with the apex of the claval suture. This is the line of flexure for the apical part of the wing. The hind wings are entirely covered by the forewings and the venation is generally reduced and usually hyaline.

#### 3.2.5.4 **Legs**

The typical planthopper leg consists of five segments *viz.*, coxa, trochanter, femur, tibia and tarsus. The pro- and mesocoxae are subcylindrical with the widely spaced mesocoxae closer to the procoxae than the metacoxae. The trochanters of the pro- and mesothoracic legs are small and subcylindrical, the metathoracic legs are relatively larger, cup-like, and may bear medially facing teeth. The metathoracic femora are elongate relative to the pro- and mesothoracic femora. The foretibia and midtibia are generally slender although some may be foliaceous and armed with spines. The metathoracic tibia may bear one to several teeth on the lateral aspect of the shaft and a row of teeth at the apex. The members of the family Delphacidae are characterized by the presence of a moveable spur at the apex of both hind tibiae. The spur varies with shape from slender spike-like structure that lacks teeth to a flattened curved foliaceous structure with a row of small teeth on the lateral edge. The tarsi of all legs are divided into three tarsomeres. The first and second tarsomeres of the pro and mesotarsi are reduced and may be wedge-shaped. The first and second tarsomeres of the metatarsi are cylindrical; the second may bear an apical transverse row of spines. The third tarsomeres of all legs are subcylindrical and curved and bear a pair of apical claws and a median arolium.



a



b



c



d



e

**Figs.2a-e. General body structures of planthoppers**

**Fig.a & b** *Nilaparvata lugens* (Stal) (from Okada, 1977)

a. Head and Thorax, dorsal view;

v. vertex, e. eye, p. pronotum, t. tegula, m. mesonotum, s. mesoscutellum, mc. median carina, lc. lateral carinae.

b. Face

f. frons, o. ocellus, a. antenna, g. gena, c. clypeus, r. rostrum

**Figs.c-e.** Hind leg- tibia and tarsus (from Wilson and Claridge, 1991)

c) *Nilaparvata lugens* (Stal)

d) *Pyrrilla perpusilla pusana* (Disatant)

e) *Nisia nervosa* Motschulsky

### 3.2.5.5 Abdomen

The abdomen is elongate and subcylindrical, dorsoventrally or laterally flattened. Abdomen consists of 11 visible segments. Tergite 1 is reduced, 2 to 8 tergites are generally subrectangular and extended ventrolaterally, and the ninth segment forms a partial or complete capsule termed as pygofer. Tergite 10 forms the anal tube that often bears spines, and the 11<sup>th</sup> is represented by the anal style. Anal tube and anal style serve as a dorsal cover for the genitalia. The anal tube is usually movable but may be fused to the pygofer. The male genitalia proved to be authentic diagnostic features useful for the identification of species. The pygofer forms a capsule that has other parts of male genitalia.

The aedeagus is a sclerotised tube bearing an apical or subapical gonopore. It may bear a number of teeth or spines. The styles are moveable, paired often plate like structures, which may bear spines or hooks. The styles are greatly enlarged and seal off the genital chamber. The styles are attached to the aedeagus by a 'Y' or 'T' shaped movable connective. Another ring-like connective extends from the base of the anal tube and surrounds the base of the aedeagus in Delphacidae. Relative to the structures of the male genitalia, those of the female have been little used in planthopper taxonomy





**Fig. 1 :** Map showing the areas surveyed for collection of planthoppers fauna associated with different crop ecosystems in Andhra Pradesh

## CHAPTER-IV

### RESULTS

The planthopper specimens were collected from different Agro-climatic zones of Andhra Pradesh by sweep netting in rice, sugarcane, sorghum, maize and grassland eco-systems and were brought to the laboratory, processed and taxonomic characters studied. These planthoppers have been adequately described, illustrated and identified. The identification key to distinguish these specimens was prepared and given in this chapter.

#### **4.1 Planthopper species identified in different crop ecosystems.**

In the present study 19 planthopper species under 16 genera belonging to the families of Delphacidae, Cixiidae, Meenoplidae and Lophopidae were identified from different crop ecosystems of Andhra Pradesh, the list of which is provided here under.

Family: **Cixiidae**

1. *Oliarus* sp.

Family: **Delphacidae**

2. *Cemus* sp.
3. *Coronacella sinhalana* (Kirkaldy)
4. *Euidella* sp.
5. *Harmalia anacharsis* (Fennah)

6. *Nilaparvata lugens* (Stal)
7. *Peregrinus maidis* (Ashmead)
8. *Perkinsiella* sp.
9. *Perkinsiella sinensis* Kirkaldy
10. *Sardia rostrata* (Melichar)
11. *Sogatella furcifera* (Horvath)
12. *Sogatella kolophon* (Kirkaldy)
13. *Sogatella vibix* (Haupt)
14. *Tagosodes pusanus* (Distant)
15. *Terthron albovittatum* (Matsumura)
16. *Toya propinqua* (Fieber)
17. *Tropidocephala serendiba* (Melichar)

Family: **Lophopidae**

18. *Pyrilla perpusilla pusana* (Distant)

Family: **Meenoplidae**

19. *Nisia nervosa* (Motschulsky)

**Table 2: Biodiversity of planthopper fauna (Hemiptera: Fulgoroidea) of different crop-ecosystems in Andhra Pradesh.**

<b>Crop ecosystem</b>	<b>Name of the species</b>
<b>1. Rice</b>	<i>Nilaparvata lugens</i> (Stal)
	<i>Sogatella furcifera</i> (Horvath)
	<i>S. kolophon</i> (Kirkaldy)
	<i>S. vibix</i> (Haupt)
	<i>Cemus</i> sp.
	<i>Coronacella sinhalana</i> (Kirkaldy)
	<i>Euidella</i> sp.
	<i>Harmalia anacharsis</i> (Fennah)
	<i>Sardia rostrata</i> (Melichar)
	<i>Terthron albovittatum</i> (Matsumura)
	<i>Tagosodes pusanus</i> (Distant)
	<i>Oliarus</i> sp.
	<i>Nisia nervosa</i> (Motschulsky)
	<i>Toya propinqua</i> (Fieber)
<b>2. Sugarcane</b>	<i>Tropidocephala serendiba</i> (Melichar)
	<i>Pyrilla perpusilla pusana</i> (Distant)
	<i>Toya propinqua</i> (Fieber)
	<i>Tagosodes pusanus</i> (Distant)
	<i>Sogatella furcifera</i> (Horvath)
	<i>S. kolophon</i> (Kirkaldy)

### **3. Maize**

*Peregrinus maidis* (Ashmead)

*Perkinsiella* sp.

*Perkinsiella sinensis* Kirkaldy

### **4. Sorghum**

*Perkinsiella* sp.

*Perkinsiella sinensis* Kirkaldy

*Peregrinus maidis* (Ashmead)

## 4.2 KEY TO THE ECONOMICALLY IMPORTANT PLANTHOPPER FAUNA ASSOCIATED WITH RICE, SUGARCANE, MAIZE AND SORGHUM ECOSYSTEMS OF ANDHRA PRADESH

The key has been prepared to aid rapid and accurate identification of the common species of planthoppers in rice, sugarcane, maize and sorghum ecosystems of Andhra Pradesh. For those species which were not studied here, literature or a Taxonomist working on the planthoppers may be consulted.

1. Hind tibia with a movable apical spur (Delphacidae) (Fig. 2c) ---- 2
- Hind tibia without a movable apical spur (Figs. 2e & 2d)  
(Cixiidae, Meenoplidae, Lophopidae) ----- 17
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. 8a-d & Plate 3B) ----- ***Nilaparvata lugens* (Stal)**
- 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. 13a-d & Plate 6A)  
----- ***Sogatella furcifera* (Horvath)**

----- 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. 14a-d & Plate 6B)

----- ***Sogatella kolophon* (Kirkaldy)**

---- 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. 15a-d & Plate 7A)

----- ***Sogatella vibix* (Haupt)**

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. 17a-d & Plate 8A)

----- ***Terthron albovittatum* (Matsumura)**

---- 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. 16a-d & Plate 7B)

----- ***Tagosodes pusanus* (Distant)**

9. Aedeagus long, narrow and whip like, with subapical processes; light yellowish brown to yellow orange in colour, mesonotum with a pair of orange longitudinal bands between median and lateral carinae (Fig. 9a-d & Plate 5A) ----- ***Peregrinus maidis* (Ashmead)**
- Aedeagus not as above ----- 10
10. Anal tube process not shorter than its length; aedeagus tubular with a small sub apical spine and a pair of process medially; genital styles foot shaped (Fig. 11a-c & Plate 4B) ----- ***Perkinsiella sinensis* Kirkaldy**
- Anal tube process longer than its length; aedeagus elongated, curved with a pair of process subapically; genital styles broader basally and narrowed apically (Fig. 10a-d & Plate 4A) ----- ***Perkinsiella* sp.**
11. 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. 12a-d & Plate 5B)
- ***Sardia rostrata* (Melichar)**
- Vertex short, not so elongated ----- 12
12. Anal tube process absent, anal style elongated with sclerotised curved apex and also with sclerotised serrated processes arising inner side of style; aedeagal process sickle shaped arising from base of aedeagus (Fig. 19a-e & Plate 9A) ----- ***Tropidocephala serendiba* (Melichar)**
- Anal tube process present, genital styles without serrated processes ----- 13



13. 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. 4a-d & Plate 1B)

----- ***Cemus* sp.**

- Frons without conspicuously raised pits on either side of median carina; tegmina not granulate ----- 14

14. 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. 5a-d & Plate 2A)

----- ***Coronacella sinhalana* (Kirkaldy)**

- Vertex and mesonotum dark brown without characteristic cream coloured band on pronotum ----- 15

15. Aedeagus flattened, curved with a pair of long unequal subapical processes; genital style L- shaped (Fig. 6a-d & Plate 2B) ----- ***Euidella* sp.**

- Aedeagus and genital styles are not as above ----- 16

16. Aedeagus tubular with uniform width throughout and without any teeth; genital style bifurcated apically (Fig. 7a-d & Plate 3A)

----- ***Harmalia anacharsis* (Fennah)**

- Aedeagus tubular but not with uniform width, serrated subapically, below which slightly sinuated; diaphragm Y- shaped (Fig. 18a-d & Plate 8B)

----- ***Toya propinqua* (Fieber)**

17. 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. 21a-c & Plate 21A)

----- ***Nisia nervosa* (Motschulsky)**

- The claval vein of tegmina not granulate, median ocellus not pearl like--18
18. Vertex elongated, rectangular, length is more than twice the width at base; mesonotum with three carinae; conjunctival hook of phallus is very strongly developed, slightly twisted in the middle; aedeagus have a sinuation on the ventral aspect (Fig. 20a-f & Plate 9B)

----- ***Pyrilla perpusilla pusana* (Distant)**

- Vertex excavated, reddish brown in colour, mesonotum large with five carinae; aedeagus with processes (Fig. 3a-d & Plate 1A) ----- ***Oliarus* sp.**

## 4.3 DESCRIPTION OF DIFFERENT PLANTHOPPER SPECIES

### 4.3.1 *Oliarus* sp.

(Figs. (3a-d) & Plate 1A)

*Oliarus* sp. Wilson and Claridge, 1991: 48

*Oliarus* sp. Bourgoïn *et al.*, 1998: 100 (1)

#### **Colour**

Frons with intercarinal areas dark in colour. Posterior margin of pronotum and mesonotum medium to dark brown. Tegmina with black dots all along over the veins. Tegmina hyaline.

#### **External morphology**

Vertex longer at lateral margin than broad at level of anterior margin of eyes; posterior margin strongly notched, lateral margins elevated, median carina elevated. Frons with median carina prominent; intercarinal areas dark in colour, carinae tawny; basal fork of median carina short. Eyes fairly large; ocelli three in number, lateral ocelli situated between eye and lateral carina of the frons above the antennae, median ocellus is smaller than lateral ocelli and present on median carina in the middle of the frons. Rostrum surpassing metacoxa and is apically black in colour. Pronotum with intermediate carina attaining pale colour along posterior margin; medium to dark brown. Mesonotum with median carina prominent; lateral carinae weaker, diverging distally; medium to dark brown. Clypeus small, very much narrowed, the median carina of frons continued upto clypeus and labrum. Genae blackish in colour. Tegula paler. Tegmina hyaline, tubercles very short, concolorous with pale yellow veins; stigma pale brown. Legs yellowish, with 4 tibial spines; two small basal ones, and others longer. Hind

legs are longer than fore and middle legs, first tarsal segment is longer than the other two segments, apex of first two tarsal segments possess a row of short black spines.

### **Male genitalia**

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.

### **Measurements**

Length of macropterous male including forewings 6.11 (6.10-6.12) mm and width across the compound eyes is 1.63 (1.65-1.69) mm.

### **Specimens studied**

3 males, 2 females, Tirupati, rice, 29.IV.2010, K S H Brahma; 2 males, 1 female, Badvel, rice, 26.I.2010, K S H Brahma.

### 4.3.2 *Cemus* sp.

(Figs. (4a-d) & Plate 1B)

*Cemus* sp. Wilson and Claridge, 1991: 70

*Cemus* sp. Fennah, 1964: 116(7): 131-150

#### **Colour:**

Vertex, pronotum reddish black with cream coloured carinae. The forewings with blackish dots all along the veins and fuscous maculae apically.

#### **External morphology**

Vertex shorter submedially than broad at base, broadly and obtusely rounding into frons, lateral margins slightly concave, apical margin transverse with submedian carinae not prominent, Y-shaped carina distinct. The lateral carinae extending from the vertex, meeting in the middle of the frons in to a single median carina. Median carina forked at level of ocelli. Clypeus at base slightly wider than frons, postclypeal disc as long in middle as broad at base. Genae reddish black in colour with cream coloured pits. Antennae reaching apex of post-clypeus, basal segment longer than broad, second segment longer than first. Ocelli distinct, very close to anterior margin of gena. Tegmina with characteristic black dots along veins, fuscous streaks, apically with a distinct pterostigma. Pronotum with disc shorter in middle line than broad at anterior margin, lateral carina concave. Total length of mesonotum in macropterous form longer than that of scutellum. Fore and middle femora and tibiae a little compressed, foliately expanded. The hind legs with a leaf like mobile apical spur, 1<sup>st</sup> tarsal segment longer than 2<sup>nd</sup> and 3<sup>rd</sup> segments put together. Post-tibial spur with about 30 teeth.

## **Male genitalia**

Abdomen with anterior margin of seventh sternum obtusely but distinctly angulate at middle. Posterior margin of eighth sternum shallowly convex throughout, median portion flattened. 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. Genital styles broader basally, gradually narrowed apically with spines.

## **Measurements**

Length of macropterous male including forewings 4.22 (4.00-4.45) mm and width across the compound eyes 0.96 (0.80-1.11) mm.

## **Specimens studied**

4 males, 6 females, Narasannapeta, rice, 19.X.2009, K S H Brahma; 6 males, 8 females, Madira, rice, 12.XII.2009, K S H Brahma; 5 males, 6 females, Pentasrirampuram, rice, 22.X.2009, K S H Brahma; 2 males, 2 females, rice, 12.I.2010, K S H Brahma; 4 males, 5 females, Ravulapalem, rice, 7.X.2009, K S H Brahma; 3 males, 4 females, Jami, rice, 22.X.2009, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma; 7 males, 7 females, Darsi, rice, 10.I.2010, K S H Brahma; 7 males, 6 females,

Naira, rice, 19.X.2009, K S H Brahma; 5 males, 7 females, Ragolu, rice, 19.X.2009, K S H Brahma; 4 males, 3 females, Tirupati, rice, 29.IV.2010, K S H Brahma; 3 males, 4 females, Vasadi, rice, 22.X.2009, K S H Brahma; 6 males, 5 females, Nandyal, rice, 25.I.2010, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma; 3 males, 3 females, Sitanagaram, rice, 21.X.2009, K S H Brahma.

#### **4.3.3 *Coronacella sinhalana* (Kirkaldy)**

(Figs. (5a-d) & Plate 2A)

*Liburnia frontalis* Melichar, 1903: 100

*Coronacella sinhalana* Wilson and Claridge, 1991: 73

#### **Synonyms**

*Liburnia frontalis* Melichar

*Delphacodes sinhalanus* Kirkaldy

*Delphax puella* Kirkaldy

*Kelisia kirkaldyi* Muir

*Coronacella bella* Metcalf

#### **Colour**

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; forewings subhyaline, yellowish brown, near end of clavus with distinct black markings.

#### **External morphology**

Vertex submedially longer than wide at base, lateral carinae slightly convex, Y-shaped carina moderately distinct, submedian carina emerged at

apex, base wide posteriorly than length; frons at middle line longer than wide, widest just below level of ocelli, lateral carina slightly convex, median carina simple; clypeus basally wider than apex of frons, as wide as long; antennae surpassing frontoclypeal suture, basal segment longer than wide, shorter than second segment; tibial spur with 18 teeth.

### **Male genitalia**

Pygofer with posterior margin slightly incised near base, laterodorsal 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.

### **Measurements**

Length of macropterous male including forewings 3.07 (3.0-3.15) mm and width across the compound eyes 0.69 (0.64-0.74) mm.

### **Specimens studied**

4 males, 2 females, Naira, rice, 19.X.2009, K S H Brahma; 2 males, 1 female, Bapatla, rice, 26.XI.2009, K S H Brahma; 2 males, 3 females, Madhira, rice, 12.XII.2009, K S H Brahma; 2 males, 1 female, Darsi, rice, 10.I.2010, K S H Brahma; 2 males, 2 females, Ponnuru, rice, 23.XI.2009, K S H Brahma.



#### **4.3.4 *Euidella* sp.**

(Figs. (6a-d) & Plate 2B)

*Euidella* Muir and Giffard, 1924, 25: 6-10

#### **Colour**

Eyes reddish brown. Vertex, pronotum and mesonotum tinged with orange to yellowish markings; frons, genae, clypeus, antennae and legs yellowish brown; forewings hyaline with light brown band. Tegmina with pterostigma.

