STUDIES ON PLANTHOPPERS (HEMIPTERA:DELPHACIDAE) OCCURRING IN DIFFERENT AGROECOSYSTEMS IN KARNATAKA

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BANGALORE

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Affectionately Dedicated to

My Beloved parents

&

My beloved teacher Dr. C.A. Viraktamath

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
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CERTIFICATE

This is to certify that the thesis entitled, "Studies on planthoppers (Hemiptera: Delphacidae) occurring in different agro-ecosystems in Karnataka" submitted by **Ms. Nimisha, K.K., PAK 5095** in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture)** in **AGRICULTURAL ENTOMOLOGY** to the University of Agricultural Sciences, Bangalore, is a bona fide record of research work done by her during the period of her study in this University under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

Bangalore
July, 2008

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THESIS ABSTRACT

The study of planthoppers (Hemiptera: Delphacidae) in different agroecosystems of Karnataka was undertaken based on 818 specimens collected from districts of Bangalore Rural, Bangalore Urban, Chikmagalur, Dharwad, Kodagu, Kolar, Mandya and Mysore. The study dealt with both male genitalia characters and external morphology. Three subfamilies, 28 species belonging to 20 genera were studied. Diagnostic characters of the taxa along with the keys for their identification are given. Subfamily Delphacinae is represented two tribes, Delphacini and Tropidocephalini, 20 genera and 25 species. The genera represented in Delphacini are *Cemus* Fennah, *Coronacella* Metcalf, *Euidella* Puton, *Harmalia* Fennah, *Neycheuma* Fennah, *Nilaparvata* Distant, *Nothokalpa* Fennah, *Opiconsiva* Distant, *Peregrinus* Kirkaldy, *Perkinsiella* Kirkaldy, *Sardia* Melichar, *Sogatella* Fennah, *Syndelphax* Fennah, *Tagosodes* Asche & Wilson, *Toya* Distant. Genera of Tropidocephalini included *Arcofasciella* Fennah, *Purohita* Distant and *Tropidocephala* Stål. Species of the tribe Tropidocephalini were collected exclusively on bamboo and sugarcane and Delphacini from different annual monocotyledonous plants. Subfamily Stenocraninae was represented by a single genus *Stenocranus* Fieber containing two species collected from sugarcane and lemon grass. In the subfamily Vizcayinae the genus *Vizcaya* and the species *Vizcaya vindaloa* Asche were recorded. The genus *Arcofasciella* Fennah, *Vizcaya* Muir, the species *Neycheuma coctum* Yang, *Nilaparvata bakeri* (Muir), *Syndelphax euroclydon* Fennah and *Vizcaya vindaloa* Asche are reported for the first time from Karnataka.

Signature of student

Signature of Major advisor

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INTRODUCTION

I. INTRODUCTION

Hemiptera are a large and diverse group of insects with piercing and sucking type of mouth parts. This order is divided into five homophyletic groups. Two of these Fulgoromorpha (planthoppers) and Cicadomorpha (cicadas, froghoppers and leafhoppers) belong to Auchenorrhyncha. The other three are Heteroptera (true bugs), Sternorrhyncha (jumping lice, plant lice, scale insects and mealy bugs) and Coleorrhyncha (Campbell *et al*., 1995). These are hemimetabolous insects that suck plant juice. The planthoppers differ from leafhoppers in having a few large spines on the hind tibiae and the antennae arising below the compound eye.

Planthopper family Delphacidae belongs to the superfamily Fulgoroidea of auchenorrhynchous Hemiptera comprising 20 families. It is the largest family of the Fulgoroidea with more than 2000 described species approximately 300 genera and six subfamilies world wide (Asche, 1990). Almost all delphacids have a very limited host range with 70 percent of them being monophagous. Most host species are monocotyledonous plants, however there are delphacid genera with affinities for some dicotyledonous taxa such as Asteraceae (Wilson *et al*., 1994).

Delphacidae can be identified by the presence of hind tibial spur and by the easily visible antennae in dorsal view. They are usually small insects less than 5 mm long with tectiform wings and are often brachypterous. Females have an ensiform ovipositor and eggs are inserted into leaves or tender shoots. The five nymphal instars feed at the base of their host plants (O'brien and Wilson 1985). They are more abundant in moist habitats like rice and sugarcane ecosystems, on plants growing in marshy areas etc., a few species also colonize bamboo (Wilson and O'brein, 1987). Many species overwinter as nymphs and others overwinter as eggs or adults. They also exhibit wing dimorphism. Brachypterous forms are typical of relatively persistent stable habitat with low-lying vegetation whereas macropterous forms are characteristic of temporary often unstable habitats such as field crops. Macropterous forms have fully developed tegmina extending beyond the tip of abdomen and brachypterous forms have short tegmina with reduced wing venation. Only the macropterous forms have fully developed hind wing and the

ability to fly. Brachypterous forms are sometimes called as koeliopterous where the tegmina are not excessively reduced but instead cover the greater part of the abdomen, or just cover it completely and have the apical cells moderately developed.

The economically important planthoppers are mostly found in Delphacidae. They are phytophagous and more commonly feed by sucking plant sap and plugging the xylem and phloem vessels with feeding sheaths. The honeydew excreted by them encourages growth of sooty mould. Planthoppers damage plants directly by feeding, which cause a characteristic yellowing of tissues known as hopper burn or indirectly as vectors of a variety of plant pathogens (Denno and Roderick, 1990). Delphacidae include 55 species recorded as pests of 25 plant species. Among these 27 species are vectors of viruses or presumed viruses of 13 host plants. These include nine virus vectors of rice, three of sugarcane, one of taro, two of coconut palms, seven of maize and nine of the cereals, oats, wheat, barley and rye (Wilson and O'brein, 1987).

The economically important planthoppers are; (1) the Brown planthopper *Nilaparvata lugens* (Stål), an endemic pest of Asian rice in the tropics and vector of grassy stunt and ragged stunt viral diseases; (2) *Laodelphax striatellus* (Fallen) vector of rice stripe and black streaked dwarf; (3) *Tagosodes oryzicolus* (Muir) vectoring rice hoja blanca disease (Narayana *et al*., 2005); (4) sugarcane planthopper *Perkinsiella saccharicida* Kirkaldy widely distributed in tropical areas and cause damage by feeding and also vectoring Fiji disease of sugarcane and (5) corn planthopper *Peregrinus maidis* (Ashmead), is a pantropical and sub-temperate pest of corn and sorghum. It vectors maize mosaic virus and maize stripe; also has been reported sporadically as a pest of sorghum in south India and it also vectors sorghum chlorosis virus (Benrey and Lamp, 1994).

Intensive agriculture paved way for tremendous change in the pest fauna of agricultural crops and the pests of minor importance have attained major pest status. Hence, accurate identification of pest species affecting any crop is the first and foremost important step in integrated pest management programme. Rao and Chalam (2007) reported on the biodiversity of planthopper fauna associated with rice and sugarcane ecosystems mainly from Andhra Pradesh. Similar systematic study of planthoppers of

Karnataka is not available to date. Keeping these lacunae in view the present study was undertaken with the following objectives:

1. To collect different species of planthoppers occurring on different crop habitats in Karnataka.
2. To record the host plants of Delphacidae with emphasis on economically important species.
3. To identify the collected material, redescribe poorly known genera and species and describe new taxa if any discovered.
4. To prepare an illustrated key for the identification of Delphacidae of Karnataka.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The planthopper family Delphacidae belongs to the superfamily Fulgoroidea of auchenorrhynchous Hemiptera. Delphacidae is the largest family of the Fulgoroidea with more than 2000 described species grouped in approximately 300 genera and six subfamilies world wide (Asche,1990). Delphacidae can be easily identified by the presence of a movable hind tibial spur. They are usually small insects, less than 5mm with tectiform wings, often brachypterous, feeding mostly on monocots but also on dicots (O'brien and Wilson 1985).

2.1 Economic importance of planthoppers

Delphacidae are cosmopolitan and occur in both Old and New world. The nymphs and adults occur together on the above ground parts of their host plants although many species inhabit the basal portion of their host and are associated with the crown. They cause direct damage by feeding and oviposition and indirect damage by vectoring plant disease causing organisms. Brown planthopper, *Nilaparvata lugens* (Stål) is the endemic pest of Asian rice in the tropics (Benrey and Lamp, 1994). Brown planthopper acts as vector of grassy stunt and ragged stunt viral disease of rice (Narayana *et al*., 2005). Sugarcane planthopper, *Perkinsiella saccharicida* widely distributed in tropical areas cause damage by feeding and also vectors Fiji disease of sugarcane. Taro planthopper, *Tarophagus colocasiae*, attacks taro and is suspected vector of alomae and bobone virus disease and also causes injury by feeding. Corn planthopper, *Peregrinus maidis* is a pantropical and sub-temperate pest of corn and sorghum. It vectors maize mosaic virus and maize stripe virus. *Peregrinus maidis* has been reported sporadically as a pest of sorghum in south India and it also vectors sorghum chlorosis virus. Cereal planthopper, *Javasella pellucida* (Fabricius), is a serious pest of cereals especially oats in Europe and its distribution is limited to the temperate areas of the northern hemisphere (Benrey and Lamp, 1994). Kalode (1983) listed the planthoppers of rice in India including *Nilaparvata lugens* (Stål), *Sogatella furcifera* (Horváth), *Unkanodes sapporonus* (Matsumura) and *Laodelphax striatellus*. *Laodelphax striatellus* (Fallen) has been implicated as possible vector of an MLO (Mycoplasma like organism) of citrus (Wilson

and O'brien, 1987). Wilson (2005) reviewed the economic importance of planthoppers and listed 28 species of Delphacidae as vectors of Phytoplasma and viral pathogens of sugarcane, maize, sorghum, barley, taro, rice, wheat and oats. He also prepared a key for the economically important species. Chatterjee (1971) for the first time reported the serious damage caused by the planthopper *Eoeurysa flavocapitata* Muir on sugarcane in India.