#### **External morphology**

Vertex as long as wide, basal compartment deeply concave, longer than pronotum. Frons with median carina forked above mid length of frons, closer to base, mottled with yellowish white spots. Antennae distinctly beyond frontoclypeal suture, almost up to midclypeus; pronotum tricarinate, one-third length of mesonotum, lateral carina curved posteriolaterally but not reaching hind margin. Mesonotum tricarinate, longer than length of vertex and pronotum. Legs fairly long and slender, hind basal tarsi distinctly longer than the other two segments together.

#### **Male genitalia**

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. Anal segment with a pair of thin and long spines curved inward to the concave area of paramere; aedeagus flattened with long unequal flagellar appendages. Genital styles long and L- shaped.

## **Measurements**

Length of macropterous male including forewings 3.95 (3.80-4.10) mm and width across the compound eyes 0.84 (0.74-0.94) mm.

## **Specimens studied**

3 males, 2 females, Nandyal, rice, 25.I.2010, K S H Brahma; 2 males, 1 female, Sarvaipalli, rice, 25.I.2010, K S H Brahma; 3 males, 2 females, Konejedu, rice, 25.I.2010, K S H Brahma; 1 male, 1 female, Madhira, rice, 12.XII.2009, K S H Brahma; 3 males, 2 females, Darsi, rice, 10.1.2010, KSH Brahma; 3 males, 2 females, Polla, rice, 8.XI.2009, K S H Brahma.

### **4.3.5. *Harmalia anacharsis* Fennah**

(Figs. (7a-d) & Plate 3A)

*Harmalia anacharsis* Fennah, Wilson and Claridge, 1991: 66

## **Colour**

Body is light brown in colour.

## **External morphology**

Vertex very short, broad and excavated, triangular between eyes. Frons dark brown in colour, broadly rounded from the vertex, elongated, more or less three times longer than vertex and carinae lighter in colour. Ocelli on the edge of the carinae near the eyes. Tegmina more or less uniformly pale brown without pterostigma. Light brown coloured legs, first tarsal segments longer than the remaining segments, leaf like tibial spur which is broader.

## **Male genitalia**

Pygofer dorsoventrally broader with posterior opening, slightly longer. Anal segment collar like with a pair of spines directed ventrally. Aedeagus tubular without teeth, uniform width throughout. Genital styles bifurcated apically.

## **Measurements**

Length of macropterous male including forewings is 3.06 (3.04-3.09) mm and width across the compound eyes is 0.7 (0.69-0.71) mm.

## **Specimens studied**

2 males, 2 females, Polla, rice, 8.XI.2009, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma; 2 males, 1 female, Sitanagaram, rice, 21.X.2009, K S H Brahma; 3 males, 2 females, Darsi, rice, 10.I.2010, K S H Brahma; 1 male, 1 female, Ichhada, rice, 30.I.2010, K S H Brahma; 2 males, 1 female, Ravulapalem, rice, 9.X.2009, K S H Brahma.

### **4.3.6 *Nilaparvata lugens* (Stal)**

(Figs. (8a-d) & Plate 3B)

*Nilaparvata lugens* (Stal). Okada, 1977: 3

*Nilaparvata lugens* (Stal). Wilson and Claridge, 1991: 49

## **Synonyms**

*Delfax lugens* Stal

*Liburnia greeni* Motschulsky

*Nilaparvata greeni* Distant

*Kalpa aculeata* Distant

*Delphax oryzae* Matsumura

*Delphax ordovix* Kirkaldy

*Delphax parysatis* Kirkaldy

*Dicranotropis anderida* Kirkaldy

*Hikona formosana* Matsumura

## **Colour**

Yellowish brown or dark brown in colour with eyes slightly bluish.

## **External morphology**

Vertex longer than wide, obviously shorter than twice the width, not convergent apically. Frons longer than broad not excavated with a distinct median carina, forked basally, lateral carina conspicuous on the either side of median carina. Carinae of vertex relatively less obvious, faintly prominent. Clypeus triangular, very much shorter than frons with median and lateral carina. Genae normal, eyes reniform, incised medially above the antennae. Ocelli present near the edge of the compound eye below the lateral carina of the frons. Antennae moderate in length, and produced a short distance from the apex of the clypeus. Antennae surpasses the fronto-clypeal suture, second segment longer and thicker than first with numerous sensoria. Pronotum shorter than mesonotum with a median and lateral carina. Mesonotum with distinct median and lateral carinae with a triangular scutellum. Tegmina transparent, veins darker with pterostigma, Sc+R forked near middle of wing. Legs slender with tectiform post tibial spur and

with teeth on margin. Posterior basitarsus less than twice the length of the other two tarsal segments put together. Lateral spines of the post-tarsal segment can usually be observed on both sides of the tarsus. Number of teeth on tibial spur is 15-35.

### **Male genitalia**

Pygofer moderately long, posterior opening slightly longer dorsoventrally than broad. Posterior margin of the pygofer is without a ventral process. 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 with sub-apical wider margin.

### **Measurements**

Length of macropterous male including forewings 3.90 (3.70-4.10) mm and width across the compound eyes 1.01 (1.01-1.02) mm.

### **Specimens studied**

7 males, 6 females, Gara, rice, 19.X.2009, K S H Brahma; 7 males, 6 females, Ragolu, rice, 19.X.2009, K S H Brahma; 6 males, 4 females, Narasannapeta, rice, 19.X.2009, K S H Brahma; 2 males, 2 females, Sitanagram, rice, 21.X.2009, K S H Brahma; 4 males, 3 females, Nellore, rice, 8.XII.2009, K S H Brahma; 5 males, 2 female, Madira, rice, 12.XII.2009, K S H Brahma; 3 males, 2 females, Nandyal, rice, K S H Brahma; 2 males, 3 females, Polla, rice, 8.XI.2009, K S H Brahma; 4 males, 5 females, Bhimadolu, rice, 8.XI.2009,

K S H Brahma; 4 males, 2 females, Gudivada, rice, 23.XI.2009, K S H Brahma; 4 males, 5 females, Darsi, rice, 10.I.2010, K S H Brahma; 5 males, 6 females, Maruteru, rice, 9.XI.2009, K S H Brahma; 2 males, 3 females, Kavali, rice, 8.XII.2009, K S H Brahma; 4 males, 5 females, Konejedu, rice, 25.I.2010, K S H Brahma; 4 males, 3 females, Ichhada, rice, 30.I.2010, K S H Brahma; 8 males, 6 females, Sarvaipalli, rice, 25.I.2010, K S H Brahma; 6 males, 4 females, Badvel, rice, 29.I.2010, K S H Brahma; 4 males, 5 females, Vasadi, rice, 22.X.2009, K S H Brahma.

#### **4.3.7 *Peregrinus maidis* (Ashmead)**

(Figs. (9a-d) & Plate 4A)

*Peregrinus maidis* Fennah 1965, 17: 1-59

*Peregrinus maidis* Wilson and Claridge, 1991: 70

#### **Synonyms**

*Delphax maidis* Ashmead

*D. psylloides* Lethierry

*Dicranotropis maidis* Van Duzee

*Liburnia psylloides* Melichar

*Pundaluoya simplicia* Distant

#### **Colour**

Light yellow-brown to yellow-orange, mesonotum with a pair of orange longitudinal bands between the white median and yellow-brown lateral carina. Frons, clypeus and genae yellow-brown with lateral carinae thinly black; ocelli black. Femora yellow-brown, tibiae yellowish.

## **External morphology**

Head narrower than pronotum; vertex truncate anteriorly, wider than long basally, frons at widest point at level of Y-median carina, longer than wide; median carina forked nearly at mid length, boldly higher than lateral carinae, carinae with sharp edges; clypeus tricarinate similar to frons. Vertex and pronotum shorter than mesonotum, the latter longer than the two together; lateral carinae of pronotum slightly convex posteriorly, not reaching hind margin; mesonotum's median carina fades at the base of scutellum; lateral carinae wide posteriorly and narrow anteriorly. First segment of antennae shorter than second, apex with black ring band; second longer than first, base black, narrower than apex, with apical one-third black; overall antennae reach a little beyond the frontoclypeal suture. Transparent ungranulated wings banded brown on apical one-third radiating from apex of cubital cell to longitudinal vein. Pterostigma present. Forewings extends beyond abdominal tip as long as total length of mesonotum and abdomen.

## **Male genitalia**

Abdomen including pygofer dark brown to dark reddish brown. Pygofer slightly oblong to rounded; parameres small, bases sunken into deeply concave medioventral area, parallel basally, the apical one-third curved out and bent inward, truncated to slightly cleft apices face each other; anal style short and relatively small. Aedeagus long, narrow and whip like with processes sub apically. Genital style very characteristic.

## **Measurements**

Length of macropterous male including forewings 4.24 (3.58-4.9) mm and width across the compound eyes 0.69 (0.64-0.74) mm.

### **Specimens studied**

4 males, 3 females, Nandyal, sorghum, 25.I.2010, K S H Brahma; 5 males, 3 females, Sarvaipalli, sorghum, 25.I.2010, K S H Brahma; 3 males, 2 females, Konejedu, maize, 25.I.2010, K S H Brahma; 3 males, 2 females, Madhira, maize, 12.XII.2009, K S H Brahma; 2 males, 3 females, Gara, maize, 19.X.2009, K S H Brahma; 4 males, 5 females, Ponnur, maize, 23.XI.2009, K S H Brahma; 4 males, 3 females, Vasadi, maize, 22.X.2009, K S H Brahma; 2 males, 3 females, Jami, sorghum, 22.X.2009, K S H Brahma; 3 males, 2 females, Bapatla, maize, 26.X.2009, K S H Brahma.

#### **4.3.8 *Perkinsiella* sp.**

(Figs. (10a-d) & Plate 4B)

*Perkinsiella* Wilson and Claridge, 1991: 70-72

### **Colour**

Head broad with a broad medio-longitudinal, yellow to white band running from vertex to mesonotum. Wings are brownish. Scutellum yellow in colour.

### **External morphology**

Vertex slightly projected frontally in front of eyes, mediolateral carinae raised along lateral carinae, slightly posterior to middle, moderately converging anteriorly, continued to frons and branch near the lower margin of eyes; Y-shaped carina which usually fades to indistinct transverse carinae; face about as long as broad between eyes, the broadest area narrow and distinctly concave towards the apex; clypeus base about as wide as apex of frons. Antennae large, reaching apex of clypeus, first segment rather triangular (broader at apex than at base) and both first and second segments flattened, and second segment longer than



first. Pronotum slightly broader than vertex at eye region, lateral carinae diverging and curving posteriorly, fading before reaching lower margin; mesonotum relatively small obtusely projected posteriorly, length subequal to vertex and pronotum combined. Wings are brownish, veins are granulate and pterostigma present. Legs simple, hind basitarsus as long as the other two tarsal segments put together; spurs relatively small, thin with many minute teeth along the hind margin.

### **Male genitalia**

Aedeagus elongated, curved with a pair of process subapically. Pygofer with two spines on vertical margin. Genital styles broader basally narrowed apically more or less foot shaped. Diaphragm deeply sinuated in the middle.

### **Measurements**

Length of macropterous male including forewings 4.49 (3.89-5.10) mm and width across the compound eyes 0.79 (0.74-0.84) mm.

### **Specimens studied**

6 males, 7 females, Nandyal, sorghum, 25.I.2010, K S H Brahma; 2 males, 1 female, Sarvaipalli, sorghum, 25.I.2010, K S H Brahma; 3 males, 2 females, Konejedu, sorghum, 25.I.2010, K S H Brahma; 3 males, 4 females, Madhira, maize, 12.XII.2009, K S H Brahma; 3 males, 4 females, Vasadi, maize, 22.X.2009, K S H Brahma; 3 males, 1 female, Krishna, sorghum, 23.XI.2009, K S H Brahma; 3 males, 2 females, Madira, maize, 12.XII.2009, K S H Brahma; 2 males, 1 female, Ichhada, maize, 30.I.2010. K S H Brahma.

### **4.3.9 *Perkinsiella sinensis* Kirkaldy**

(Figs. (11a-c) & Plate 5A)

*Perkinsiella sinensis* Kirkaldy, 1903 (36) : 179-181

#### **Colour**

Brownish black in colour with vertex, pronotum and scutellum yellowish.

#### **External morphology**

Vertex is broader and more or less equal to its length. Wings are brownish in colour, veins are granulate and pterostigma present. Pronotum slightly broader than vertex at eye region; lateral carinae diverging and curving posteriorly, fading before reaching lower margin. Mesonotum relatively small obtusely projected posteriorly, length subequal to vertex and pronotum. Legs simple, hind basitarsus as long as the other two tarsal segments put together; spurs relatively small, thin with many minute teeth along the hind margin.

#### **Male genitalia**

Anal tube processes paired and shorter. Aedeagus tubular, slightly curved with a pair of process in the middle and another process subapically. Genital style foot shaped.

#### **Measurements**

Length of macropterous male including forewings 4.4 (3.90-4.90) mm and width across the compound eyes 0.84 (0.71-0.98) mm.

#### **Specimens studied**

5 males, 4 females, Nandyal, sorghum, 25.I.2010, K S H Brahma; 4 males, 2 females, Sarvaipalli, sorghum, 25.I.2010, K S H Brahma; 5 males, 2 females, Konejedu, sorghum, 25.I.2010, K S H Brahma; 2 males, 1 female, Madhira, sorghum, 12.XII.2009, K S H Brahma; 2 males, 1 female, Darsi, maize, 10.I.2010,

K S H Brahma; 2 males, 2 females, Ponnuru, maize, 23.XI.2009, K S H Brahma; 4 males, 3 females, Vasadi, maize, 22.X.2009, K S H Brahma; 2 males, 3 females, Jami, maize, 22.X.2009, K S H Brahma; 3 males, 2 females, Bapatla, maize , 26.X.2009, KS H Brahma.

#### **4.3.10 *Sardia rostrata* Melichar**

(Figs. (12a-d) & Plate 5B )

*Sardia rostrata* Melichar, Wilson and Claridge, 1991: 72

##### **Colour:**

The colouration of vertex, thorax and tegmina is dark brown with black fuscous markings.

##### **External morphology**

Vertex narrow, elongated between the larger compound eyes. Frons much longer, sinuated medially and broader apically with raised median and lateral carinae. The clypeus is black in colour and gradually narrows apically. Genae black in colour. Eyes large and as long as vertex. Pro and mesonotum with a distinct median carina and the lateral carinae reaching the posterior margin. Forewings are dark brown with pterostigma and fuscus apically. Legs light yellowish in colour, the first hind tarsus more or less twice the length of second and third segment put together and the tibial spur foliaceous.

## **Male genitalia**

Pygofer broadly rounded, posterior opening longer dorsoventrally. Anal segment collar like with a pair of moderately longer, slender processes. 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 styles.

## **Measurements**

Length of macropterous male including forewings 3.97 (3.56-4.38) mm and width across the compound eyes 0.88 (0.75-1.00) mm.

## **Specimens studied**

5 males, 7 females, Darsi, rice, 10.I.2010, K S H Brahma; 7 males, 6 females, Naira, rice, 19.X.2009, K S H Brahma; 5 males, 7 females, Ragolu, rice, 19.X.2009, K S H Brahma; 2 males, 1 female, Tandur, rice, 12.I.2010, K S H Brahma; 3 males, 2 females, Ravulapalem, rice, 7.X.2009, K S H Brahma; 3 males, 4 females, Vasadi, rice, 22.X.2009, K S H Brahma; 6 males, 5 females, Nandyal, rice, 25.I.2010, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma; 3 males, 3 females, Sitanagaram, rice, 21.X.2009, K S H Brahma; 3 males, 2 females, Madira, rice, 12.XII.2009, K S H Brahma; 2 males, 1 female, Ichhada, rice, 30.I.2010, K S H Brahma; 7 males, 6 females, Ponnuru, rice, 23.XI.2009, K S H Brahma; 7 males, 6 females, Bapatla, rice, 26.XI.2009, K S H Brahma; 3 males, 2 females, Kandukuru, 10.I.2010, K S H Brahma.

#### **4.3.11 *Sogatella furcifera* (Horvath)**

(Figs. (13a-d) & Plate 6A)

*Sogatella furcifera* (Horvath). Asche and Wilson, 1990: 9

*Sogatella furcifera* (Horvath). Wilson and Claridge, 1991: 56

*Sogatella furcifera* (Horvath). Okada, 1977:3

#### **Synonyms**

*Delphax furcifera* Horvath

*Sogata distincta* Distant

*Sogata pallescens* Distant

*Sogata kyusyuensis* Matsumura and Ishihara

*Sogata tandojamensis* Qadri and Mirza

#### **Colour**

Vertex yellowish white, mediolateral carina blackish; Frons, clypeus and genae black in colour. Carina whitish yellow and laterally darkened, 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 and hence commonly referred to as white backed planthopper.

#### **External morphology**

Vertex slightly longer than broad at base, lateral margins carinate, parallel or weakly convergent, apical margin truncate, with submedian carinae slightly

prominent, posterior margin transverse. Carina is Y-shaped but not so prominent. Frons longer than broad with lateral margins carinate. Clypeus about as long as frons, postclypeal disc as long as its basal width. Clypeus is basally wider than frons at apex; anteclypeus not as long as basal portion. Genae more or less broad. Rostrum short, attaining mesotrochanters but not post-trochanters, subapical segment slightly longer than apical. Antennae pale brown in colour and second segment is about 1.5 times as long as the first and with sensoria on the ventral surface. Eyes reniform, deeply incised below, lateral ocelli well developed. Clypeus and genae blackish with whitish yellow carinae.

Pronotum yellowish white and laterally darkened. The lateral carinae does not reach the posterior margin. Mesonotum is yellowish white, lateral carinae black and with a triangular scutellum. Forewing sub-transparent, with black pterostigma, apical veins brownish, anterior veins yellow, Sc+R forked in the middle, M forked at nodal line of cross veins. Cu forked distally at the level of Sc+R. Legs usually pale dirty yellow, first segment of hind tarsus distinctly longer than the length of second and third segment put together. Post tibial spur thin, foliaceous with 17-22 black minute teeth.

### **Male genitalia**

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 peculiar, broad basally, bifurcated apically.

## **Measurements**

Length of macropterous male including forewings 3.83 (3.65-4.02) mm and width across the compound eyes 1.04 (1.03-1.06) mm.