Rao and Chalam (2007) explored the biodiversity of planthopper fauna associated with rice and sugarcane crop-ecosystem in south India. They covered the five states, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala and Maharashtra and 23 planthoppers of 17 genera were identified. They recorded 12 species of nine genera for the first time from India.

Beneficial role of planthoppers had been studied. Sosa *et al*., (2005) studied the life history of *Megamelus scutellaris* Berg and described the immature stages. Biological data obtained based on the laboratory study and field observations indicate it to be a potential biolocontrol agent of the invasive aquatic weed *Eichhornia crassipes* (Martius) Solms Laubach.

2.2 Host plant association

Delphacidae show a strong tendency towards monophagy. Among the species with recorded hosts 74% are reported from a single host plant genus; only 14% are oligophagous and 12% are polyphagous. Narrow host range is characteristic of species of all delphacid subfamilies and tribes, from primitive (Asiracinae) to advanced (Delphacinae). Examples include the Asiracine genus *Pentagramma*, all species are restricted to the *Scirpus* (Cyperaceae), the Kelisine *Anakelisia* reported only on *Carex* (Cyperaceae), the *Ples*iodelphacine genus *Burnila*, known only from *Heliconia* (Heliconiaceae). In the Delphacini *Conomelus* feeds only on *Juncus* (Juncaceae), *Nilaparvata* feeds on *Oryza* (Poaceae) and closely related *Leersia* (Poaceae) and *Tarophagus* is restricted to *Colocasia* (Araceae). The tribe Ugyopini the most primitive Delphacids, appear to feed mostly on woody dicots (63% of records), ferns (25%) and among the monocots only Araceae have been recorded as hosts. The records for the small

tribe Asiracini include dicots, ferns and monocots (Cyperaceae). The Kelisinae feed only on monocots and appear restricted to Cyperaceae (83% of the records), Juncaceae (17%) and the Stenocraninae occur only on the Poaceae (62%) and Cyperaceae (38%). Within the Delphacinae, the Tropidocephalini and Saccharosydnini feed exclusively on Poaceae. The Delphacini also show strong affiliation with the Poaceae and Cyperaceae (Wilson *et al*., 1994).

2.3 Systematics of Delphacidae

The largest family of Fulgoroidea is the Delphacidae with six subfamilies and nine tribes. In phylogenetic sequence, they are as follows: Asiracinae (176 spp.) including Ugyopini (148 spp.) and Asiracini (176 spp.); Vizcayinae (5 spp); Kelisiinae (44 spp); Stenocraninae (64spp.) Plesiodelphacinae (7 spp.) and Delphacinae (1221 spp.) including the Delphacini (1090 spp.), Tropidocephalini (122spp.) and Saccharosydnini (9 spp.) (Wilson *et al*., 1994).

Metcalf (1943) catalogued the world Delphacidae under the name Areopidae, considering *Areopus* Spinola 1839 as the type genus. The catalogue dealt with 137 genera and 1114 species. Delphacidae was not recognized by the earlier workers, but in 1798 Fabricius recognized the group by describing the genus *Delphax*. The group was given family rank by Leach in 1815. This nomenclatural controversy was resolved when the International Commission on Zoological Nomenclature (1961) placed Delphacidae on its Official List of Family Group names and fixed the type genus as *Delphax* Fabricius (Hamilton, 2006).

One of the earliest works on the Indian fauna of Delphacidae is by Distant (1906, 1916) in the monumental Fauna of British India series. He treated the family as the subfamily Delphacinae under the family Fulgoridae recognised by long robust mobile spur attached to the apices of the posterior tibiae. Distant (1906, 1916) dealt with 19 genera and 51 species including nine new genera and 15 new species. Among the list of new taxa described two genera and three species were from south India. Distant (1906) provided a key for 11 genera.

Muir (1916) made some additions to the known Philippine Delphacidae. He clearly stated the necessity of studying the male genetalia especially in the case of complex groups. He classified the family into two subfamilies Delphacinae and Asiracinae and under the subfamily Delphacinae he recognized two tribes Tropidocephalini and Delphacini.

Fennah (1963) studied the *Sogata furcifera* species complex. He recognized 23 distinct species, some having been restored from synonomy and others described as new. They were all referred to one of the three genera *Matutinus* Distant, *Sogatella* Fennah and a new genus *Sogatodes* Fennah.

Fennah (1973-75) studied the Delphacid fauna of Ceylon. He treated them under two subfamilies Asiracinae and Delphacinae with two tribes Delphacini and Tropidocephalini under Delphacinae. Under Asiracinae he studied two genera and two species. The study included five genera, ten species under Tropidocephalini and 32 genera, 57 species under Delphacini of the subfamily Delphacinae. All together he dealt with 39 genera and 69 species with their provincial distribution. Nine new genera, 25 new species and one new subspecies were recognized in addition to several recombinations and synonomies. Fennah (1956) prepared a key for the genera of Delphacidae of Australia and Pacific islands.

Fennah (1978) studied the Fulgoroidea from Vietnam and dealt with 25 genera and 34 species. Rao (1965) reported *Tropidocephala saccharivorella* Matsumura from India on sugarcane from Bangalore and Mandya. Joseph (1964) reported a new species of *Stenocranus*, *S ajmerensis* Joseph from Ajmer, Rajasthan. Mammen (1971) studied the Indian Delphacidae and dealt with 23 genera and 45 species and also provided a key to subfamilies, tribes, genera and species. Mammen and Menon (1974) erected five new genera and 19 new species from India.

Asche and Wilson (1990) revised the genus *Sogatella* and related genera associated with rice. They redefined *Sogatella* and provided a key to the males of the 14 species. They considered type species of *Sogatodes* Fennah, *S molinus* Fennah to be a

Sogatella species and suppressed *Sogatodes* as a junior subjective synonym of *Sogatella*.The remaining species of *Sogatodes* were transferred to *Tagosodes* Acshe & Wilson.

Asche (1990) established a new subfamily Vizcayinae under Delphacidae for the Oriental genus *Vizcaya* Muir containing four species, among these *V. vindaloa* Asche was from south India. Along with the revisionary work of the genus *Vizcaya* Muir he provided a key for the subfamilies and tribes of Delphacidae and the species of *Vizcaya*. Liang (2002) described a new genus *Neovizcaya* for the inclusion of a new species under the subfamily Vizcaynae and also described five new species, four of *Vizcaya* and one from *Neovizcaya. V aschei* Liang was reported from south India.

Chen and Liang 2007 revised the oriental genus *Bambusiphaga* Huang and Ding and provided a key to the known species of the genus.

Hamilton (2006) studied the planthopper genus *Stenocranus* from Canada and revised classification of the Delphacidae. He recognized two subfamilies namely Asiracinae and Delphacinae and four tribes Vizcayini, Stenocranini, Tropidocephalini and Delphacini under Delphacinae. The subfamily Kelisiinae was reduced to the sub-tribe of Stenocranini and Saccharosydnini was placed within Tropidocephalini.

2.4 Tribes and genera of the subfamily Delphacinae

2.4.1 Tribe Delphacini

The tribe Delphacini was established by Muir (1915) and is the largest of the three tribes (Zheng, 2005). The tribe is characterised by the variously shaped post-tibial spur, either solid or flattened and normally with teeth on hind margin; the base of the aedeagus is not strongly twisted and is almost symmetrical; the diaphragm between base of aedeagus and anal segment is differentiated into a distinct plate- or ring-like suspensorium; apodemes of first abdominal sternite of male drumming organ is not bent ventrally but is directed mediodorsally (Asche, 1990).

Genus *Cemus* Fennah

Fennah (1964) described the genus *Cemus* with *Cemus leviculus* Fennah as the type species. The species of the genus are characterized by the shape of the head and the coloration of the forewings (Wilson and Claridge, 1991). Distant (1916) described *Pundaluoya pulchella* Distant from Travancore which is now considered as a junior synonym of *Cemus leviculus* Fennah

Genus *Coronacella* Metcalf

Metcalf (1950) described *Coronacella* with *Kelisia kirkaldyi* Muir as the type species. Rao and Chalam (2007) reported *Coronacella sinhalana* (Kirkaldy) on rice from Karnataka.

Genus *Euidella* Puton:

Puton established the genus *Euidella* with *Euidella basiliniea* as the type species.

Genus *Harmalia* Fennah

Fennah (1969) established the genus with *Sogata thoracica* Distant as the type species.

Genus *Nilaparvata* Distant

Distant (1906) established the genus *Nilaparvata* with *Delphax lugens* (Stål) *as* the type species. Bartlett (2007) revised the genus for the New World. This genus can be separated from other genera of Delphacini by the presence of teeth on the hind basitarsus. There are usually one to three teeth on the proximal half of the ventral margin of the hind basitarsus. At present this genus contains19 species distributed in the Oriental, Australian and Afrotropical regions.

Genus *Nothokalpa* Fennah

Fennah (1973-75) established the genus with *Nothokalpa salome* as the type species. This genus ressembles *Nilaparvata* but differs in the relatively longer and

anteriorly narrowing vertex and in the absence of spines on the basal segment of the hind tarsus.

Genus *Opiconsiva* Distant

Distant (1917) established the genus with *Opiconsiva fuscovaria* Distant as the type species.The genus is characterized by the tubular aedeagus with dorsal basal extensions (Wilson and Claridge, 1991). Zheng and Zhong (2000) described a new species *O albimarginata* from China.

Genus *Peregrinus* Kirkaldy

Kirkaldy (1904) established the genus *Peregrinus* with *Delphax maidis* Ashmead as the type species. The genus can be easily identified by the characteristic coloration of forewings and by the the distinctive male genetalia (Wilson and Claridge, 1991). Distant (1916) described *Pundaluoya simplica* from the Chikkaballapura which is now considered as junior synonym of *Peregrinus maidis*.

Genus *Perkinsiella* Kirkaldy

Kirkaldy (1903) described *Perkinsiella* with *Perkinsiella saccharicida* Kirkaldy as the type species.The genus includes large planthoppers with broad head often with a broad yellow or white stripe from the vertex extending to the pronotum and mesonotum (Wilson and Claridge, 1991). Distant (1916) described a species *Pundaluoya insignis* Distant from Bombay which is now placed in this genus.

Genus *Sardia* Melicher

Melichar (1903) desribed *Sardia* with *Sardia rostrata* Melichar as the type species. Distant (1916) dealt with a new species *Sardia pronotalis* Distant from Sri Lanka. Joseph (1961) gave a taxonomic note on *Sardia rostrata* reported from India. The overall dark coloration of the forewings and the thorax, together with the elongate head are the diagnostic characters of the genus (Wilson and Claridge, 1991). Muir (1921) added the third species *Sardia campbelli* from south India.

Genus *Sogatella* Fennah

Fennah (1956) established the genus with *Delphax furcifera* Horvath as the type species. Asche and Wilson (1990) revised the genus *Sogatella.* The genus includes fairly small, slender planthoppers with a pale white stripe extending from the vertex posteriorly on to the mesonotum. They can be distinguished externally from similar other delphacids by the U-shaped structure on the dorsal margin of diaphragm, diverging parameres tapering to apex with distal bifurcation, moderately long, twisted aedeagus with two rows of small teeth (Wilson and Claridge, 1991). Sheng *et al*. (2000) studied the nymphs of species of *Sogatella* from China.

Genus *Syndelphax* Fennah

Fennah (1963) described this genus with *Delphax matutinus* Kirkaldy from Sri Lanka. There are four species including two new species reported by Fennah from Sri Lanka (Fennah, 1973-75).

Genus *Tagosodes* Asche and Wilson

Asche and Wilson (1990) established the genus with *Dicranotropis cubanus* Crawford as the type species. They proposed nineteen new combinations and reported *Tagosodes pusanus* (Distant) from India. This genus resembles *Sogatella* in coloration and appearance but differs in the structure of the male genetalia. The diaphragm is not U-shaped (diaphragm which is broadly U- shaped in *Sogatella*) in *Tagosodes*. The aedeagus is less compressed and never twisted in *Tagosodes* which is the case in *Sogatella* but often forms a simple more or less straight tube (Wilson and Claridge, 1991). Rao and Chalam (2007) reported *Tagosodes pusanus* on sugarcane and rice from south India.

Genus *Toya* Distant

Distant (1906) established the genus with *Toya attenuata* Distant as the type species. This genus can be distinguished from the other delphacid genera by the short vertex (Wilson and Claridge, 1991). Usman and Puttarudriah (1955) reported *Delphax propinqua* Fieber from Bangalore at light. Rao and Chalam (2007) reported *Toya*

propinqua on rice and sugarcane from Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka and *T*oya *bridwelli* on rice from Tamil Nadu.

Tribe Tropidocephalini and its genera

Tribe Tropidocephalini was described by Muir (1915) and is the second largest of the three tribes of subfamily Delphacinae. The tribe is characterised by thick and large post-tibial spur which is concave on inner surface, and lacks teeth along the hind margin. It has complicated asymmetrical distortion in the basal part of the aedeagus with at least one elongate process arising from this part. Muir (1915) included six genera and later Asche (1985) recognized 21 genera. Now the tribe has been expanded to include about 30 genera. Most species of this tribe breed on bamboo or grasses. (Chen, 2003).

2.4.2 Genera of the tribe Tropidocephalini

Genus *Arcofaciella* Fennah

Fennah (1956) established the genus with *Arcofaciella verrucosa* Fennah as the type species and also included *Arcofaciella penangensis* Fennah. This genus is similar to *Arcofacies* Muir (1915) but differs from the latter in the shape of frons and in the relative size of the antennae. The mesonotum is gibbous and the median carina on the clypeus is absent (Liang and Jiang, 2004).

Genus *Purohita* Distant

Distant (1906) established *Purohita* with *Purohita cervina* Distant as the type species. He also desribed *Purohota arundinaceae* Distant breeding on bamboo from India. Rao and Chalam (2007) reported a species of *Purohita* on sugarcane from Maharashtra.

Genus *Tropidocephala* Stål

Stål (1853) established *Tropidocephala* for the type species *Tropidocephala flaviceps* Stål. Distant (1916) described *Orchesma signata* Distant from Karnataka which is now placed under the genus *Tropidocephala* and *Tropidocephala luteola* Distant from Bengal and Calcutta. Muir (1921) reported two species, *Tropidocephala butleri* and

Tropidocephala indica Muir from south India. Rao (1965) reported *Tropidocephala saccharivorella* Matsumura on sugarcane from Karnataka.

2.5 Subfamily Stenocraninae

Stenocraninae comprise five genera and 75 species. The genus *Stenocranus* is the largest (Bartlett, 2005). Preliminary molecular and morphological phylogenetic analyses placed the Stenocraninae as the sister group Kelisiinae. The features of Stenocraninae are as follows: aedeagus with a sclerotized central sperm conducting shaft, at least partially surrounded by a mostly membranous theca. Theca with at least one curved, horn-shaped process. Female ditrysic. Second abdominal sternite of male drumming organ with small shell-like or arm-like apodemes directed caudad. Hind tibial spur large, flattened, with numerous small teeth on inner margin (Asche,1990).

Stenocranus Fieber

Fieber (1866) described *Stenocranus* with *Stenocranus minutus* Oshanin as the type species. Joseph (1964) reported *Stenocranus ajmerensis* Joseph from India. Fennah (1973-75) described two new species, *Stenocranus oroba* Fennah and *Stenocranus polenor* Fennah from Sri Lanka.

2.6 Subfamily Vizcayinae

The Subfamily Vizcayinae was established by Acshe (1990) for the genus *Vizcaya* Muir with five species from south India and South- East Asia. It is regarded as the connecting link between the Asiracinae and the remaining Delphacidae, Kelisiinae, Stenocraninae, Plesiodelphacinae and Delphacinae (Liang, 2002). Vizcayinae can be distinguished from other members of Delphacidae by inverted V-shaped carina on the vertex; antennal scape and pedicel very elongate or moderately elongate, scape compressed; antennal pedicel with numerous sensory plaque organs irregularly arranged over the whole surface, conical metatibial spur, with five to twelve teeth (including apical tooth) on inner margin; forewings elongate with veins prominent and thickly covered with granules each bearing a long seta; 2nd abdominal tergite of the male drumming organ

with a deep central depression (Asche, 1990). Liang (2002) also described *Neovizcaya* Liang and distinguished it from *Vizcaya* in having a strongly compressed head.

Genus *Vizcaya* Muir

Muir (1917) described the genus *Vizcaya* with *Vizcaya bakeri* Muir as the type species. Asche (1990) reported a new species of *Vizcaya, vindaloa* Asche from south India. Currently this genus includes seven species of which two species *V. vindaloa* and *V. aschei* are known from south India. These are delphacids with slender body, elongate legs and forewing. Antennal scape and pedicel are strongly elongated. The scape is slightly or well dilated (Liang, 2002).

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The present study was confined to family Delphacidae in different agrosystems of Karnataka. A total of 818 specimens were examined during the study. Specimens belonging to three subfamilies, Stenocraninae, Delphacinae and Vizcayinae were studied. The detailed methods adopted during the course of the study are given below.

3.1 Sources of planthopper material for study

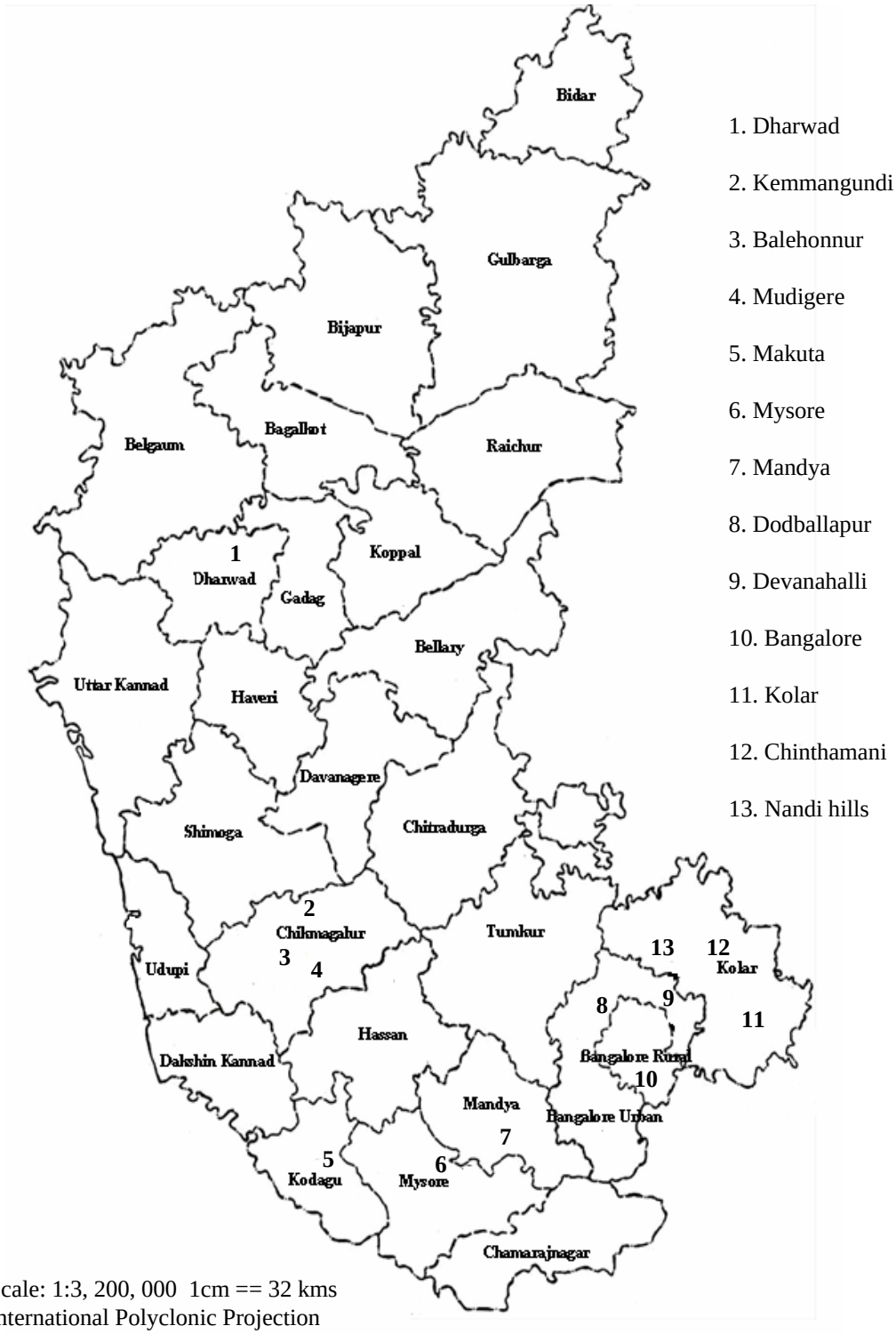
Field collections were made in and around Bangalore, Chintamani, Dharwad, Mandya, Mudigere, Chikkaballapura and Nandi hills. Planthoppers were collected by sweep netting on grasses, different crops and bamboo. Collected planthoppers were aspirated and transferred to killing tube. The dead specimens were placed in a butter paper packet with pertinent labels as to their host plant, date and locality of collection and brought to the laboratory for further processing and study. Majority of the study material also came from the light trap and field collections of the ICAR Network Project on Insect Biosystematics, Department of Entomology, University of Agricultural Sciences, Bangalore (UASB). Specimens from the personal collection of Dr. C.A. Viraktamath were also studied.