## **Specimens studied**

4 males, 5 females, Ragolu, rice, 19.X.2009, K S H Brahma; 3 males, 3 females, Naira, rice, 19.X.2009, K S H Brahma; 2 males, 3 females, Polla, rice, 8.XI.2009, K S H Brahma; 4 males, 5 females, Bhimadolu, rice, 8.XI.2009, K S H Brahma; 3 males, 2 females, Gudivada, rice, 23.XI.2009, K S H Brahma; 4 males, 5 females, Darsi, Grass, 10.I.2010, K S H Brahma; 5 males, 6 females, Maruteru, rice, 9.XI.2009, K S H Brahma; 2 males, 3 females, Kavali, rice, 8.XII.2009, K S H Brahma; 5 males, 6 females, Tandur, 12.I.2010, K S H Brahma; 5 males, 6 females, Ravulapalem, 9.X.2009, K S H Brahma; 6 males, 5 females, Nellore, 8.XII. 2009, K S H Brahma; 4 males, 5 females, Konejedu, rice, 25.I.2010, K S H Brahma; 6 males, 3 females, Ichhada, rice, 30.I.2010, K S H Brahma; 5 males, 4 females, Sarvaipalli, rice, 25.I.2010, K S H Brahma; 6 males, 4 females, Badvel, rice, 29.I.2010, K S H Brahma; 4 males, 5 females, Vasadi, rice, 22.X.2009, K S H Brahma; 3 males, 2 females, Kandukuru, 10.I.2010, K S H Brahma; 5 males, 6 females, P.S. puram, sugarcane, 22.X.2009, K S H Brahma; 4 males, 3 females, Anakapalle, sugarcane, 21.X.2009, K S H Brahma; 3 males, 4 females, Gara, sugarcane, 19.X.2009, K S H Brahma; 5 males, 4 females, Bhimadolu, sugarcane, 8.XI.2009, K S H Brahma.

#### 4.3.12 *Sogatella kolophon* (Kirkaldy)

(Figs. (14a-d) & Plate 6B)

*Sogatella kolophon* (Kirkaldy). Asche and Wilson, 1990: 16

*Sogatella kolophon* (Kirkaldy). Wilson and Claridge, 1991: 5

*Sogatella kolophon* (Kirkaldy). Okada, 1977:3

#### Synonyms

*Delphax kolophon* Kirkaldy

*Opiconsiva insularis* Distant

*Opiconsiva derelicta* Distant

*Sogatella kolophon atlantica* Fennah

*Sogatella kolophon insularis* Fennah

*Sogata meridiana* Beamer

*Sogatella kolophon meridiana* Fennah

*Opiconsiva balteata* Distant

*Sogatella belateata* Fennah

*Sogatella derelicta* Fennah

*Sogatella chenchea* Kuoh

*Delphacodes eleganteissima* Ishihara

*Sogatella elegantissima* Fennah

*Sogatella nebris* Fennah

#### Colour

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.



## **External morphology**

Vertex longer sub medially than broad at base. Frons longer than broad with median and lateral marginal carinae. Antennae reaching to frontoclypeal suture. Pale brown antennae, second segment about 1.5 times as long as first segment. Eyes are reniform, black with well developed lateral ocelli. Median length of mesonotum exceeds length of mesoscutellum. Clypeus and genae are light brown with yellow carinae. Clypeus slightly wider than frons at apex. Pronotum yellowish white with lateral carinae not reaching the posterior margin. Tegmina subtransparent without pterostigma. Tegmina longer than wide, Sc +R forked in the middle. M forked at nodal line of cross line. Cu<sub>1</sub> forked distally at the level of Sc +R. Legs usually pale dirty yellow, first segment of hind tarsus distinctly longer than the length of second and third segments put together, tibial spur thin and foliaceous. Post tibial spur with 19-21 teeth.

## **Male genitalia**

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.

## **Measurements**

Length of macropterous male including forewings is 2.84 (2.69-2.99) mm and width across the compound eyes is 0.81mm.

## **Specimen studied**

6 males, 7 females, Ragolu, rice, 19.X.2009, K S H Brahma; 4 males, 3 females, Ichhada, rice, 30.I.2010, K S H Brahma; 6 males, 2 females, Sarvaipalli, rice, 25.I.2010, K S H Brahma; 1 male, 2 females, Badvel, rice, 29.I.2010, K S H Brahma; 3 males, 5 females, Maruteru, rice, 9.X.2009, K S H Brahma; 4 males, 3 females, Ponnur, rice, 23.XI.2009, K S H Brahma; 6 males, 7 females, Bapatla, rice, 26.XI.2009, K S H Brahma; 1 male, 2 females, Tandur, rice 12.I.2010, K S H Brahma; 4 males, 5 females, Konejedu, rice, 25.I.2010, K S H Brahma; 6 males, 5 females, Darsi, rice, 10.I.2010, K S H Brahma; 4 males, 5 females, Bhimadolu, sugarcane, 8.XI.2009, K S H Brahma; 7 males, 6 females, Pentasrirampuram, sugarcane, 22.X.2009, K S H Brahma; 5 males, 4 females, Gara, sugarcane, 19.X.2009, K S H Brahma; 4 males, 3 females, Anakapalle, sugarcane, 21.X.2009, K S H Brahma.

### 4.3.13 *Sogatella vibix* (Haupt)

(Figs. (15a-d) & Plate 7A)

*Sogatella vibix* (Haupt). Asche and Wilson, 1990: 22

*Sogatella vibix* (Haupt). Wilson and Claridge, 1991: 62

*Sogatella vibix* (Haupt). Fennah, 1963b : 54

#### Synonyms

*Liburnia vibix* Haupt

*Sogatella suezensis* Linnavuori

*Sogatella catoptron* Fennah

*Sogatella diachenhea* Kuoh

*Delphacodes dogensis* Ishihara

*Delphacodes longifurcifera* Esaki and Ishihara

*Delphacodes panicicola* Ishihara

*Sogatella longiturcifera* Fennah

*Sogatella panicicola* Fennah

*Liburnia matsumurana* Metcalf

*Sogatella matsumurana* Nast

*Sogatella parakolophon* Linnavuori

#### Colour

Head with carinae sordid white. Disc of frons between carinae and disc of clypeus, white in colour, gena dark fuscous. Vertex yellowish white and black in colour beyond mid lateral carinae. Forewings without pterostigma and are subtransparent.

## **External morphology**

Vertex longer submedially than broad at base. Frons longer than broad with median and lateral marginal carinae. Antennae surpassing frontoclypeal suture, second segment about 2.4 times as long as first segment. Eyes black and reniform, deeply incised below, lateral ocelli well developed. Clypeus light brown with yellow carinae and genae distinctly blackish or dark. Laterally darkened yellowish white pronotum with lateral carinae not reaching posterior margin. Tegmina subtransparent and longer than wide. Sc+R forked in the middle. M forked at nodal line of cross line. Cu<sub>1</sub> forked distally at the level of Sc+R. Legs usually pale dirty yellow, first segment of hind tarsus distinctly longer than the length of second and third segments put together, with thin and foliaceous tibial spur.

## **Male genitalia**

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, the diaphragm more or less 'U' shaped and differ from *S. kolophon*.

## Measurements

Length of macropterous male including forewings is 3.03 (2.74-3.33) mm and width across the compound eyes is 0.74 (0.64-0.84) mm.

## Specimens studied

4 males, 2 females, Ragolu, rice, 19.X.2009, K S H Brahma; 2 males , 3 females, Gara, rice, 19.X.2009, K S H Brahma; 1 male, 2 females, Bhimadolu, rice, 8.XI.2009, K S H Brahma; 3 males, 2 females, Badvel, rice, 29.I.2010, K S H Brahma; 3 males, 3 females, Maruteru, rice, 9.X.2009, K S H Brahma; 2 males, 3 females, ponnur, rice, 23.XI.2009, K S H Brahma; 4 males, 4 females, Sitanagram, rice, 21.X.2009, K S H Brahma; 4 males, 2 females, Anakapalle, rice, 21.X.2009, K S H Brahma; 1 male, 1 female, Narasannapeta, rice, 19.X.2009, K S H Brahma.

### 4.3.14 *Tagosodes pusanus* (Distant)

(Figs. (16a-d) & Plate 7B)

*Tagosodes pusanus* (Distant) comb. n. Wilson and Claridge, 1991: 63

## Synonyms

*Sogata pusana* Distant

*Kelisia fieberi* Muir

*Unkana formosella* Matsumura

*Sogata striatus* Quadri and Mirza

*Himeunka chibana* Tian and Kuoh

*Sogatodes assimilis* Yang

## **Colour**

In external characters similar to *S. furcifera* but can be distinguished by the pattern of the dark markings of the forewings and by the male genitalia. 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.

## **External morphology**

Vertex slightly longer than wide, lateral margins carinate. Frons longer than broad with yellowish white median and lateral marginal carinae. Frons and genae are black in colour. Clypeus light brown in colour. Black reniform eyes deeply incised below. Second segment of antennae longer than first segment. Well developed lateral ocelli. Tegmina subtransparent, longer than wide with a pattern of dark markings and pterostigma. Legs pale dirty yellow first segment of hind tarsus distinctly longer than the length of second and third segments put together. Post tibial spur thin, foliaceous and with minute teeth marginally.

## **Male genitalia**

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 never twisted as found in *Sogatella*, wider basally, gradually narrowed and tubular, 2-3 spines are there sub-apically, gonopore apical. Genital styles relatively flattened, trapezoidal distally and shallowly bifurcated. Diaphragm never forms a broad U shape as in *Sogatella*.

## **Measurements**

Length of macropterous male including forewings 3.45 (3.40-3.50) mm and width across the compound eyes 1.16 (1.12-1.21) mm.

## **Specimens studied**

5 males, 7 females, Naira, rice, 19.X.2009, K S H Brahma; 4 males, 3 females, Polla, rice, 8.XI.2009, K S H Brahma; 6 males, 2 females, Kavali, rice, 8.XII.2009, K S H Brahma; 1 male, 2 females, Badvel, rice, 29.I.2010, K S H Brahma; 5 males, 6 females, Nellore, rice, K S H Brahma; 6 males, 4 females, Maruteru, rice, 9.X.2009, K S H Brahma; 4 males, 3 females, Ponnur, rice, 23.XI.2009, K S H Brahma; 4 males, 6 females, Madira, rice, 12.XII.2009, K S H Brahma; 6 males, 7 females, Bapatla, rice, 6.XI.2009, K S H Brahma; 4 males, 2 females, Tandur, rice, 12.I.2010, K S H Brahma; 3 males, 5 females, Konejedu, rice, 25.I.2010, K S H Brahma; 6 males, 5 females, Darsi, rice, 10.I.2010, K S H Brahma; 3 males, 4 females, Jami, rice, 22.X.2009, K S H Brahma; 4 males, 5 females, Vasadi, rice, 22.X.2009, K S H Brahma; 5 males, 4 females, Sitanagram, sugarcane, 21.X.2009, K S H Brahma; 4 males, 2 females, Anakapalle, sugarcane, 21.X.2009, K S H Brahma; 1 male, 1 female, Narasannapeta, sugarcane, 19.X.2009, K S H Brahma; 3 males, 2 females, Gara, sugarcane, 19.X.2009, K S H Brahma.

#### **4.3.15 *Terthron albovittatum* (Matsumura)**

(Figs. (17a-d) & Plate 8A)

*Terthron albovittatum* (Matsumura). Wilson and Claridge, 1991: 69

#### **Synonyms**

*Dicranotropis albovittata* (Matsumura)

*Delphacodes albovittata* (Matsumura)

*Liburnia albovittata* (Matsumura)

*Sogata albovittata* (Matsumura)

#### **Colour**

Vertex to apex of mesonotum dark brown with cream colour dorsal median stripe. Frons, clypeus, genae black in colour with cream coloured lateral and median carinae.

#### **External morphology**

Vertex very short. On the edge of the lateral carinae two ocelli present near eyes. Genae black in colour, pronotum short with three cream coloured carinae. Vertex slightly longer than wide, frons distinctly longer than wide, broadest at level of ocelli, slightly convex along lateral margins; median carinae forked nearly base of frons; clypeus with distinct median carina; pronotum with distinct median and lateral carina, slightly concave lateral carinae, not reaching hind margin of pronotum, diverging; combined length of vertex and pronotum as long as or slightly shorter than length of mesonotum; forewings subhyaline with a gray tinge, tegmina distal venation fuscous. Legs slender, dark brown, femur and tibia cream coloured. Tibial spur leaf like; first segment of hind tarsus distinctly longer than the length of second and third segments put together.



**Male genitalia**

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.

**Measurements**

Length of macropterous male including forewings 2.67 (2.70-2.65) mm and width across the compound eyes is 0.72 (0.69-0.75) mm.

**Specimens studied**

2 males, 1 female, Madira, rice, 12.XII.2009, K S H Brahma; 2 males, 2 females, Pentasrirampuram, rice, 22.X.2009, K S H Brahma; 1 male, 2 females, Tandur, rice, 12.I.2010, K S H Brahma; 3 males, 5 females, Ravulapalem, rice, 7.X.2009, K S H Brahma; 3 males, 2 females, Darsi, rice, 10.I.2010, K S H Brahma; 3 males, 4 females, Jami, rice, 22.X.2009, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma.

#### 4.3.16 *Toya propinqua* (Fieber)

(Figs. (18a-d) & Plate 8B)

*Delphax propinqua* (Fieber), Wilson and Claridge, 1991:73

##### **Synonym**

*Delphax propinqua* Fieber

##### **Colour**

Stramineous in colour.

##### **External morphology**

Vertex very short and shallowly excavated. Frons elongated with distinct median and lateral carinae. Genae light brown in colour incised ventrally. Ocelli near compound eyes by the side of lateral carinae. Pronotum and mesonotum with pale yellowish median and lateral carinae. Tegmina without pterostigma and is light stramineous in colour. Legs normal, tibiae foliaceous, first tarsal segment is longer than the remaining two segments.

##### **Male genitalia**

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.

##### **Measurements**

Length of macropterous male including forewings 2.81 (2.59-3.04) mm and width across the compound eyes 0.61 (0.59-0.64) mm.

## **Specimens studied**

2 males, 1 female, Nellore, rice, 8.XII.2009, K S H Brahma; 2 males, 3 females, Naira, rice, 19.X.2009, K S H Brahma; 1 male, 2 females, Tandur, rice, 12.I.2010, K S H Brahma; 3 males, 2 females, Ravulapalem, rice, 7.X.2009, K S H Brahma; 1 male, 2 females, Darsi, rice, 10.I.2010, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma; 3 males, 2 females, Madira, rice, 12.XII.2009, K S H Brahma. 1 male, 1 female, Ichhada, rice, 30.I.2010. K S H Brahma; 3 males, 3 females, Sitanagaram, sugarcane, 21.X.2009, K S H Brahma; 3 males, 4 females, Vasadi, sugarcane, 22.X.2009, K S H Brahma; 4 males, 2 females, Anakapalle, sugarcane, 21.X.2009, K S H Brahma.

### **4.3.17 *Tropidocephala serendiba* (Melichar)**

(Figs. (19a-e) & Plate 9A)

*Orchesma serendiba* Melichar, 1903: 95

#### **Synonym**

*Orchesma signata* Distant

#### **Colour**

Body chocolate brown in colour, greenish tinge on the pronotum and mid mesonotum; vertex, basal half of frons, and genae green; frons tricarinate, raised and pinkish in colour. Pale yellowish in apical half of frons, clypeus, and genae; blackish brown spot on mid apex of frons.

#### **External morphology**

Vertex slightly produced between the eyes, anteriorly with raised lateral carinae. Median carinae cream coloured, bordered with black. Antennae whitish

yellow, forewings subhyaline, granulated, claval base tinged with pale yellow, vein M with a small, elevated mound-like brown spot before and after cross veins, Sc+R with a pale white-yellow spine. Tegmina longer than abdomen, veins granulate with black coloured maculae near clavus and pterostigma is present.

### **Male genitalia**

Anal style is very much elongated and anal tube processes absent. Aedeagus broader basally and gradually narrowed towards apex and aedeagal process sickle shaped, arises from base of the aedeagus. Genital style with sclerotised curved apex and also with sclerotised serrated process arising from inner side of the style. Diaphragm as shown in the figure.

### **Measurements**

Length of macropterous male including tegmina 3.91 (3.73-4.10) mm and width across the compound eyes 0.78 (0.73-0.84) mm.

### **Specimens studied**

3 males, 2 females, Sitanagaram, sugarcane, 21.X.2009, K S H Brahma;  
2 males, 1 female, Anakapalle, sugarcane, 21.X.2009, K S H Brahma; 1 male,  
1 female, Narasannapeta, sugarcane, 19.X.2009, K S H Brahma.

#### **4.3.18 *Pyrilla perpusilla pusana* (Distant)**

(Figs. (20a-f) & Plate 9B)

*Pyrilla perpusilla pusana* (Distant). Fennah, 1963a: 721

*Pyrilla perpusilla pusana* (Distant). Qadri and Aziz, 1943: 883-888.

#### **Synonyms**

*Pyrilla lycoides* (Walker) Distant

*Pyrilla pusana* Distant

*Pyrilla perpusilla*(Walker) Sensu Distant

*Pyrilla aberrans* (Kby) Sensu Distant

#### **Colour**

Uniformly ochraceous coloured body, slightly paler beneath than above. Forewings are semi-opaque, more or less uniformly yellowish brown with small black spots sparsely distributed all over the wing. Cephalic process is well developed.

#### **External morphology**

The length of vertex is more than twice the width at base and is elongated, rectangular in shape. Frons very much elongated and extended as cephalic process, dorsally the length of the cephalic extension is more or less equals the length of the vertex. Below the compound eyes, on the lateral ridge of frons very small ocelli are present. Length of short pronotum is more or less half the length of mesonotum with three carinae. On mesonotum median carina is present and lateral carinae absent. Tegmina more or less yellowish brown in colour with small

black spots, sparsely distributed all over the wing. Numerous apical, sub-apical and costal cells are present. Legs are ochraceous in colour, hind tibia with very short spines present distally, first tarsal segment with pairs of black spines, broader and longer than the other two segments.

### **Male genitalia**

Conjunctival hook of phallus is very strongly developed and slightly twisted in the middle. Phallic appendage is very much elongated. Aedeagus has a sinuation on the ventral aspect.