3.2 Processing of the material for study

The field collected specimens of planthoppers were mounted singly on triangular card points by using Fevicol ^{R} to have both visible and physical access to the head, wings and abdomen on which identification is based. The data label with information regarding locality, date of collection, host plants and name of the collector was transfixed separately to the respective specimen. The sex of the planthopper was indicated on the right hand side of the card point by code colouring it with green for male and orange or red for female.

3.3 Host association

During the collection trips observations were made on the breeding host plants of the planthoppers. The host plants were got identified by the specialists in systematic Botany.



1. Dharwad
2. Kemmangundi
3. Balehonnur
4. Mudigere
5. Makuta
6. Mysore
7. Mandya
8. Dodballapur
9. Devanahalli
10. Bangalore
11. Kolar
12. Chinthamani
13. Nandi hills

Scale: 1:3, 200, 000 1cm == 32 kms
International Polyclonic Projection

Map.1 Localities from where planthoppers were collected from karnataka

3.4 Preparation of genitalia

For the study of male genitalia the procedure advocated by Oman (1949) and Knight (1965) for the leafhoppers was followed. The male specimen was gently supported on a cork piece on its back, and with the help of a fine needle the abdomen was detached from the thorax at the junction of the two. The abdomen was then transferred to a test tube containing a few milliliters of 10% caustic potash. This was warmed gently in a water bath till the convection currents were observed in the solution (about five minutes).The abdomen was removed to a glass cavity dish containing water and the macerated soft tissues were removed with the help of bent needles. After washing the traces of KOH in water, the abdomen was transferred to glycerin in a glass cavity dish for further dissection (separation of genitalic parts from the genital capsule) and the observations were made under a stereoscopic microscope. After study the dissected parts were placed in the abdomen of the specimen and preserved in a drop of glycerin held in arthropod microvial^{R}. The vial was stoppered with a neoprene cork and the latter was transfixed to the pin holding the rest of the specimen, with a slight downward inclination.

3.5 Photographs and Illustrations

All the representative specimens from each species studied were photographed for the ease of identification. The genitalic parts were illustrated using a compound microscope Ortholux II and Leica MZl2 with built in drawing tube. The parts of the male genitalia was held in the desired position on the cavity slide by means of a small quantity of bee wax firmly fixed to the bottom of the cavity slide before placing glycerin to avoid movement while preparing illustrations. However, the illustrations of parameres were prepared out of temporary slide mounts in glycerin. The illustrations of head, thorax, face and forewing were prepared using a stereoscopic microscope (Leica MZl2) with built in drawing tube. The specimens used for illustration were labeled "Illustrated NKK" which served to identify them.

3.6 Descriptions

Generic descriptions were prepared based on the representative species. Descriptions for the species were made fairly elaborate. In the case of poorly known species detailed descriptions were prepared.

3.7 Depositories

The holotypes of the new taxa described are deposited in the collections of the Department of Entomology, University of Agricultural Sciences, Bangalore (UASB).

3.8 Measurements

Five male and five female specimens of each species were used for the measurement. Where the number of specimens collected was less than five, the available number of specimens was used for measurement. The measurements of various body parts were made with the help of a standardized ocular micrometer placed in one of the eyepieces of stereoscopic microscope. All the measurements are expressed in millimeters. Various measurements made are as follows:

Total length: Distance between the anterior most point of head and the posterior tip of the folded forewings along the middorsal line or tip of the abdomen.

Length of antennal segments: Length of scape and pedicel, the distance between the anterior and posterior joints of it.

Length of clavus: Length along the claval suture from the articulatory point of forewing (with mesothorax).

Length of forewing: Distance between the articulatory point of forewing (with mesothorax) and its apical tip.

Length of frons: Distance between the anterior and the posterior margin of the frons along the mid ventral line.

Length of postclypeus: Distance between frontoclypeal suture and the posterior margin of post clypeus.

Length of pronotum: Distance between the anterior and posterior margins of the pronotum along the middorsal line.

Length of scutellum: Distance between posterior margin of pronotum and caudal apex of scutellum along the middorsal line.

Length of vertex: Distance between the anterior and the posterior margins of vertex along the middorsal line.

Distance between eyes: Distance between the outer margins of eyes dorsally, towards anterior margin of head.

Width of antennal segments: Width of antennal segments excluding the flagellum is measured along the widest margin of first (Scape) and second (Pedicel) segments.

Width of forewing: Distance measured in middle line of forewing where it is having maximum width.

Width of frons: Distance between the lateral carinae of frons at its maximum width.

Width of head: Distance between the lateral margins of the eyes where the width is maximum.

Width of postclypeus: Distance between the lateral margins of clypeus at the anterior margin at its maximum width.

Width of pronotum: Distance measured across the posterior angles where the pronotum is with maximum width.

Width of vertex: Distance between the lateral carina of vertex at the basal margin.

Fig 1 and II. Measurements of different parts of planthopper

1. **Dorsal view**
    - A. Total length of body
    - B. Length of clavus of forewing
    - C. Total length of forewing
2. **Head and thorax**
    - D. Distance between eyes
    - E. Length of vertex
    - F. Width of vertex
    - G. Width of head
    - H. Width of pronotum
    - I. Length of scutellum
    - J. Length of pronotum
3. **Forewing**
    - K. Width of forewing
4. **Antenna**
    - L. Width of pedicel
    - M. Length of pedicel
    - N. Width of scape
    - O. Length of scape
5. **Face**
    - P. Length of frons
    - Q. Width of frons
    - R. Length of postclypeus
    - S. Width of postclypeus