### **Specimens studied**

6 males, 8 females, Anakapalle, sugarcane, 21.XI.2009, K S H Brahma; 2 males, 3 females, Gara, sugarcane, 19.X.2009, K S H Brahma; 3 males, 2 females, Sitanagaram, sugarcane, 21.X.2009, K S H Brahma; 3 males, 4 females, Pentasrirampuram, 22.X.2009, K S H Brahma; 3 males, 2 females, Ravulapalem, 9.X.2009, K S H Brahma.

### **4.3.19 *Nisia nervosa* (Motschulsky)**

(Figs. (21a-c) & Plate 10A)

*Nisia nervosa* (Motschulsky), Wilson and Claridge, 1991: 47

### **Synonyms**

*Livilla nervosa* Motschulsky

*Nisia atrovenosa* (Lethierry)

## **Colour**

Stramineous to whitish in colour.

## **External morphology**

Vertex deeply excavated and is not demarcated from the frons. Frons very much elongated, excavated and curved along the eyes with outer carina very much raised, black in colour and median carina absent. Clypeus shorter and triangular in shape. Eyes comparatively smaller, ocelli three in number, median ocellus pearl like, present just above the frontoclypeal suture. Pronotum short and very much narrower. Mesonotum longer than pronotum with a median carina. 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.

## **Male genitalia**

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.

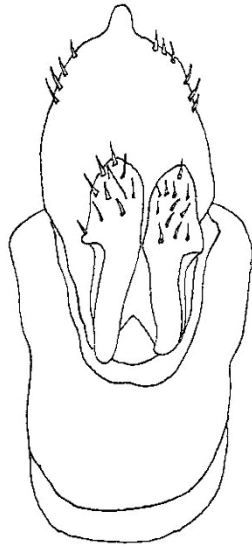
## **Measurements**

Length of macropterous male including forewings 3.40 (3.40-3.41) mm and width across the compound eyes 1.17 (1.12-1.22) mm.

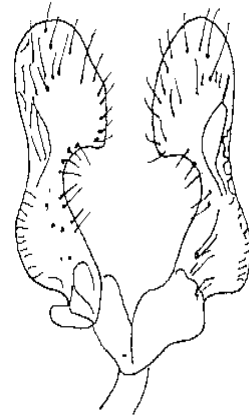
## **Specimens studied**

8 males, 7 females, Darsi, rice, 10.I.2010, K S H Brahma; 7 males, 6 females, Naira, rice, 19.X.2009, K S H Brahma; 5 males, 7 females, Ragolu, rice, 19.X.2009, K S H Brahma; 4 males, 3 females, Tirupati, rice, 29.IV.2010, K S H Brahma; 2 male, 1 female, Tandur, rice, 12.I.2010, K S H Brahma; 3 males, 2 females, Ravulapalem, rice, 7.X.2009, K S H Brahma; 3 males, 4 females, Vasadi, rice, 22.X.2009, K S H Brahma; 6 males, 5 females, Nandyal, rice, 25.I.2010, K S H Brahma; 2 males, 1 female, Krishna, rice, 23.XI.2009, K S H Brahma; 3 males, 3 females, Sitanagaram, rice, 21.X.2009, K S H Brahma; 3 males, 2 females, Madira, rice, 12.XII.2009, K S H Brahma; 2 males, 1 female, Ichhada, rice, 30.I.2010, K S H Brahma; 7 males, 6 females, Ponnur, rice, 23.XI.2009, K S H Brahma; 7 males, 6 females, Bapatla, rice, 26.XI.2009, K S H Brahma; 4 males, 5 females, Sarvaipalli, rice, 25.I.2010, K S H Brahma; 3 males, 3 females, Bhimadolu, rice, 8.XI.2009, K S H Brahma; 2 males 3 females, Badvel, rice, 29.I.2010, K S H Brahma.

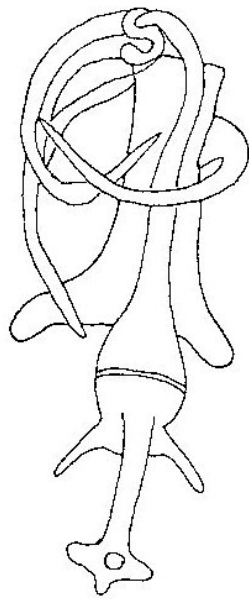




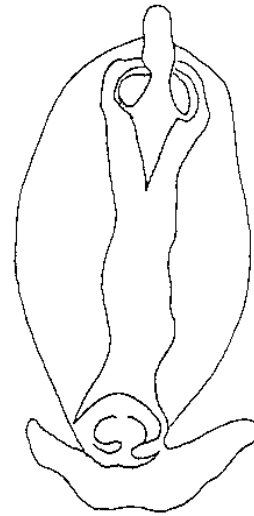
3a



3b

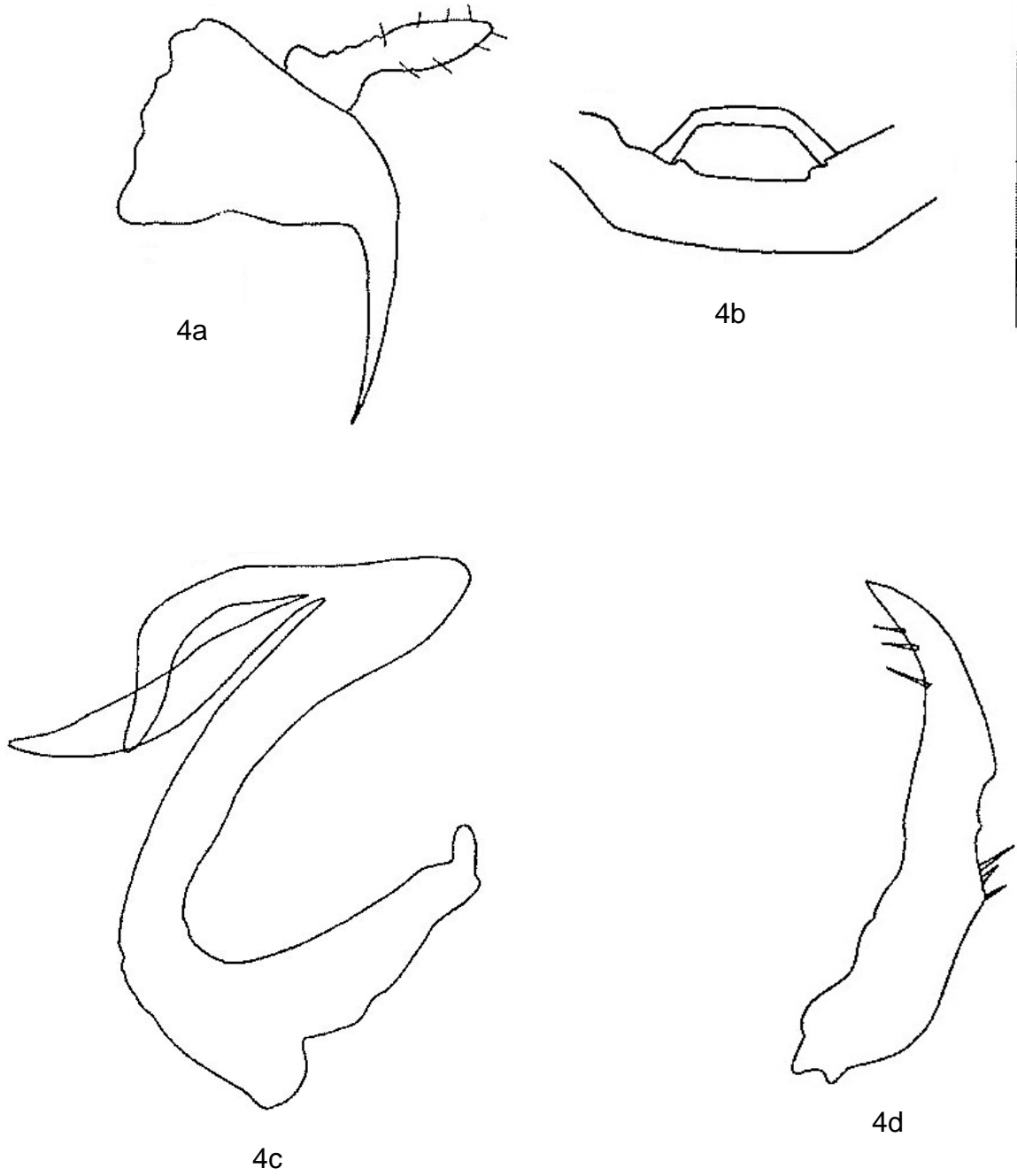


3c

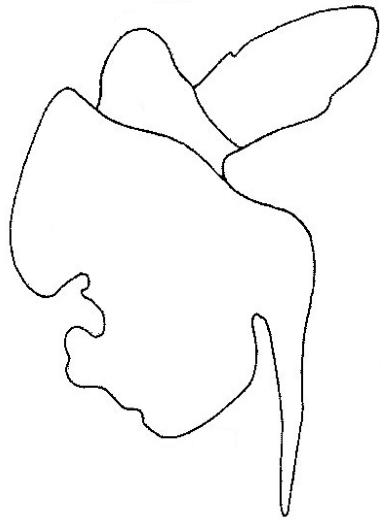


3d

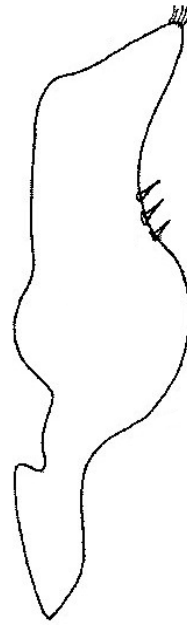
**Figs 3a-d. *Oliarus* sp.:** 3a. Male genitalia, Ventro caudal view; 3b. Genital styles; 3c. Aedeagus; 3d. Anal tube.



**Figs 4a-d. *Cemus* sp. :** 4a. Anal tube; 4b. Diaphragm; 4c. Aedeagus;  
4d. Style.

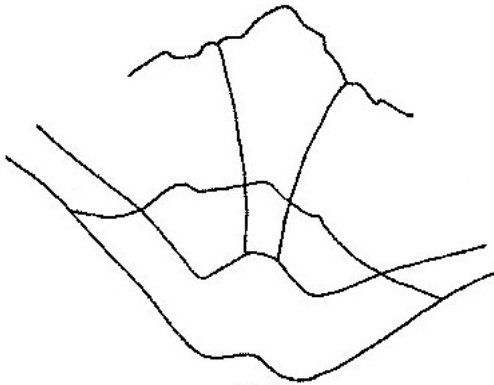


5a

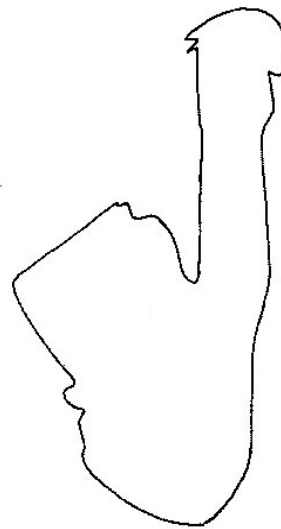


5b

0.0025mm

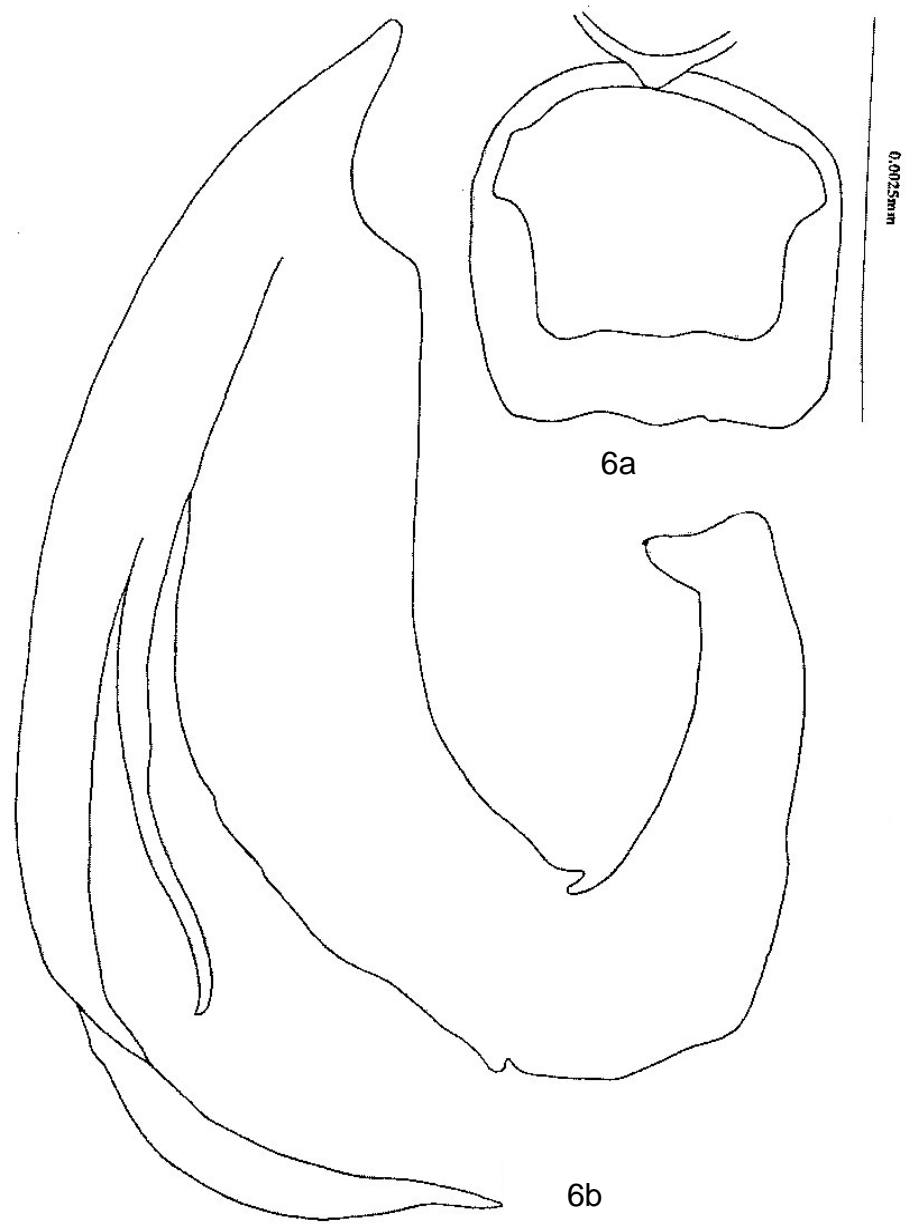


5c

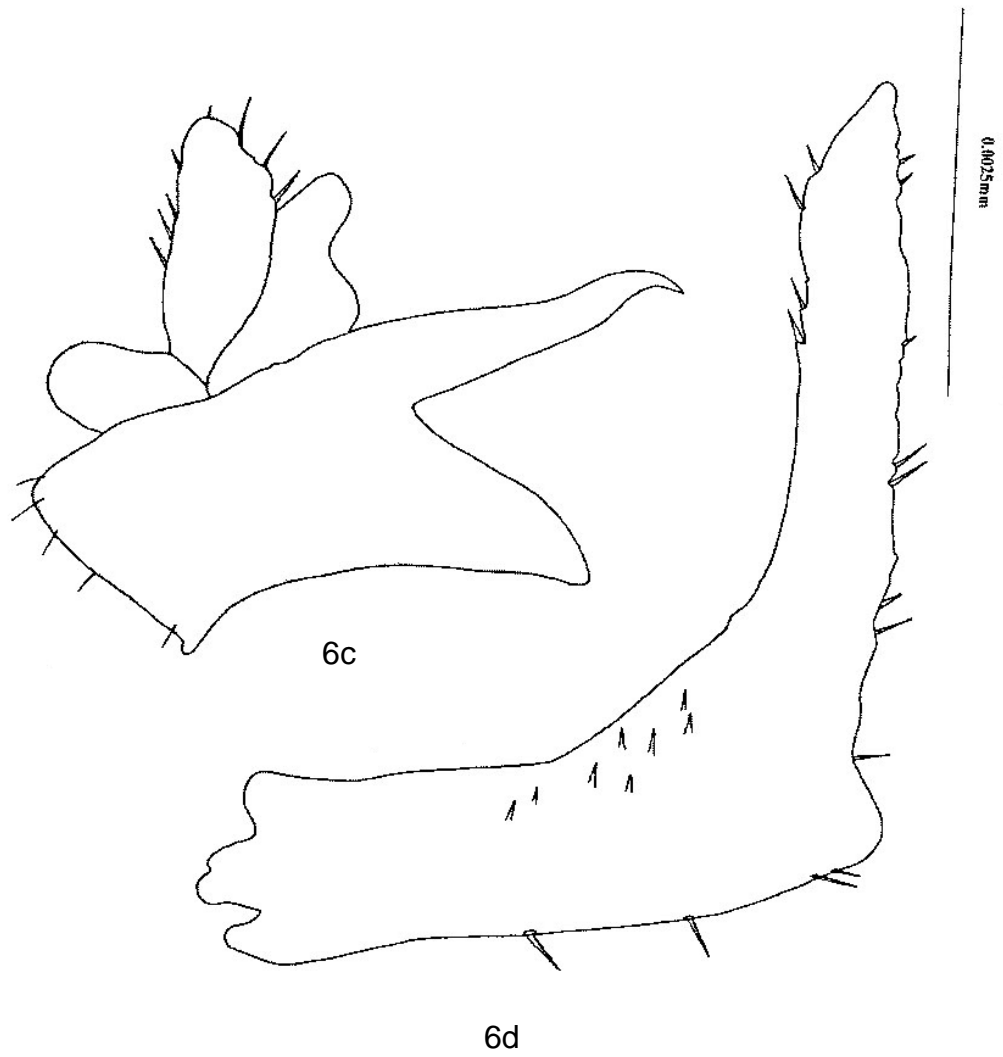


5d

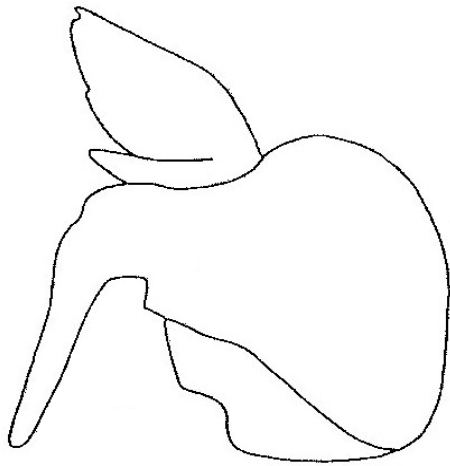
**Figs. 5a-d. *Coronacella sinhalana* (Kirkaldy):** 5a. Anal tube; 5b. Style;  
5c. Diaphragm; 5d. Aedeagus.



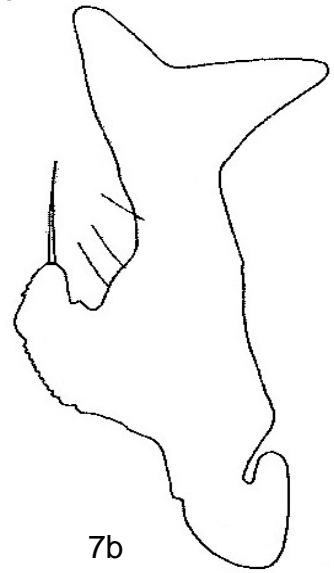
**Figs. 6a-b. *Euidella* sp. :** 6a. Diaphragm; 6b. Aedeagus, lateral view.



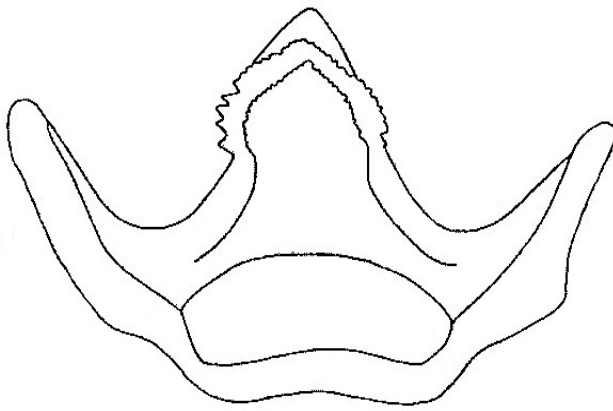
**Figs. 6c-d. *Euidella* sp.:** 6c. Anal tube; 6d. Style.