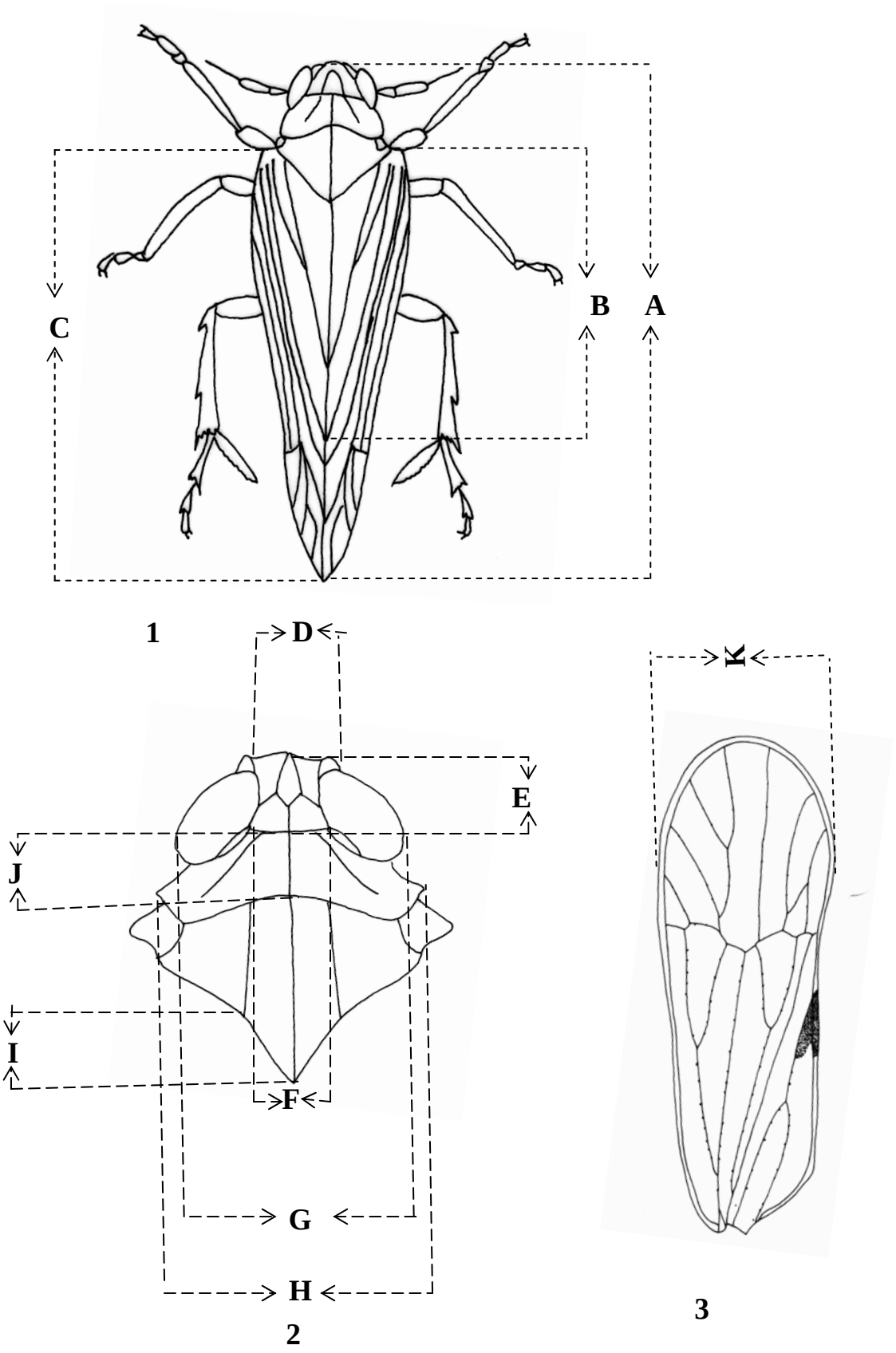


Fig 1. Measurements of different parts of planthopper

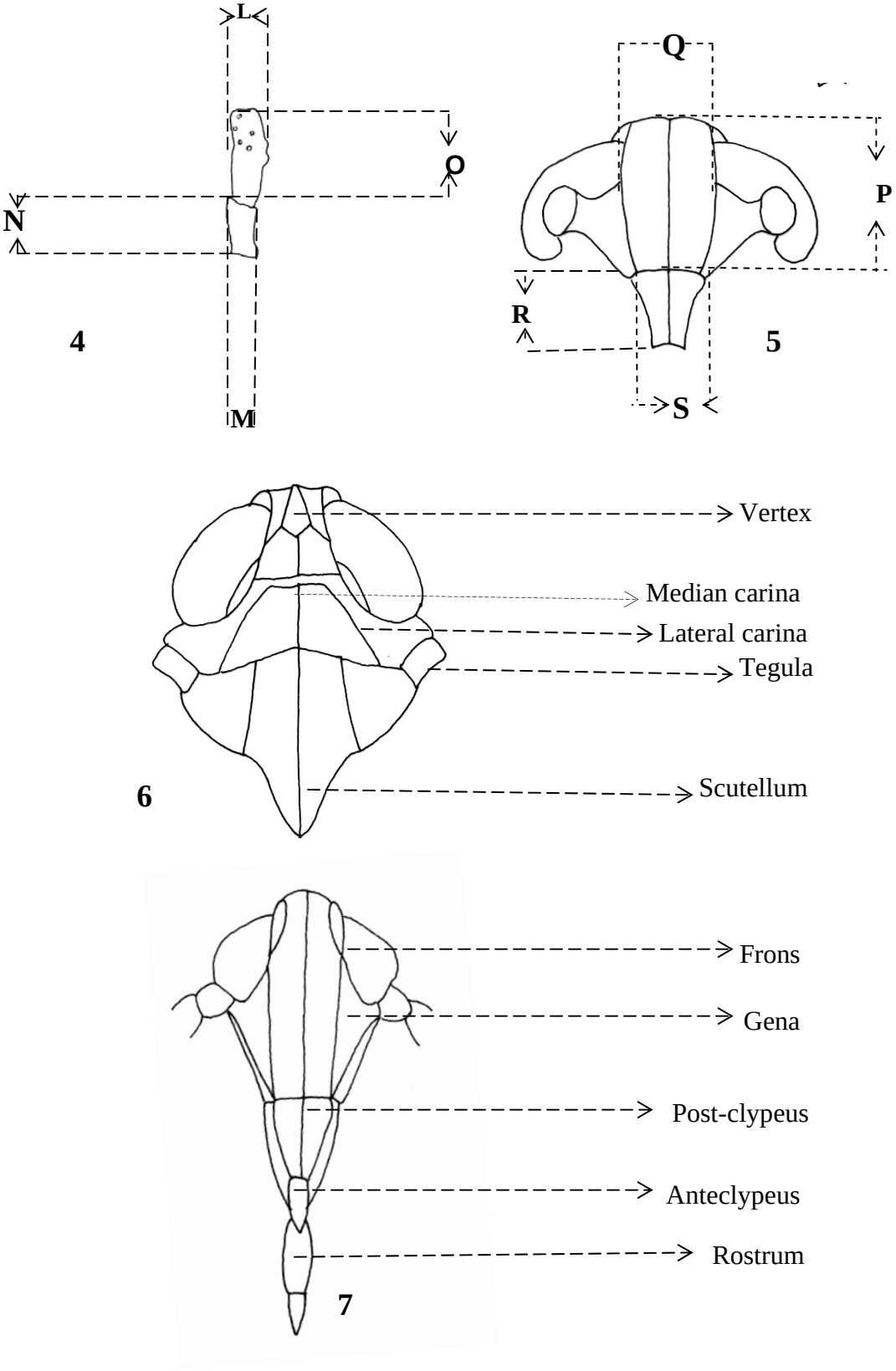


Fig 2. Measurements of Antenna (4) and Face (5) external morphology of planthopper (6 &7)

3.9 Terminology

Terms used in the description of the genera and species are those used by O' Brein and Wilson (1985) and Ossiannilsson *et al*. (1970). The various parts are illustrated.These terminologies are briefly defined below.

Adeagus: Sclerotised tube bearing an apical or subapical gonopore, it may bear a number of teeth or spines

Anal tube: Tenth abdominal segment often bears spinose process, usually movable but fused to pygophore.

Anteclypeus: Distal Part of clypeus which is separated from post clypeus by trans-clypeal suture.

Diaphragm: Modification of phallobase divides the pygophore into a anterior and posterior chambers.

Frons: Bordered by lateral carinae and separated from the clypeus by the frontoclypeal suture.

Gena: Region between the lateral border of the frons and the compound eye and contains a lateral ocellus.

Gonopore: Apical or subapical opening of the adeagus.

Lateral carina: lateral longtitudinal carina of thorax.

Median carina: Dorsal longtitudinal carina of thorax

Paramere: Movable paired often plate-like structures which may bear spines or hooks, attached to the aedeagus by a Y or T-shaped movable connective

Phallobase: Base of the penis which is geneally fused with the base of adeagus, act as penis guide.

Phallus: The median partly sclerotised intromittent coupulatory organ.

Post clypeus: Anterior part of clypeus separated from the anteclypeus by a partial transclypeal suture.

Post-tibial spur: Movable spur at the apex of each meta-tibia

Pronotum: Collar-like, structure extends laterally overlapping the reduced pleural sclerites.

Pygophore: Ninth abdominal segment forms a partial or complete capsule and contains the elements of male genetalia.

Rostrum: Three segmented beak

Scutellum: The part of mesothorax forming a posteriorly directed triangle.

Tegula: Pad like structure sclerite at the base of forewing.

Vertex: Dorsal aspect of head bounded posteriorly by the back of head, laterally by the compound eyes.

RESULTS

Fig 3. Male genitalia of planthopper- Terminologies used

ASP: Anal process

D: Pygophore posterior view

DGM: Diaphragm of pygophore

E: Pygophore lateral view

F: Adeagus

G: Anal segment

H: Paramere

I: Anal segment with Adeagus and phallobase (adeagus guide)