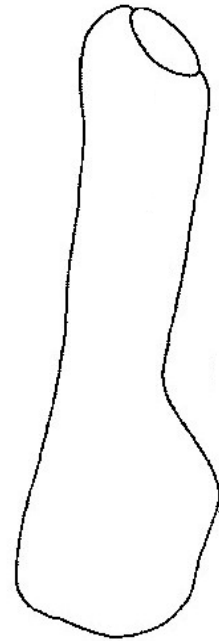
7a



7b

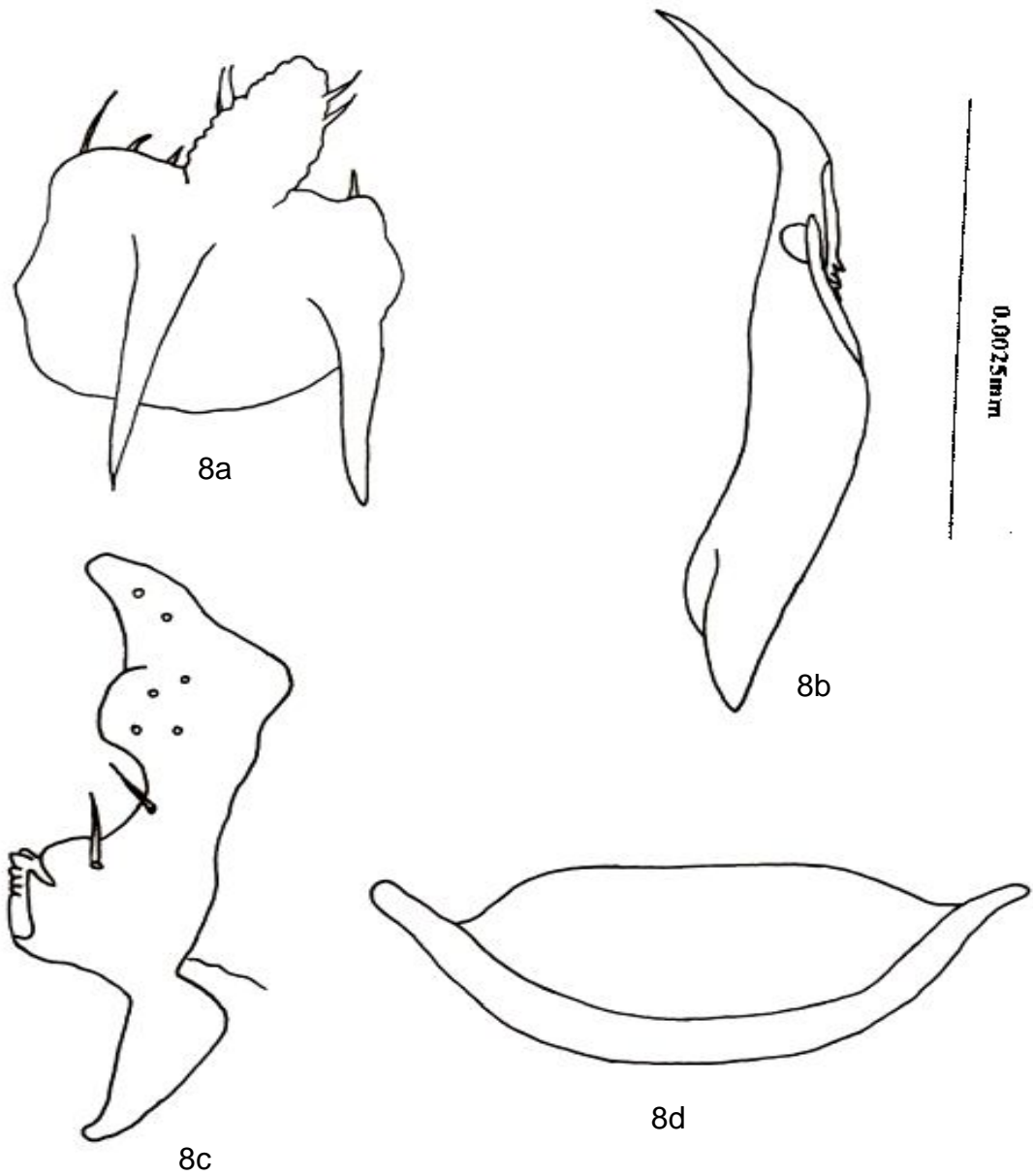


7c

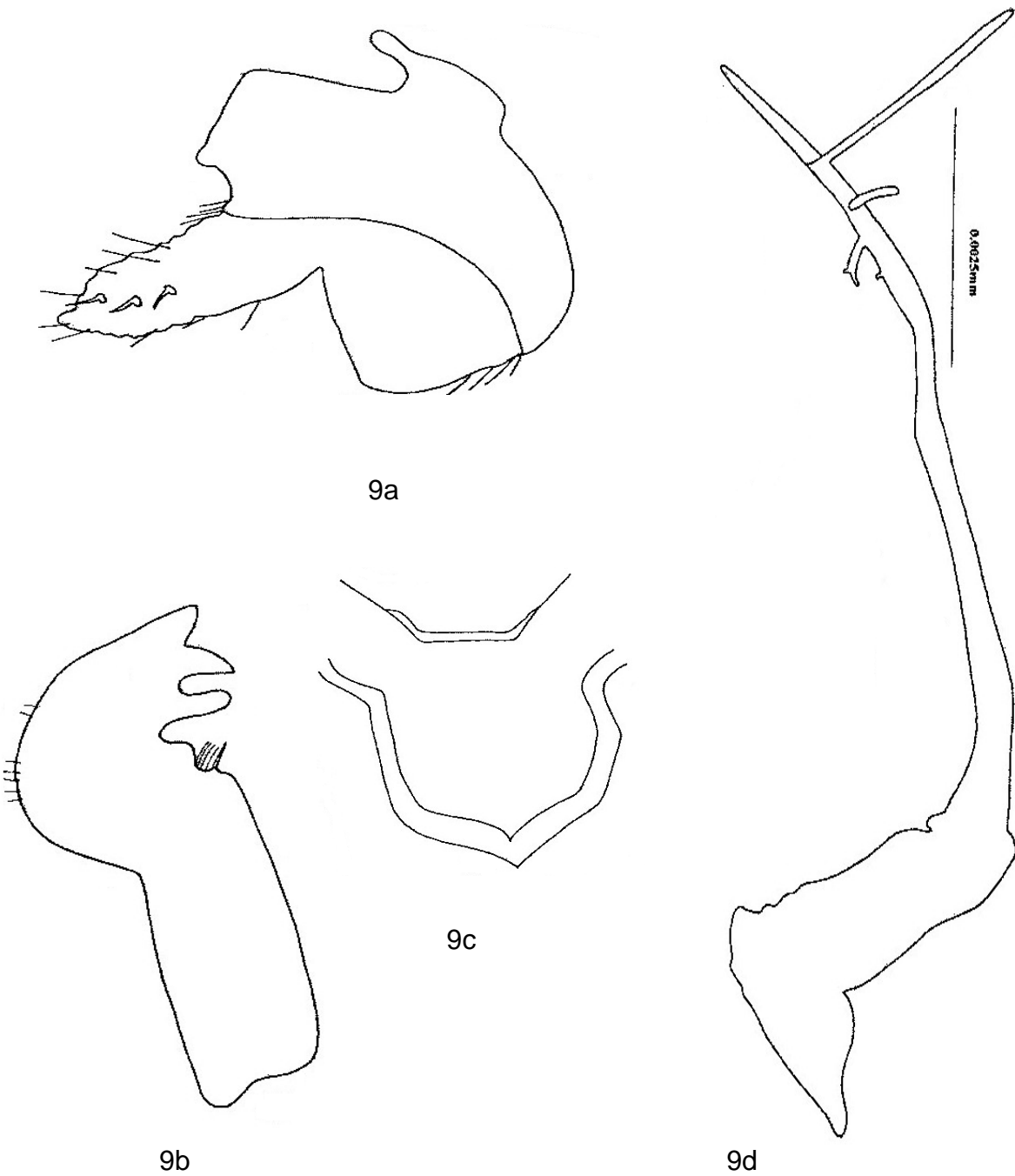


7d

**Figs. 7a-d. *Harmalia anacharsis* Fennah:** 7a. Anal tube; 7b. Style;  
7c. Diaphragm; 7d. Aedeagus, lateral view.

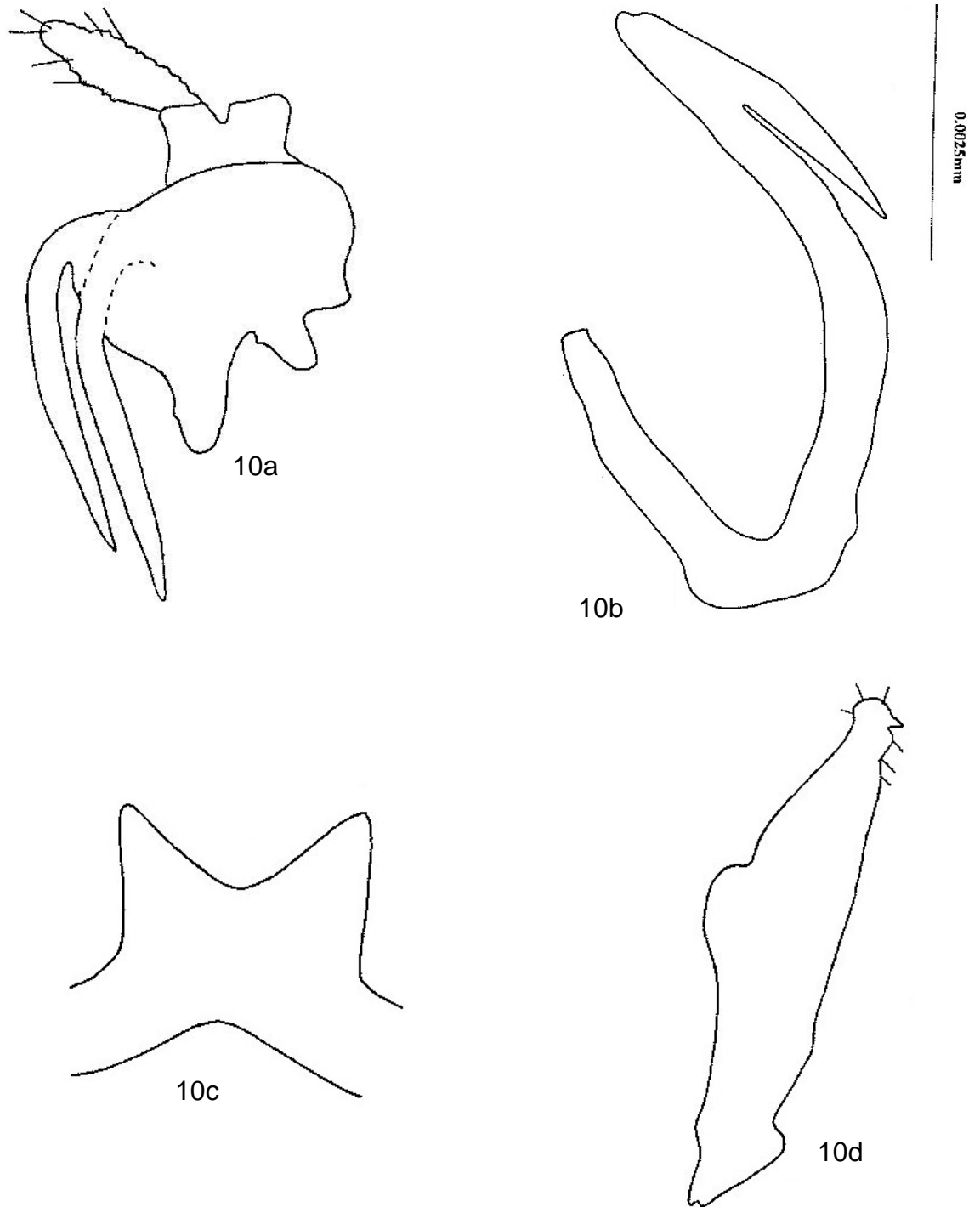


**Figs. 8a-d. *Nilaparvata lugens* (Stal):** 8a. Anal tube; 8b. Aedeagus  
8c. Style; 8d. Diaphragm.

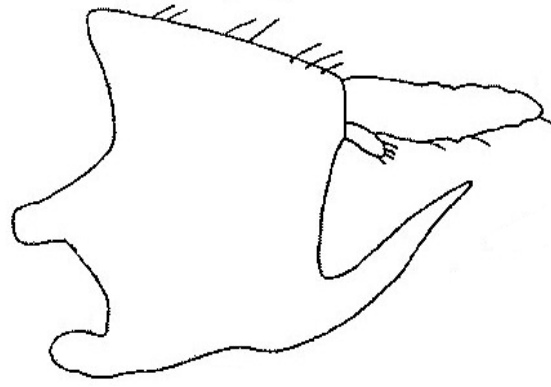


**Figs. 9a-d. *Peregrinus maidis*:** 9a. Anal tube; 9b. Style; 9c. Diaphragm; 9d. Aedeagus, lateral view.





**Figs. 10a-d. *Perkinsiella* sp. :** 10a. Anal tube; 10b. Aedeagus, lateral view; 10c. Diaphragm; 10d. Style.

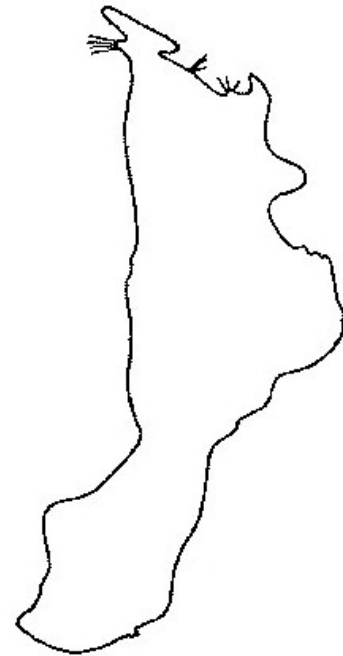


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11a

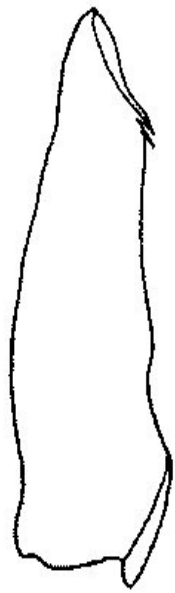


11b

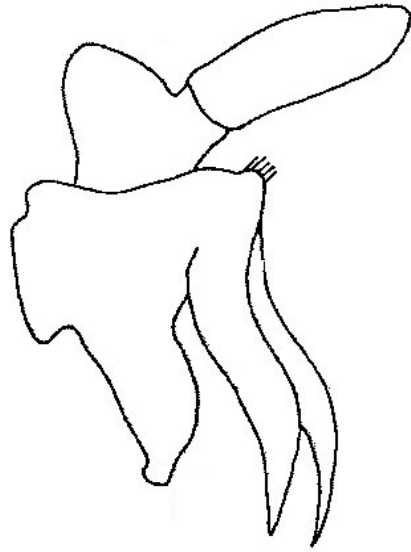


11c

**Figs. 11a-c. *Perkinsiella sinensis* Kirkaldy :** 11a. Anal tube;  
11b. Aedeagus; 11c. Style.



12a

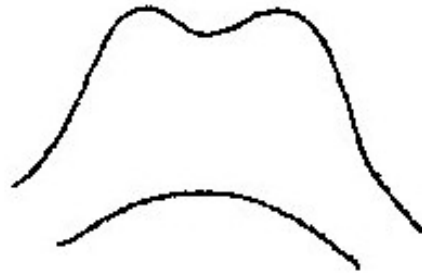


12b

0.0025mm



12c

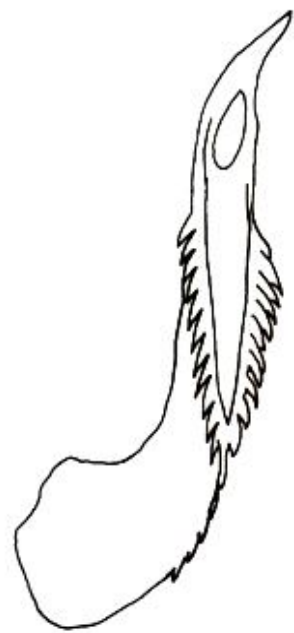


12d

**Figs. 12a-d. *Sardia rostrata* Melichar:** 12a. Aedeagus, lateral view;  
12b. Anal tube; 12c. Style; 12d. Diaphragm.

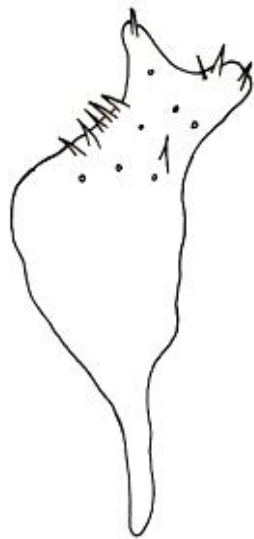


13a

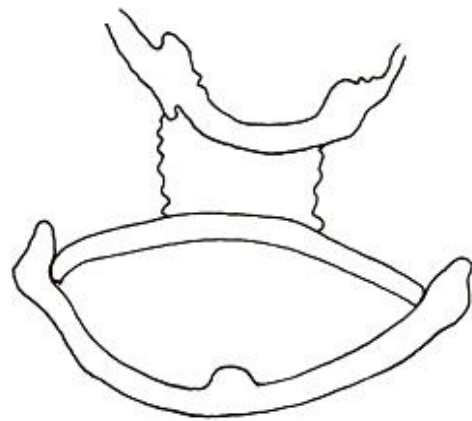


13b

0.0025mm

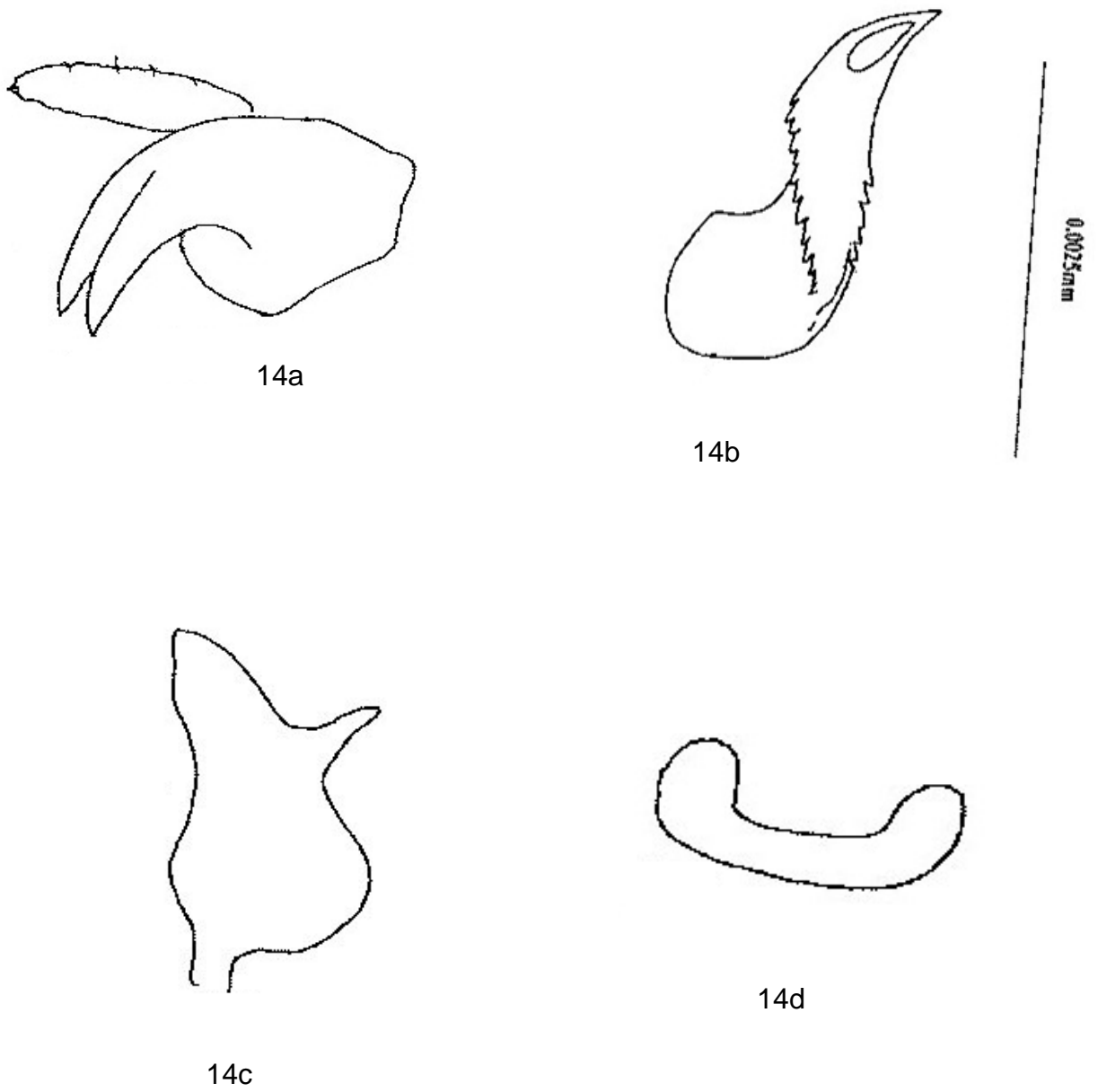


13c

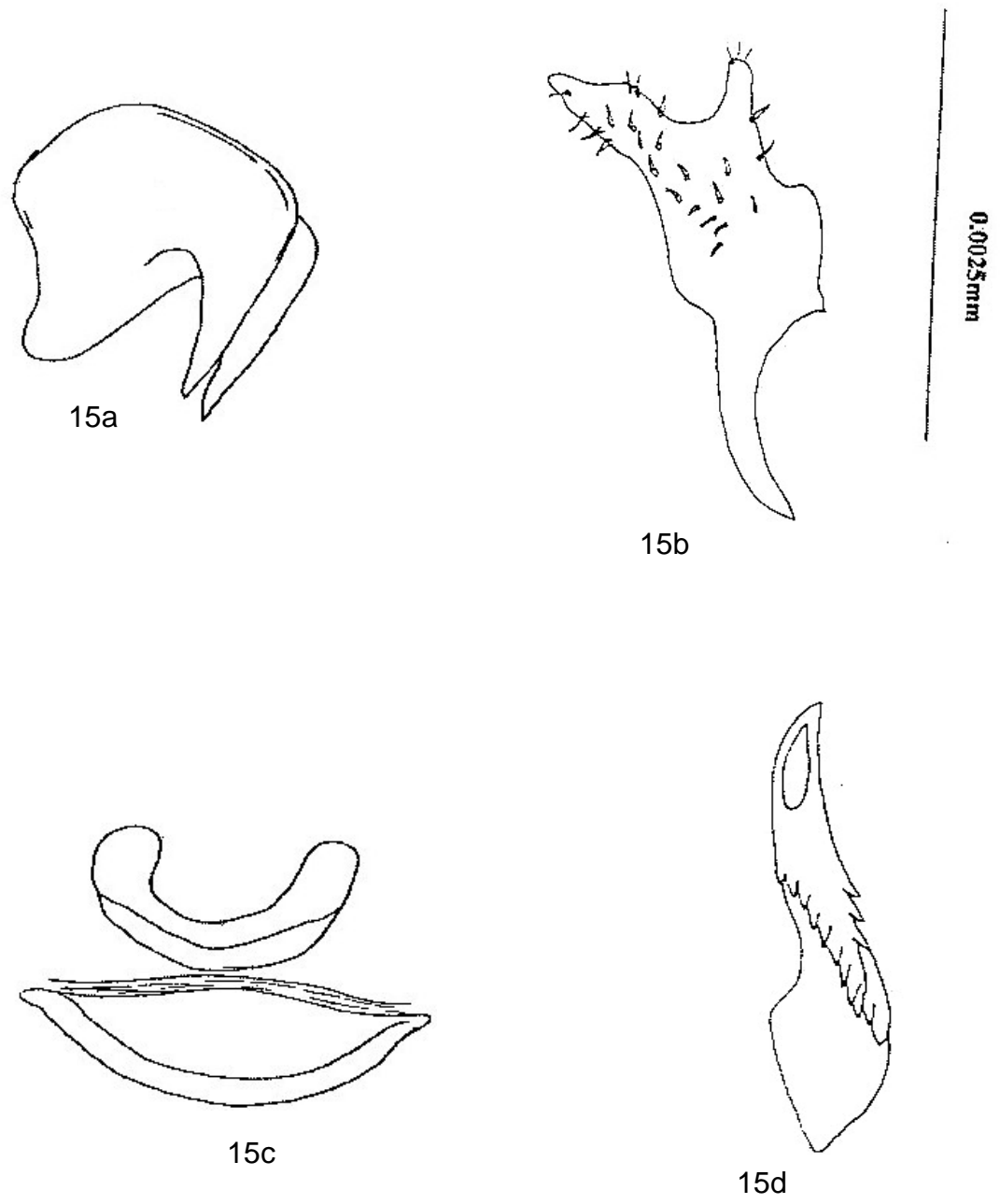


13d

**Figs. 13a-d. *Sogatella furcifera* (Horvath):** 13a. Anal tube;  
13b. Aedeagus; 13c. Style; 13d. Diaphragm.



**Figs. 14a-d. *Sogatella kolophon* (Kirkaldy):** 14a. Anal tube;  
14b. Aedeagus, lateral view; 14c. Style; 14d. Diaphragm.



**Figs. 15a-d. *Sogatella vibix* (Haupt):** 15a. Anal tube; 15b. Style; 15c. Diaphragm; 15d. Aedeagus, lateral view.



16a

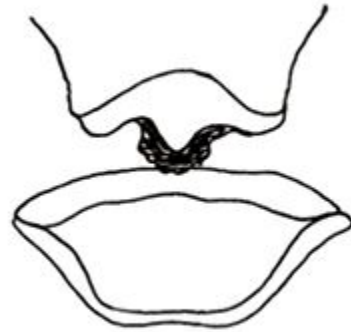


16b

0.0025 mm

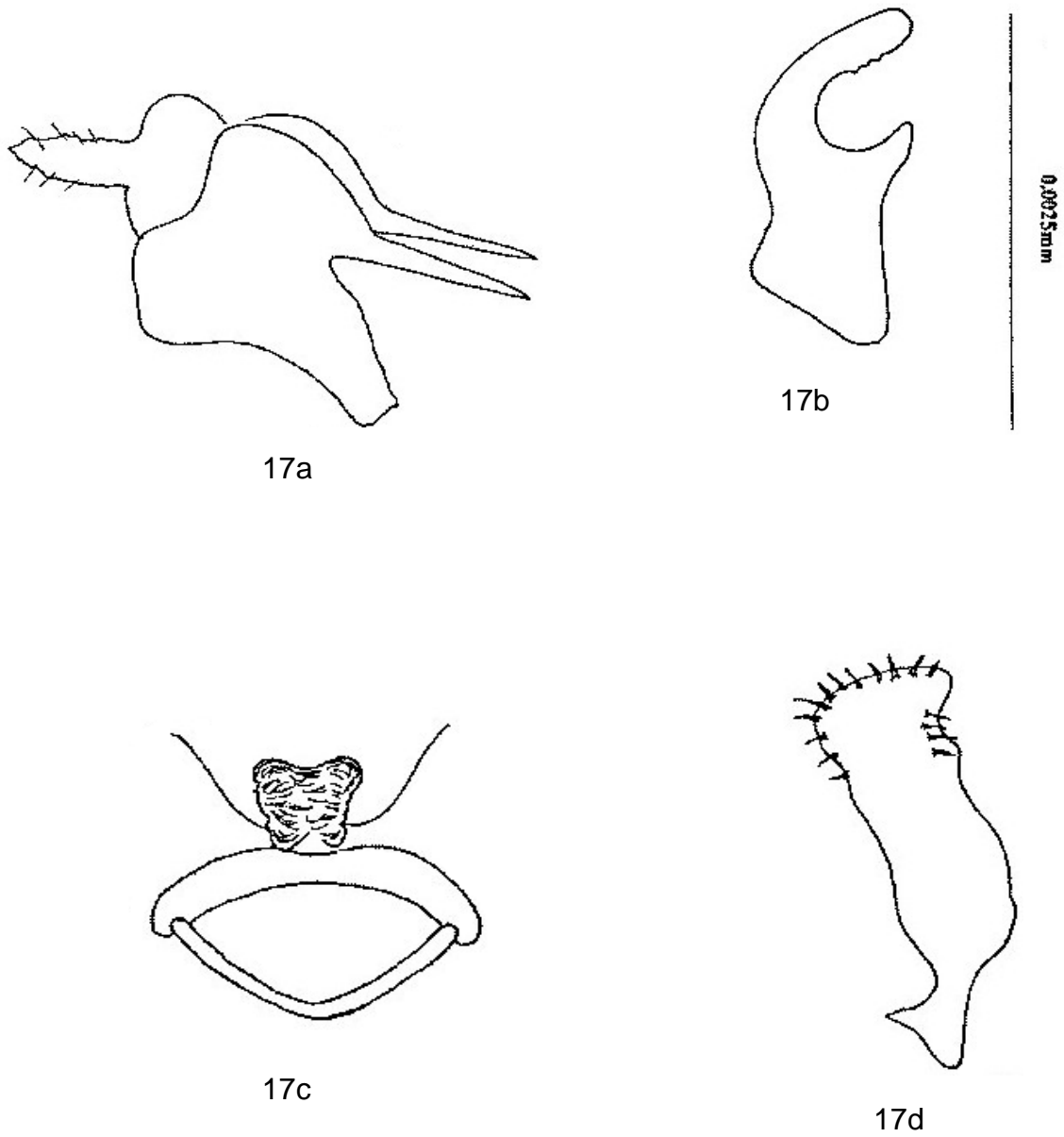


16c



16d

**Figs. 16a-d. *Tagosodes pusanus* (Distant):** 16a. Aedeagus, lateral view; 16b. Style; 16c. Anal tube; 16d. Diaphragm.

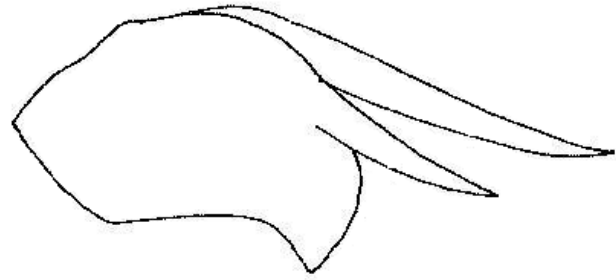


**Figs. 17a-d. *Terthron albovittatum* (Matsumura):** 17a. Anal tube;  
17b. Aedeagus, lateral view; 17c. Diaphragm; 17d. Style.



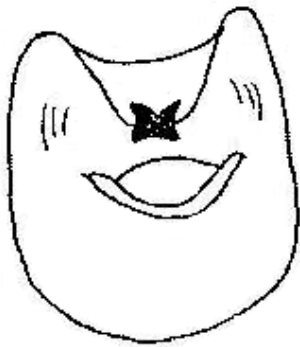


18a

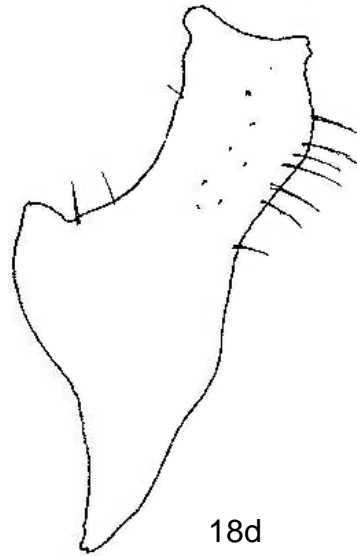


18b

0.0025mm

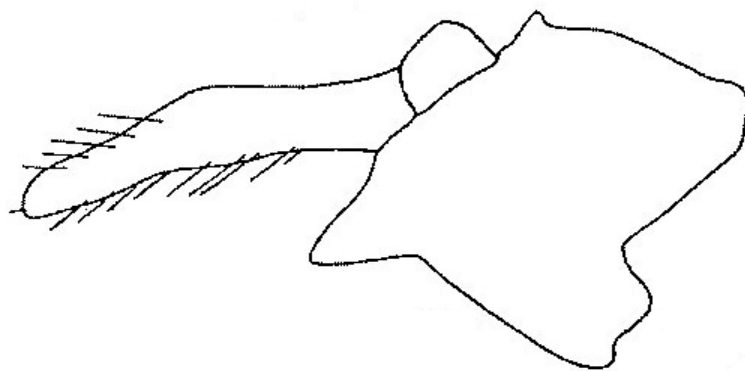


18c

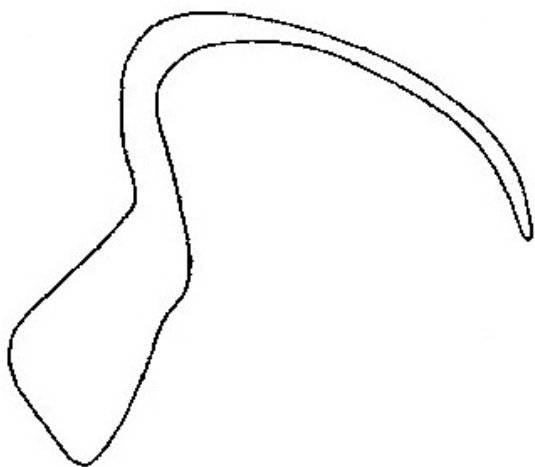


18d

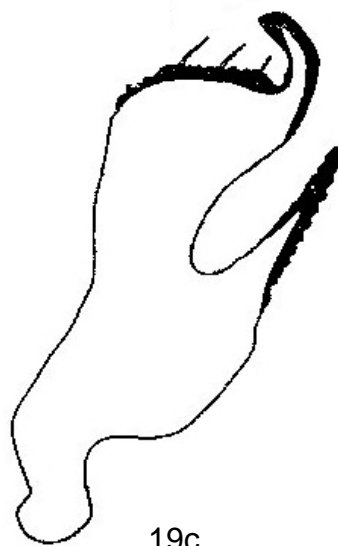
**Figs. 18a-d. *Toya propinqua* (Fieber):** 18a. Aedeagus, lateral view;  
18b. Anal tube; 18c. Pygofer with diaphragm; 18d. Style.