PH: Adeagus

PHB: Phallobase or penis guide

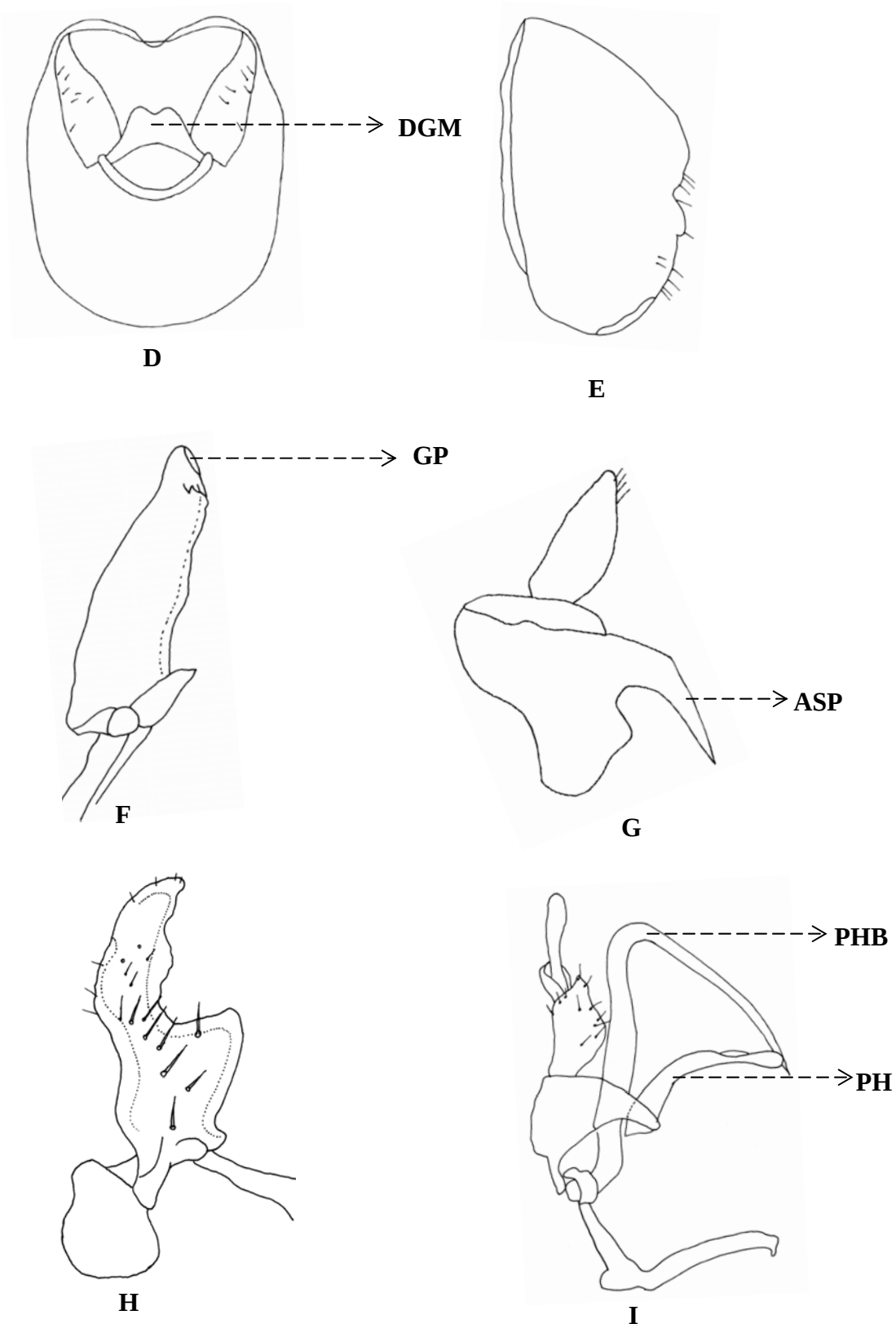


Fig 3. Male genitalia of planthopper - Terminologies used

RESULTS

IV. RESULTS

In this work a total of 818 specimens of 28 species under 20 genera of three subfamilies were studied. Taxonomic keys for the genera and species of Delphacidae of Karnataka is provided and illustrations of male genitalia for 27 species studied are also presented here. Taxa are arranged alphabetically. These results are presented in the following pages.

Key to the subfamilies of the Delphacidae of Karnataka

1. Antennae elongate with pedicel almost twice as long as scape……..……..……...**Vizcayinae**

- Antennae not elongate, if elongated and foliaceous, pedicel shorter than scape……...…...……..……...……**2**

2. Post-tibial spur with or without teeth on hind margin, if without teeth well developed penis guide present……...…...**Delphacinae**

- Post-tibial spur with numerous teeth on hind margin, aedeagus with well developed phallobase, phallus slender and passes through phallobase, aedeagus slender.....…….**Stenocraninae**

4.1 Subfamily Delphacinae

Key to the Tribes of Delphacinae of Karnataka

1. Post-tibial spur without teeth on hind margin…..... **Tropidocephalini**

- Post-tibial spur with teeth on hind margin ……...…….……**Delphacini**

Tribe Delphacini

Key to the genera of the tribe Delphacini of Karnataka

1. Hind basitarsomere with 1-5 teeth…..…….….. ***Nilaparvata* Distant**

- Hind basitarsomere without teeth...…..……...…..……...**2**

2. Median carina forked beyond base of frons……...……...…..**3**

- Median carina not forked, or forked before frons…….…….…….**7**

3. Antennal scape triangular……..……...…… ***Perkinsiella*** **Kirkaldy**

- Antennal scape not triangular.…….……**4**

4. Forewing veins with prominent black granules, antennal scape black, mesonotal disc tumid in dorsal view……..…….…….. ***Cemus*** **Fennah**

- Forewing veins not granulated, antennal scape not black; mesonotal disc not as above……...….**5**

5. Frons, genae, clypeus and abdomen stramineous, wings hyaline except light brown longtitudinal band towards the claval region.……..…….…… ***Euidella*** **Puton**

- Frons, genae and clypeus not stramineous, abdomen black..……..……**6**

6. Small species measuring less than 3.5 mm: pygophore with median and lateral process at base of caudal margin, anal tube with short ventrall directed spine-like process ……... …….. …….. ***Neycheuma*** **Fennah**

- Larger species measuring more than 4.00 mm; pygophore not as above and anal tube with out spine-like process. ….……...……...…….…… ***Peregrinus*** **Kirkaldy**

7. Vertex apically pointed extending beyond compound eyes; median carina raised at base……..……... ***Sardia*** **Melichar**

- Vertex not pointed apically and extending beyond compound eyes; median carina not raised at base…….…….…….……..….**8**

8. Wings not hyaline, body including eyes chocolate brown except antennae, legs (some specimens) and compound eyes, pygophore in profile with laterodorsal angle strongly produced……..…….……..***Harmalia*** **Fennah**

- Wings hyaline, pygophore with or without strongly produced laterodorsal angle…….…….……..……..**9**

9. White broad transverse band towards posterior margin of pronotum, frontal carina pale with fuscous intercarinal areas, mesonotum completely black except at tip of scutellum…….……...…….……...…….. ***Coronacella*** **Metcalf**

- Pronotum without transverse white band if present mesonotum with a longitudinal white patch and adeagus with or without series of teeth…….....…**10**

10. Mesonotum with a longitudinal white median band, aedeagus twisted with rows of teeth or tubular with rows of teeth towards the apex …….**11**

- Mesonotum without a longtitudinal white median band, forewing without any marking towards apical margin ……..……...……..……....**13**

11. Pronotum pale except a black fascia at the posterior margin of compound eye, pygophore with a U-shaped armature at the diaphragm and adeagus twisted with rows of teeth……...……...***Sogatella* Fennah**

- Pygophore with well developed diaphragm, shape of the armature varies but not with U-shaped armature ….…….…….……..…**12**

12. Aedeagus without series of teeth instead irregularly placed teeth towards apex, paramere forked at apical end and wing pattern as shown in figure (Fig. 21e) …..…….……..… ***Tagosodes* Acshe & Wilson**

- Aedeagus with series of teeth , paramere long with truncate or tapering apex, white longtitudinal stripe across vertex……..…….……***Latristria* Huang and Ding**

13. Mesonotum shiny black, wings completely hyaline except claval pterostigma, aedeagus with a basal fold like extension…..…....……..… ***Opiconsiva* Distant**

- Mesonotum not black, either ochraceous or stramineous, both frons and clypeus with Pale carina, brown-black genae and intercarinal areas…….……..……....**14**

14. Genae brown to black, medioventral margin of pygophore with a Y-shaped process or wavy margin as shown in (Fig.22f, 23f) aedeagus with teeth.....…***Toya* Distant**

- Aedeagus without teeths, medioventral magin of pygophore not strongly produced…….....…**15**

15. Adeagus asymmetrical, twisted in the middle with forked process at midlength, gonopore apical …….…….……. ***Nothokalpa* Fennah**

- Adeagus not twisted tubular……...……..… ***Syndelphax* Fennah**

4.1.1.1 Genus *Cemus* Fennah

Black. Head including compound eyes as wide as pronotum. Lateral carinae shallowly convex. Frons longer than broad, widest at level of ocelli. Rostrum reaching hind coxae. Antennal scape longer than broad, second segment almost twice as long as first segment. Thorax tricarinate, fuscous except at the carinae, mesothorax raised. Lateral carinae of pronotum not reaching hind margin. Legs fuscous, post-tibial spur with toothed hind margin pale compared to other segments. Male pygophore ventrally long, caudal margin truncate with median lobe-like projection. Diaphragm with a V-shaped excavation at middle. Parameres narrow not broad. Aedeagus elongate, asymmetrical.

***Cemus* sp.**

(Plate 1: A and D; Fig. 4)

Vertex slightly shorter than broad at base, Y-shaped carina distinct with prominent median arm, of equal width both at apex and base. Frons tricarinate, median carina forked at level of ocelli, with pit-like areas on intercarinal region, paler. Frontoclypeal suture truncate. Post clypeus wider than frons at apex. Mesothorax excavated from level of prothorax, convex in profile. Antennal segments fuscous, scape darker than pedicel on dorsal side. Forewing venation as in Fig. 4e; veins thickly granulated with black granules. Crescent shaped marking on wing prominent. Legs fuscous with post-tibial spur toothed on hind margin.

Male genitalia: Anal collar with well developed rather straight process. Pygophore with ventral margin longer, convex, produced into short projection, caudal margin truncate with median lobe-like projection. Parameres narrowed gradually distally and slightly curved. Aedeagus with well developed paired lobe-like subapical process on ventral margin, gonopore apical.

Measurement: Male 3.64 ± 0.36 mm long, 0.70 ± 0.04 mm wide across head and 0.55 ± 0.02 mm across pronotum. Female 3.92 ± 0.18 mm long, 0.78 ± 0.04mm wide across head and 0.65 ± 0.02 mm across pronotum (Table 1).