19a

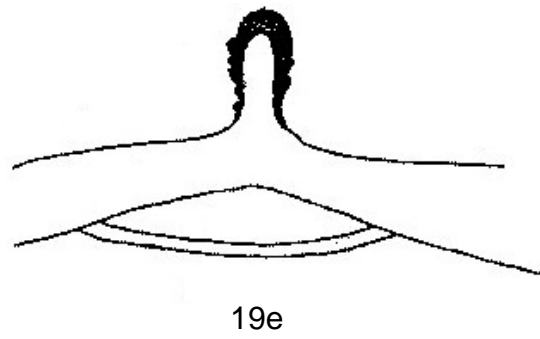
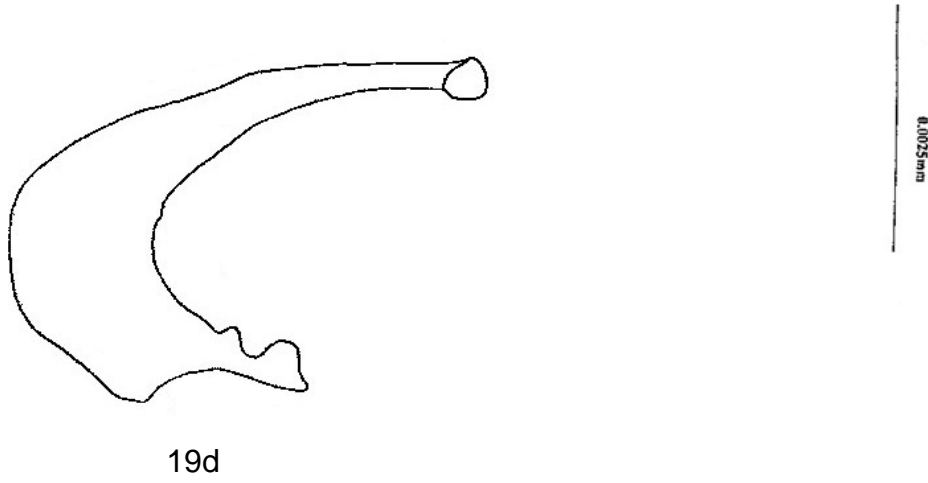


19b

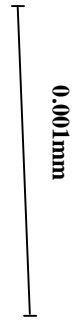
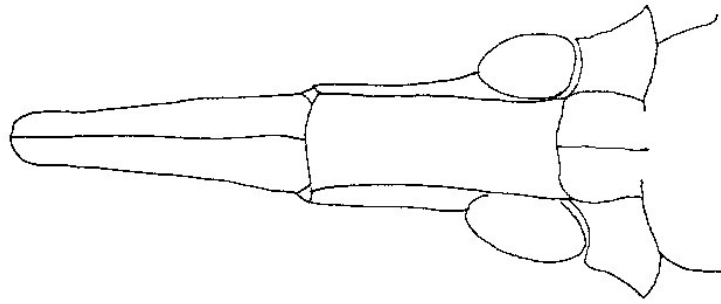


19c

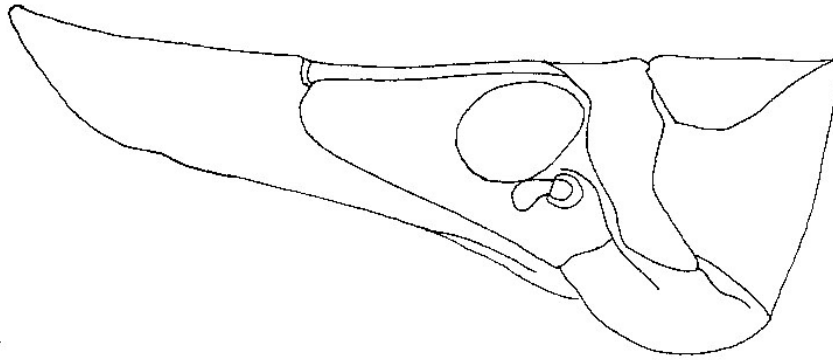
**Figs. 19a-c. *Tropidocephala serendiba* (Melichar):** 19a. Anal tube;  
19b. Aedeagal process; 19c. Style.



**Figs. 19d-e. *Tropidocephala serendiba* (Melichar):** 19d. Aedeagus, lateral view; 19e. Diaphragm.

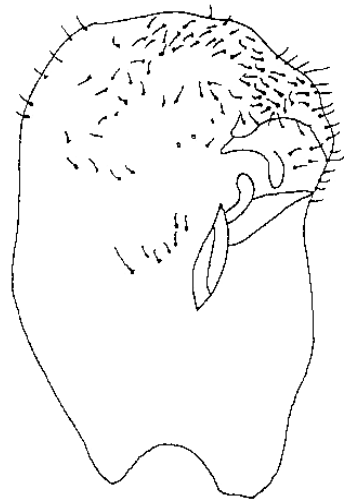


20a

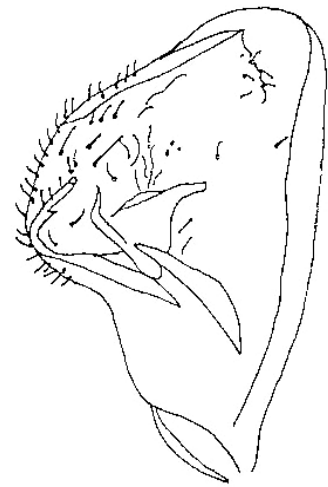


20b

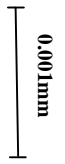
**Figs.20a-b. *Pyrilla perpusilla pusana* (Distant):** 20a. Head, dorsal view;  
20b. Head, lateral view.



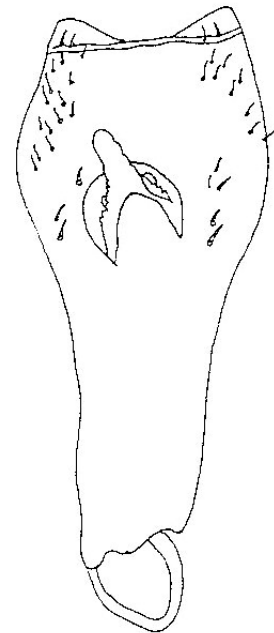
20c



20d

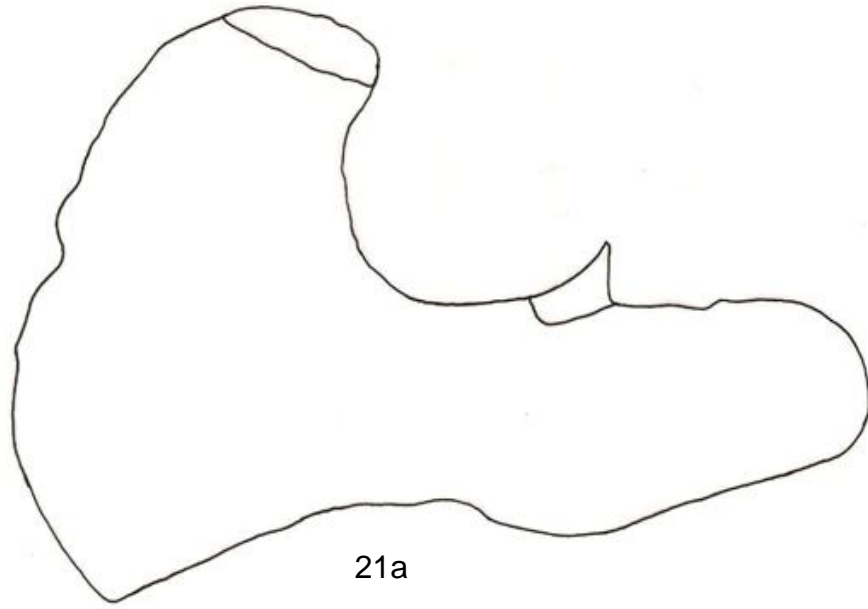


20e



20f

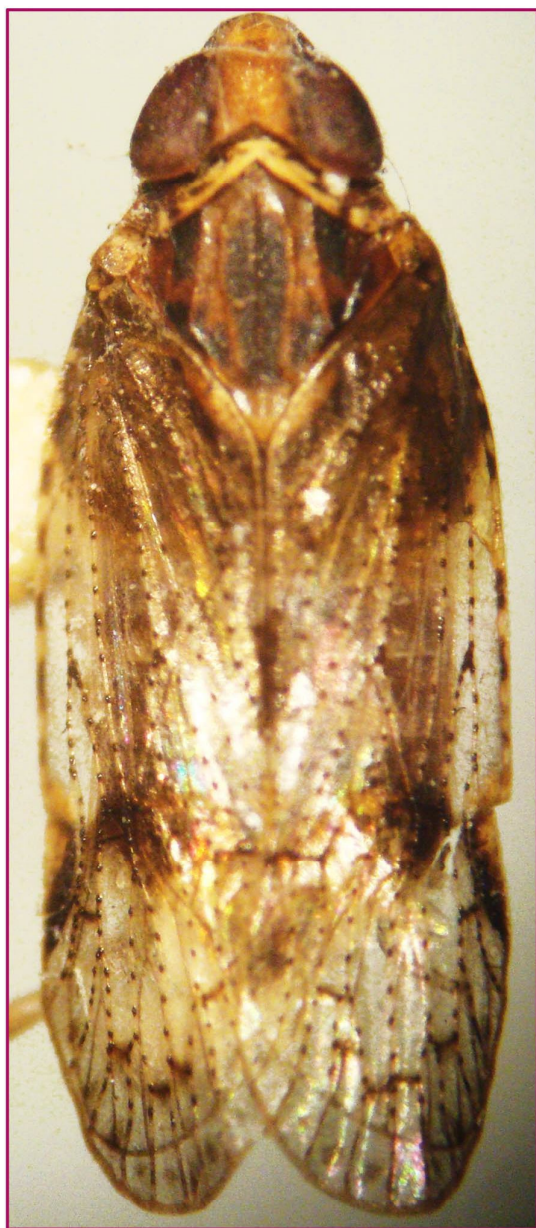
**Figs. 20c-f. *Pyrilla perpusilla pusana* (Distant):** 20c. Genital style; 20d. Genital style, lateral view; 20e. Aedeagus; 20f. Anal tube.



0.0025mm



**Figs. 21a-c. *Nisia nervosa* Motschulsky:** 21a. Pygofer, lateral view; 21b. Aedeagus, lateral view; 21c. Style.

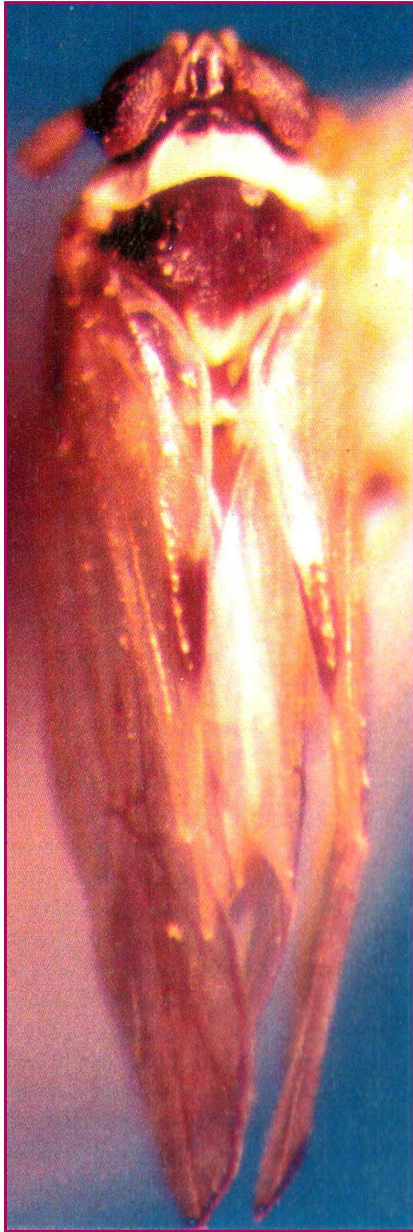


A



B

Plate 1: A. *Oliarus* sp.  
B. *Cemus* sp.



A



B

Plate 2: A. *Coronacella sinhalana* (Kirkaldy)  
B. *Euidella* sp.



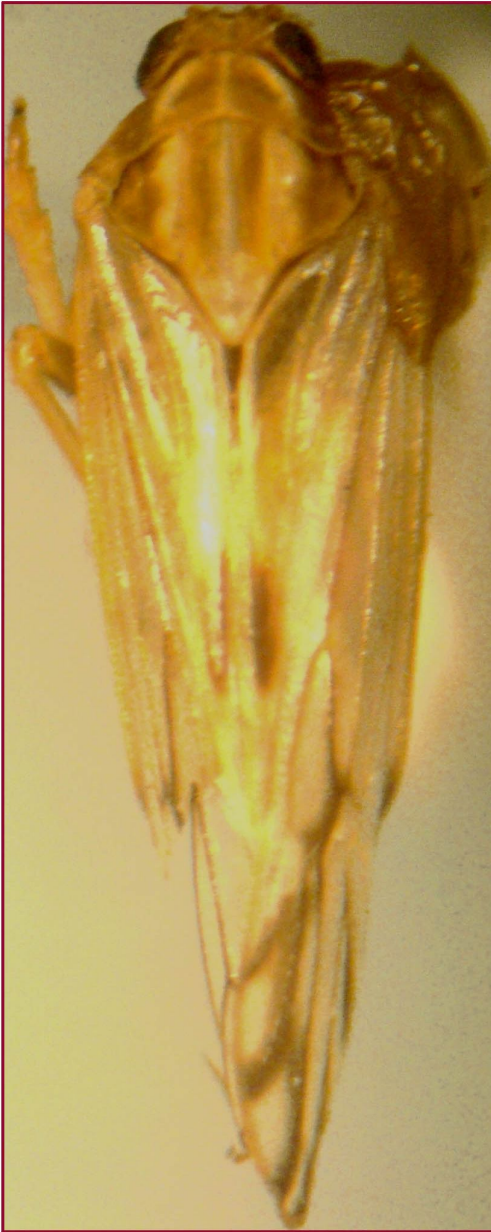


A



B

Plate 3: A. *Harmalia anachrasis* (Fennah)  
B. *Nilaparvata lugens* (Stal)



A



B

Plate 4 : A. *Peregrinus maidis* (Ashmead)  
B. *Perkinsiella* sp.



A



B

Plate 5 : A. *Perkinsiella sinensis* (Kirkaldy)  
B. *Sardia rostrata* (Melichar)



A



B

Plate 6: A. *Sogatella furcifera* (Horvath)  
B. *Sogatella kolophon* (Kirkaldy)



A



B

Plate 7: A. *Sogatella vibix* (Haupt)  
B. *Tagosodes pusanus* (Distant)



A



B

Plate 8: A. *Terthron albovitattum* (Matsumura)  
B. *Toya propinqua* (Feiber)

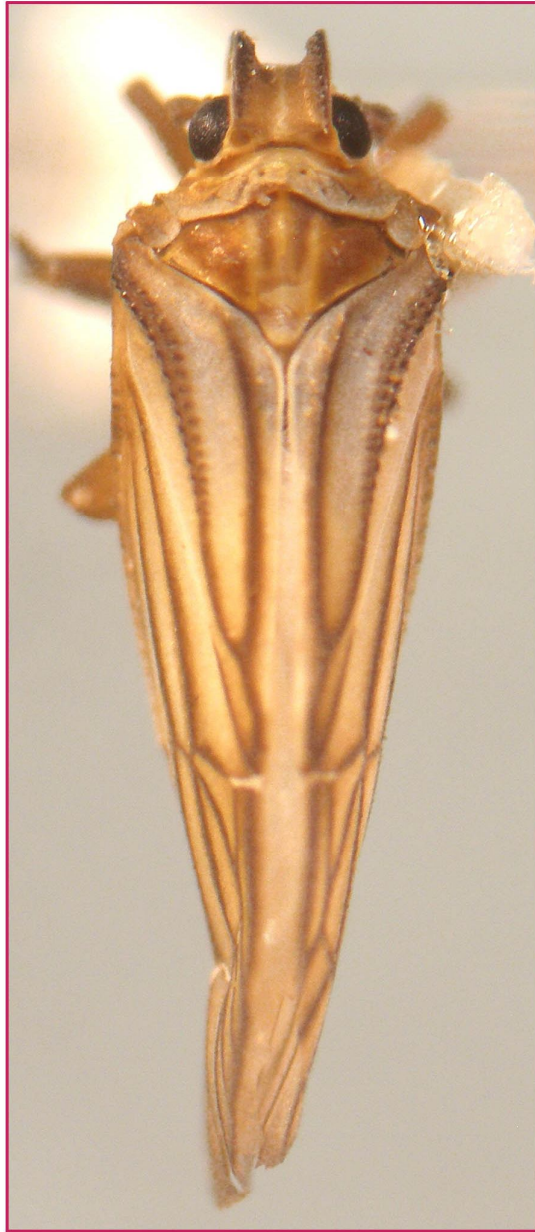


A



B

Plate 9 : A. *Tropidocephala serendiba* (Melichar)  
B. *Pyrilla perpusilla pusana* (Distant)



A

Plate 10: *A. Nisia nervosa* (Motschulsky)



## CHAPTER -V

### DISCUSSION

Delphacidae is the largest family of planthoppers belonging to the super family Fulgoroidea of the order Hemiptera. Members of this family mostly feed on grasses and some feed on different crops viz., rice, sugarcane, maize and sorghum and thus economically important. Delphacidae also contains potent vector genera which transmit various microorganisms causing diseases in crop plants. Revisionary works on many genera of planthoppers belonging to the super family Fulgoroidea of Auchenorrhynchos-Hemiptera done by various scientists in India and abroad are available, but the literature on a consolidated work of a specific agro-ecosystem is limited. 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 Fulgoridae on rice. Ishihara and Lowe (1969) reported six planthoppers associated with rice ecosystems in the major rice growing areas in India. Misra (1980) recorded two planthoppers viz., *S. fucifera*, *N. lugens* and considered these two planthoppers as major pests of rice crop in Orissa. The correct identification of planthoppers associated with different crop ecosystems is very much needed for accurate identification and there by to suggest suitable pest management practices whenever they reach the pest status. Since, studies

on this important super family are lacking in Andhra Pradesh, the present studies entitled "Taxonomic studies on planthopper fauna (Fulgoroidea: Hemiptera) of Andhra Pradesh" were undertaken to study the planthopper fauna on rice, sugarcane, maize and sorghum crop ecosystems.