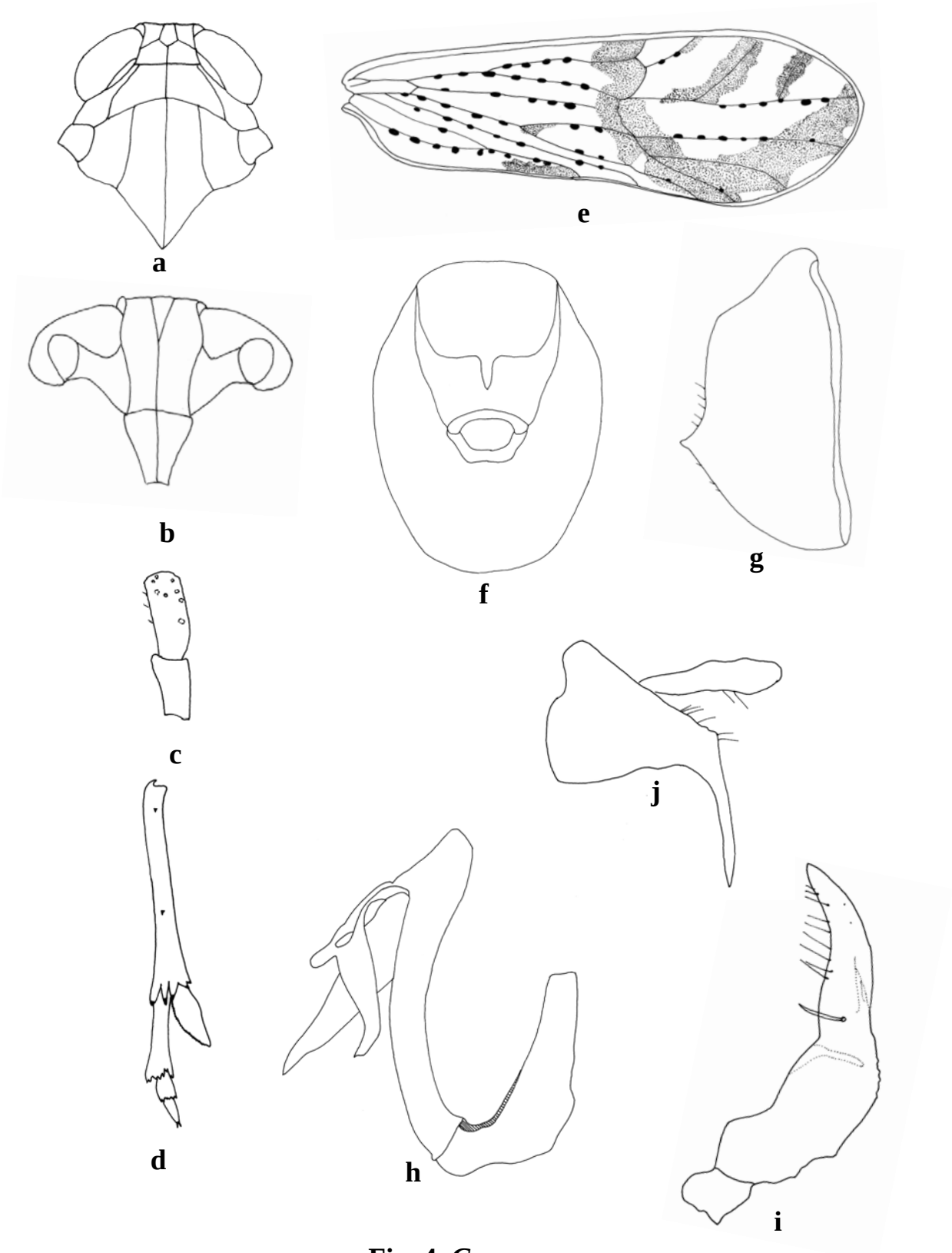


Fig. 4. *Cemus* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 1. Measurements (mm) of the male and female of *Cemus* sp.

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.37 ± 0.14	1.53 ± 0.15
Clypeus	0.26 ± 0.01	0.29 ± 0.04
Forewing	2.15 ± 0.28	2.45 ± 0.17
Frons	0.37 ± 0.01	0.43 ± 0.03
Pedicel	0.35 ± 0.02	0.38 ± 0.01
Pronotum	0.16 ± 0.01	0.18 ± 0.00
Scape	0.21 ± 0.04	0.24 ± 0.02
Scutellum	0.25 ± 0.02	0.28 ± 0.01
Vertex	0.15 ± 0.00	0.19 ± 0.01
Total length	3.64 ± 0.36	3.92 ± 0.18
Width		
Clypeus	0.22 ± 0.01	0.26 ± 0.03
Forewing	0.72 ± 0.11	0.85 ± 0.05
Frons	0.24 ± 0.00	0.28 ± 0.02
Head	0.70 ± 0.04	0.78 ± 0.04
Pedicel	0.13 ± 0.00	0.13 ± 0.00
Pronotum	0.55 ± 0.02	0.65 ± 0.02
Scape	0.11 ± 0.00	0.11 ± 0.00
Vertex	0.27 ± 0.02	0.29 ± 0.01
Distance between eyes	0.23 ± 0.01	0.26 ± 0.01

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 17.vi.2006, at light; 1♀, 29.vi.2006; 1 ♀, 30.vi.2006; 1 ♂, 3.viii.2006; 2 ♀, 20.viii.2006; 2 ♂, 21.viii.2006; 1 ♀, 24.viii.2006; 1 ♂, 26.viii.2006; 1 ♂, 1 ♀, 28.viii.2006; 1 ♂, 2 ♀, 2.ix.2006; 1 ♂, 3 ♀, 4.ix.2006; 1 ♂, 2 ♀, 6.ix.2006; 1 ♂, 7.ix.2006; 2 ♀, 8.ix.2007; 4 ♀, 9.ix.2006; 5 ♂, 5 ♀, 11.ix.2006; 1 ♀, 13.ix.2006; 1 ♂, 2 ♀, 14.ix.2006; 1 ♂, 16.ix.2006; 1 ♀, 19.ix.2006; 1 ♂, 14.xii.2006; all collected by Nimisha, K. K.; 1 ♂, 12.i.2007; David, K.J.; 2 ♂, 1 ♀, Chinthamani, 16.x.2006; 1 ♂, 2 ♀, Devanahalli, 16.x.2006; 1 ♀, Mandya, 24.i.2007, at light; 1 ♂, 25.i.2007; 1 ♂, Mudigere, 6.x.2006, at light; 1 ♀, Nandi hills, 13.x.2006, all collected by Nimisha, K. K. (UASB).

Remarks: This species can be recognised by the forewings having black thick granules on the veins, crescent shaped markings on the apical area and by the gibbous mesonotum.

4.1.1.2 Genus *Coronacella* Metcalf

Black. Head including eyes distinctly narrower than pronotum. Vertex as wide at base as at apex, longer than broad at base, lateral carinae obtusely rounding to frons; frons in middle line longer than broad at widest margin, lateral carinae pale, intercarinal areas along with median carina black. Antennal scape black, pedicel stramineous. Thorax with white longtitudinal band on posterior three fourth of pronotum, mesonotum black except at tip of scutellum. Forewings hyaline with distinct claval pterostigma. Pygophore short, aedeagus tubular with broad base, apex rounded with tooth.

***Coronacella sinhalana* (Kirkaldy)**

(Plate 1: B and E; Fig. 5)

Post clypeus tricarinate, carinae pale, intercarinal areas fuscous. Rostrum reaching meso-trochanter. Antennal scape longer than broad, pedicel longer than scape, stramineous with brown ring basally. Thorax tricarinate, lateral carinae reaching hind margin, anterior 0.33 margin black rest of pronotum with creamy band, mesonotum completely black except apical half of scutellum, anterior margin of tegulae fuscous. Post tibial spur lamellate, outer surface convex with concave inner surface, hind margin of

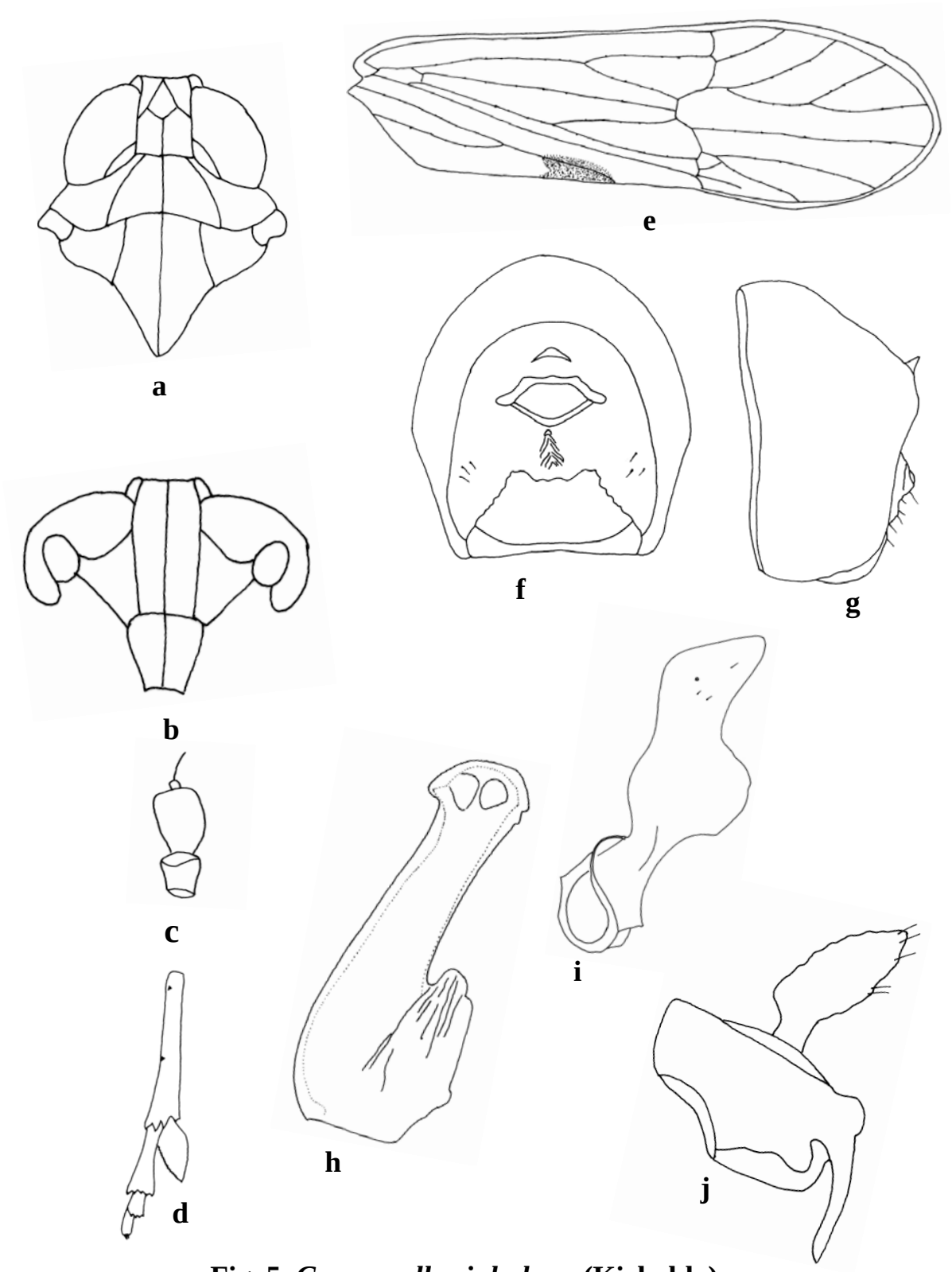


Fig. 5. *Coronacella sinhalana* (Kirkaldy)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 2. Measurements (mm) of the male and female of *Coronacella sinhalana* (Kirkaldy).