During the course of study, 19 planthopper species belonging to 16 genera comprising of four families viz., Delphacidae, Cixiidae, Meenoplidae and Lophopidae of the super family Fulgoroidea were identified from different agro-climatic zones of Andhra Pradesh. All these species were adequately described, illustrated with line drawings and good colour photographs. The identification key for distinguishing these economically important planthopper species was given in detail in the results chapter. In the present investigation, four planthopper species viz., *Coronacella sinhalana* (Kirkaldy), *Euidella* sp. on rice, *Perkinsiella* sp. on sorghum and maize and *Tropidocephala serendiba* (Melichar) on sugarcane were recorded for the first time in Andhra Pradesh.

### **5.1 Family: Delphacidae (Delphacid planthoppers)**

The Delphacidae is the largest family of planthoppers and its members can be recognized by the flattened spur at the apex of the hind tibia. They are usually small insects lesser than 5 mm in length with tectiform wings, often brachypterous, feeding mostly on monocots and also the dicots. There are about 1835 species of which 22 are recorded on rice (Wilson and O'Brien, 1987). Rao and Chalam (2007) reported 23 delphacid planthoppers in India from rice and sugarcane ecosystems. In present studies 16 delphacid planthoppers were collected, described and identified. They are *Nilaparvata lugens* (Stal), *Sogatella*

*furcifera* (Horvath), *Sogatella kolophon* (Kirkaldy), *Sogatella vibix* (Haupt), *Tagosodes pusanus* (Distant), *Terthron albovittatum* (Matsumura), *Toya propinqua* (Fieber), *Sardia rostrata* (Melichar), *Harmalia anacharsis* (Fennah), *Cemus* sp., *Tropidocephala serendiba* (Melichar), *Peregrinus maidis* (Ashmead), *Eudiella* sp., *Perkinsiella* sp., *Perkinsiella sinensis* Kirkaldy and *Coronacella sinhalana* (Kirkaldy).

Among the identified delphacid planthoppers *N. lugens* and *S. furcifera* were considered as major pests causing severe damage to rice crop by sucking the sap and plugging the xylem and phloem with their feeding sheaths and the honeydew secreted by them encourages sooty mould. *N. lugens* commonly called as Brown planthopper (BPH), can be identified externally by its yellowish brown colour, position of leaf like mobile spur on the apex of hind tibia and spinuation on hind tarsus, but the authentic identification is based on male genitalia *i.e.*, aedeagus slender, broader medially, tapering apically with upturned apex; genital styles flattened, inner margin deeply concave in middle. In the present studies three species belonging to genus *Sogatella viz.*, *S. furcifera*, *S. kolophon* and *S. vibix* were identified and studied in detail. Among these three, *S. furcifera* was considered as major pest on rice. *S. furcifera* has a distinct yellowish white longitudinal band in the middle of mesothorax hence commonly referred as white backed planthopper. The distinguishing male genital characters include, twisted aedeagus tapering towards apex with two rows of small teeth; diaphragm 'U' shaped and genital styles strongly dilated at base. *S. kolophon* can be identified by its genital styles which are deeply bifurcated distally and anterior process of the apical bifurcation strongly produced tapering towards apex. The diaphragm is

rectangular in shape. *S. vibix* can be identified by a 'U' shaped diaphragm and genital styles which are not as deeply bifurcated as that of *S. kolophon*. However *S. furcifera*, the commonest among these three species of *Sogatella*, can be easily identified by its external colouration. The differentiation of three species viz., *S. furcifera*, *S. kolophon* and *S. vibix* can be done on the basis of diaphragm and styles. In the present investigation, a species that externally closely resembles that of *S. furcifera* was collected and identified as *Tagosodes pusanus*. Even though the two species externally resemble each other, they can be easily distinguished by their aedeagal characters. In case of *T. pusanus* the aedeagus is tubular, never twisted, with two to three spines sub apically, but in *S. furcifera* the aedeagus is tubular with rows of teeth.

*Sardia rostrata* which was collected and identified in the present investigation can be distinguished on its colour i.e., dark brown tegmina with distinct pterostigma. The aedeagus is straight, tubular with distinct subapical serrations. *Cemus* sp. is characterized by aedeagus elongated, slightly decurved with a long process arising at apex. The tegmina are granulated with fuscous veins. *Coronacella sinhalana* which was recorded for the first time in Andhra Pradesh can be identified by its characteristic cream coloured band on pronotum and tubular aedeagus with small teeth near apex. Another planthopper species viz., *Euidella* sp. was also identified for the first time in Andhra Pradesh, which can be identified by its L-shaped genital style; aedeagus flattened, curved with a pair of long unequal subapical processes. *Harmalia anacharsis* is characterized by tubular aedeagus with uniform width throughout and without any spinuation, the genital styles are deeply bifurcated. In the present studies *Peregrinus maidis*

which was collected from sorghum and maize ecosystems can be identified by its light yellow brown to yellow orange colour and mesonotum with a pair of orange longitudinal bands. The aedeagus is long, narrow and whip like with subapical processes. Two species belonging to genus *Perkinsiella* viz., *Perkinsiella sinensis* and *Perkinsiella* sp. were collected from sorghum and maize crop-ecosystems. Out of these two species, *Perkinsiella* sp. was recorded for the first time from Andhra Pradesh. Both species resemble each other in colouration and external appearance, but can be distinguished by male genital characters viz., aedeagus with a small subapical spine in *Perkinsiella sinensis* where as in *Perkinsiella* sp. the aedeagus is elongated, curved with a pair of processes subapically. In *Perkinsiella sinensis* genital styles are foot shaped where as in *Perkinsiella* sp. genital styles are not foot shaped. Among the delphacid planthoppers collected from the sugarcane crop ecosystem a new planthopper species viz., *Tropidocephala serendiba* was identified for the first time from Andhra Pradesh. It can be identified by a sclerotised serrated processes arising near inner side of style and sickle shaped aedeagal process arising from the base of the aedeagus. *Terthron albovittatum* is characterized by tubular aedeagus which is deeply curved and densely spinose genital styles. *Toya propinqua* can be identified by a Y-shaped diaphragm with serrated aedeagus.

In the present investigation 16 delphacid planthopper species from four crop-ecosystems were identified. All these species were adequately described and identification key was provided along with figures of genital parts and coloured photographs in the results chapter. The delphacid planthopper species found associated with rice crop ecosystem were *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 albovittatum* (Matsumura), *Tagosodes pusanus* (Distant) and *Toya propinqua* (Fieber). The delphacid planthopper fauna associated with sorghum and maize were *Perigrinus maidis* (Ashmead), *Perkinsiella* sp. and *Perkinsiella sinensis* Kirkaldy and five delphacid planthopper species found associated with sugarcane were *Tripidocephala serendiba* (Melichar), *Toya propinqua* (Fieber), *Tagosodes pusanus* (Distant), *S. furcifera* and *S. kolophon*. Wilson and Claridge (1985) reported 25 delphacids on rice in major rice growing areas in the world. Wilson and O'Brien (1987) reported 22 delphacids on rice. Ishihara and Lowe (1969), Kalode (1983) and Misra (1980) reported 4 delphacids viz., *N. lugens*, *S. furcifera*, *S. rostrata* and *U. sapporonus* from India. Narayana *et al.* (2005) reported 7 planthoppers species associated with different rice ecosystems of Andhra Pradesh. Rao and Chalam (2007) reported 18 species of delphacid planthoppers on rice and 10 delphacids on sugarcane ecosystems from South India. Shashank (2009) reported 5 delphacid planthoppers viz., *Cemus* sp., *Nilaparvata lugens*, *Sogatella furcifera*, *Sardia rostrata*, and *Tagosodes pusanus* found associated with different rice ecosystems from Karnataka.

## **5.2 Family: Meenoplidae** (Meenoplid planthoppers)

In the present investigation one meenoplid planthopper associated with rice viz., *Nisia nervosa* was identified. *N. nervosa* is characterized by moderately long pygofer which is shoe shaped laterally. Aedeagus very broad basally, gradually narrowed and slightly curved with a pair of transparent wing like

structures. Meenoplids can also be identified by the presence of one or both claval veins tuberculate and hind tarsomere with apical spines. They are small, 3-7 mm in size, pale grey to black insects. This family consist of 53 species of which *Nisia nervosa* (Motshulsky) is a minor pest of rice, taro, sugarcane (Wilson and O'Brien, 1987). Ishihara and Lowe (1969) also reported this planthopper on rice at Maruteru, Warangal in Andhra Pradesh and also at Patna, Coimbatore and Cuttack. Narayana *et al.* (2005) also reported *N. nervosa* on rice from Andhra Pradesh. Shashank (2009) reported *N. nervosa* associated with different rice eco-systems from coastal and central Karnataka.

### **5.3 Family: Cixiidae** (Cixiid planthoppers)

In the present study *Oliarus* sp. (Cixiidae: Hemiptera) was collected on rice and described in detail. *Oliarus* sp. can be recognized by the presence of large mesonotum with five carinae, tegmina with black dots all along the veins. Aedeagus tubular with curved elongated flagellum like processes; genital styles with spines densely scattered.

The Cixiid planthoppers may also be identified by the forewings which are usually membranous having tubercles set with small setae along the veins. The size of these members range from 3-11 mm, this family consists of 768 species which includes 11 species regarded as pests on 11 crops and only one species *Oliarus apicalis* (Uhler) on rice (Wilson and O' Brien, 1987). The other *Oliarus* species reported on different crops were, *O. annandalei cocosivora* Muir on coconut palm, *O. atkinsoni* Myers on flax lily, *O. mori* Matsumura on mulberry, *O. oryzae* Matsumura on sugarcane and rice and *Oliarus* sp. on mango

(Wilson and O' Brien, 1987). Narayana et al. (2005) reported *Oliarus* sp. associated with different rice eco-systems from Andhra Pradesh.

#### **5.4 Family: Lophopidae** (Lophopid planthoppers)

In the present study, *Pyrilla perpusilla pusana* (Distant) belonging to family Lophopidae was collected on sugarcane which can be identified by means of its well developed cephalic process and shape. These planthoppers were characterized by conjunctival hook of phallus which is very strongly developed and slightly twisted in the middle. These planthoppers may also be identified by the absence of spines on 2<sup>nd</sup> hind tarsomere, vertex with width less than 3 times length at midline and frons, usually longer than wide with 1 to 3 longitudinal carinae. They vary in length from 6-15 mm. The sub species of *Pyrilla perpusilla pusana* were reported by Pruthi (1937) from India. Fennah (1963a) reported and described 10 subspecies of *Pyrilla perpusilla*. Among these, *Pyrilla perpusilla* Walker was considered as a major pest of sugarcane and rice in India (Brar and Bains, 1979 and Rahman and Nath, 1940). Prasad (1992) collected *P. perpusilla* from sugarcane at several locations in Haryana, Bihar and Uttar Pradesh in India, and the morphology of forms from different areas of India was described. The rainy season form viz., *Pyrilla perpusilla* var. *negriventris* nov. a new form was proposed. Lakshminarayana et al. (2003) reported *P. pusana* (Lophopidae) for the first time from rice-ecosystems of Andhra Pradesh, India. The brief male genitalia descriptions and diagnosis of these species were given.

Among the planthoppers identified, two species viz., Brown planthopper (BPH), *Nilaparvata lugens* (Stal) and white backed planthopper (WBPH), *Sogatella furcifera* (Horvath) were observed as major pests of rice. *Pyrilla perpusilla pusana* (Distant) on sugarcane; *Peregrinus maidis* (Ashmead) on



sorghum and maize were observed to be in minor pest status and the remaining were only associated with different crop ecosystems. The brown planthopper *Nilaparvata lugens* was described as *Delphax lugens* by Stal in 1854 and the white backed planthopper, *Sogatella furcifera* by Horvath as *Delphax furcifera* in 1899 which were reported as minor pests during 1960's but now both have attained major pest status causing devastating damage throughout the major rice growing areas of the world. Hence, the accurate identification of fauna associated with a particular agro-ecosystem is very much needed which may or may not attained pest status at present.

## Conclusions

The following conclusions are drawn from the present investigation.

1. Nineteen species of planthoppers belonging to 16 genera under 4 families were identified.
2. During the present studies, four species were recorded for the first time from Andhra Pradesh. They are

1. *Coronacella sinhalana* (Kirkaldy)
2. *Euidella* sp.
3. *Tropidocephala serendiba* (Melichar)
4. *Perkinsiella* sp.

3. During the present studies, following planthoppers were identified from rice crop ecosystem.

1. *Nilaparvata lugens* (Stal)
2. *Sogatella furcifera* (Horvath)
3. *S. kolophon* (Kirkaldy)
4. *S. vibix* (Haupt)
5. *Cemus* sp.
6. *Coronacella sinhalana* (Kirkaldy)
7. *Euidella* sp.
8. *Harmalia anacharsis* (Fennah)
9. *Sardia rostrata* (Melichar)
10. *Terthron albovittatum* (Matsumura)
11. *Tagosodes pusanus* (Distant)
12. *Oliarus* sp.

13. *Nisia nervosa* (Motschulsky)

4. The following six planthopper species were identified from sugarcane crop ecosystem.

1. *Tropidocephala serendiba* (Melichar)

2. *Pyrilla perpusilla pusana* (Distant)

3. *Toya propinqua* (Fieber)

4. *Tagosodes pusanus* (Distant)

5. *Sogatella furcifera* (Horvath)

6. *S. kolophon* (Kirkaldy)

5. The following three species were identified from maize and sorghum crop ecosystems.

1. *Peregrinus maidis* (Ashmead)

2. *Perkinsiella* sp.

3. *Perkinsiella sinensis* Kirkaldy

6. Key for separating all these planthoppers studied in the present investigation, are provided and supplemented with illustrations and colour photographs for easy identification of the species.

7. In the present investigation, the two delphacid planthoppers viz., *Nilaparvata lugens* (Stal) and *Sogatella furcifera* (Horvath) were observed as major pests of rice. *Pyrilla perpusilla pusana* (Distant) on sugarcane; *Peregrinus maidis* (Ashmead) on sorghum and maize were observed to be in minor pest status and the remaining were only associated with different crop ecosystems.

# CHAPTER - VI

## SUMMARY

The investigation on Taxonomic studies on planthopper fauna (Fulgoroidea: Hemiptera) of Andhra Pradesh was conducted at Agricultural College, Bapatla, Guntur District during 2009-2010. The summary of the results obtained from the present study is presented here under.

### TAXONOMIC STUDIES ON PLANTHOPPERS

The planthoppers were collected from rice, sugarcane, maize and sorghum ecosystems of Andhra Pradesh, processed in the laboratory, adequately described and identified. The list of nineteen planthopper species belonging to 16 genera under 4 families and associated crop-ecosystems were provided here under.

### Biodiversity of planthopper fauna (Hemiptera: Fulgoroidea) of different crop-ecosystems in Andhra Pradesh.

Crop ecosystem	Name of the species
1. Rice	<i>Nilaparvata lugens</i> (Stal)
	<i>Sogatella furcifera</i> (Horvath)
	<i>S. kolophon</i> (Kirkaldy)
	<i>S. vibix</i> (Haupt)
	<i>Cemus</i> sp.
	<i>Coronacella sinhalana</i> (Kirkaldy)
	<i>Euidella</i> sp.
	<i>Harmalia anacharsis</i> (Fennah)
	<i>Sardia rostrata</i> (Melichar)

	<i>Terthron albovittatum</i> (Matsumura)
	<i>Tagosodes pusanus</i> (Distant)
	<i>Oliarus</i> sp.
	<i>Nisia nervosa</i> (Motschulsky)
	<i>Toya propinqua</i> (Fieber)
<b>2. Sugarcane</b>	<i>Tropidocephala serendiba</i> (Melichar)
	<i>Pyrilla perpusilla pusana</i> (Distant)
	<i>Toya propinqua</i> (Fieber)
	<i>Tagosodes pusanus</i> (Distant)
	<i>Sogatella furcifera</i> (Horvath)
	<i>S. kolophon</i> (Kirkaldy)
<b>3. Maize</b>	<i>Peregrinus maidis</i> (Ashmead)
	<i>Perkinsiella</i> sp.
	<i>Perkinsiella sinensis</i> Kirkaldy
<b>4. Sorghum</b>	<i>Perkinsiella</i> sp.
	<i>Perkinsiella sinensis</i> Kirkaldy
	<i>Peregrinus maidis</i> (Ashmead)

Among these the following four species were recorded for the first time from Andhra Pradesh.

1. *Euidella* sp.
2. *Tropidocephala serendiba* (Melichar)
3. *Perkinsiella* sp.
4. *Coronacella sinhalana* (Kirkaldy)

The economically important planthoppers are mostly found in the family Delphacidae. The identification 'Key' for distinguishing all these planthoppers was provided along with the line diagrams and the colour photographs of each specimen for clear understanding and easy identification of these planthoppers.

In the present investigation, the two delphacid planthoppers viz., *Nilaparvata lugens* (Stal) and *Sogatella furcifera* (Horvath) were observed as major pests of rice. *Pyrilla perpusilla pusana* (Distant) on sugarcane; *Peregrinus maidis* (Ashmead) on sorghum and maize were observed to be in minor pest status and the remaining were only associated with different crop ecosystems. The present investigations are very much useful in order to increase the capabilities of identifying fauna of planthoppers of the super family Fulgoroidea associated with rice, sugarcane, maize and sorghum crop ecosystems. This study help to adopt species specific Integrated Pest Management Programmes.

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