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.09 ± 0.03	1.16 ± 0.04
Clypeus	0.17 ± 0.03	0.24 ± 0.00
Forewing	1.75 ± 0.04	1.80 ± 0.03
Frons	0.37 ± 0.03	0.37 ± 0.01
Pedicel	0.21 ± 0.01	0.19 ± 0.05
Pronotum	0.16 ± 0.02	0.16 ± 0.02
Scape	0.07 ± 0.01	0.08 ± 0.00
Scutellum	0.18 ± 0.00	0.21 ± 0.00
Vertex	0.16 ± 0.01	0.18 ± 0.00
Total length	2.96 ± 0.05	3.06 ± 0.09
Width		
Clypeus	0.18 ± 0.03	0.24 ± 0.00
Forewing	0.54 ± 0.02	0.55 ± 0.03
Frons	0.17 ± 0.01	0.18 ± 0.00
Head	0.50 ± 0.02	0.52 ± 0.02
Pedicel	0.11 ± 0.00	0.11 ± 0.00
Pronotum	0.55 ± 0.02	0.61 ± 0.02
Scape	0.08 ± 0.00	0.08 ± 0.00
Vertex	0.17 ± 0.02	0.18 ± 0.00
Distance between eyes	0.15 ± 0.00	0.15 ± 0.00

spur toothed. Forewing hyaline, vein concolorous, claval pterostigma distinct, venation as in Fig. 5e.

Male genitalia: Pygophore short, dorsally longer than ventrally, in lateral view small triangular lobe medially on ventral margin, diaphragm well developed. Paramere short, basally broad with a median constriction, broadly rounded, pointed apically with beak-like apex towards inner margin and deeply concave. Aedeagus tubular with broad base, apex rounded with tooth. Anal segment short, collar-shaped with two slender spine-like processes.

Measurement: Male 2.96 ± 0.05 mm long, 0.50 ± 0.02 mm wide across head and 0.55 ± 0.02 mm across pronotum. Female 3.06 ± 0.09 mm long, 0.52 ± 0.02 mm wide across head and 0.61 ± 0.02 mm across pronotum (Table 2).

Material examined: INDIA: Karnataka: 3 ♂, 1 ♀, 29.viii.2006, Bangalore, at light; 1 ♂, 1 ♀, 7.ix.2006; 1 ♂, 1 ♀, Devanahalli, 16.x.2006; 2 ♂, Chinthamani, 16.x.2006; 3 ♀, Mandya, 24.i.2007, all collected by Nimisha, K. K.; 1 ♂, 2 ♀, Dodballapura, 16.viii.2007, David, K.J. (UASB).

Remarks: This species can be readily recognized by the white band on the posterior three fourth of the pronotum.

4.1.1.3 Genus *Euidella* Puton

Stramineous. Head including compound eyes narrower than pronotum. Vertex almost as long as broad at base. Frons tricarinate, longer than wide, median carina forked at level of distinct brown ocelli. Rostrum reaching hind coxae. Thorax tricarinate, lateral carina of prothorax reaching hind margin. Second segment of antennae almost twice as long as first. Forewing hyaline. Pygophore with ventral margin longer than dorsal margin. Parameres long. Aedeagus asymmetrical, elongate.

***Euidella* sp.**

(Plate 1: C and F; Fig. 6)

Vertex with Y-shaped carina, median arm weak. Frontoclypeal suture arcuate. Post clypeus tricarinate, as broad as frons at frontoclypeal suture, with distinct median carina, postclypeus in profile convex, anteclypeus with distinct median carina. Forewing hyaline, vein endings darker, venation as shown in Fig. 6e. Legs elongate, post-tibial spur with teeth on hind margin.

Male genitalia: Anal collar with two short spine-like processes. Pygophore with ventral margin longer than dorsal margin, diaphragm well developed with a posterior notch-like opening, ventral margin with U-shaped with notch medially in caudal view. Parameres long, broader in basal half, apical half tapering laterally, with setae through out length. Aedeagus asymmetrical, beak-shaped apically, two subapical appendages directed dorsally, outer appendage ribbon-like and twisted, inner appendage short.

Measurement: Male 4.24 ± 0.21 mm long, 0.68 ± 0.03 mm wide across head and 0.73 ± 0.02 mm across pronotum. Female 4.84 ± 0.21 mm long, 0.77 ± 0.03 mm wide across head and 0.82 ± 0.02 mm across pronotum (Table 3).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 19.iv.2006, at light; 1 ♂, 1 ♀, 17.vi.2006; 1♀, 13.vii.20061 ♀, 24.viii.2006; 1 ♀, 1.ix.2006; 1 ♂, 8.ix.2006; 1 ♂, 9.ix.2006; 2 ♂, 11.ix.2006; 1 ♀, 13.ix.2006; 1 ♂, Mandya, 24.i.2007, at light; 4 ♂, 2 ♀, 25.i.2007, all collected by Nimisha, K. K.; 1 ♂, 9.ii.2007; 1 ♂, 21.ii.2007, Patel, V.N. (UASB).

Remarks: This species can be recongised by its elongate legs, the asymmetrical aedeagus with unequal pair of appendages directed dorsally.

4.1.1.4 *Genus Harmalia* Fennah

Chocolate brown. Head including compound eyes distinctly narrower than pronotum. Vertex longer than broad at base, Y-shaped carina present, median carina raised, lateral carinae shallowly concave; apex pointed. Frons tricarinate, intercarinal

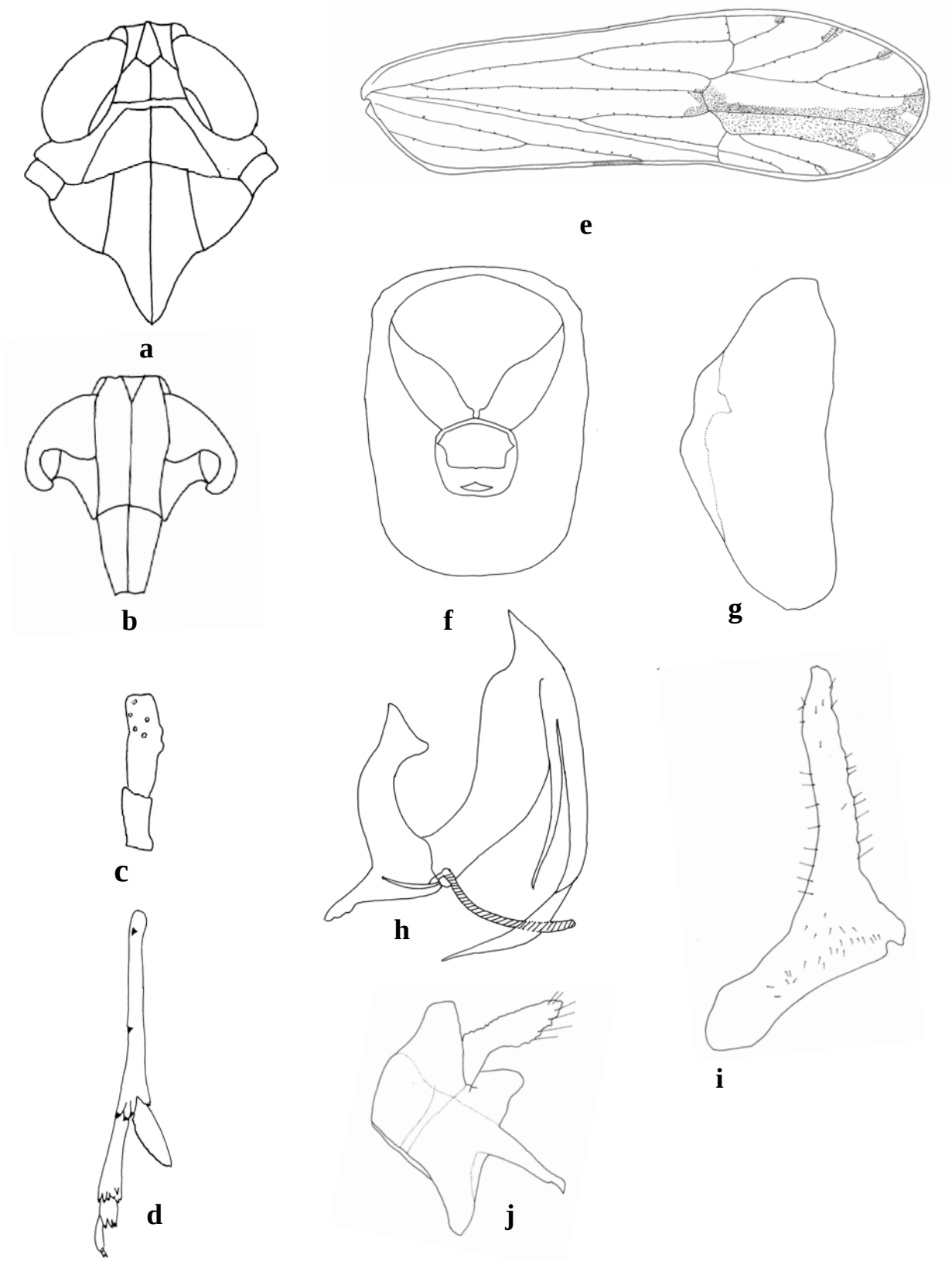
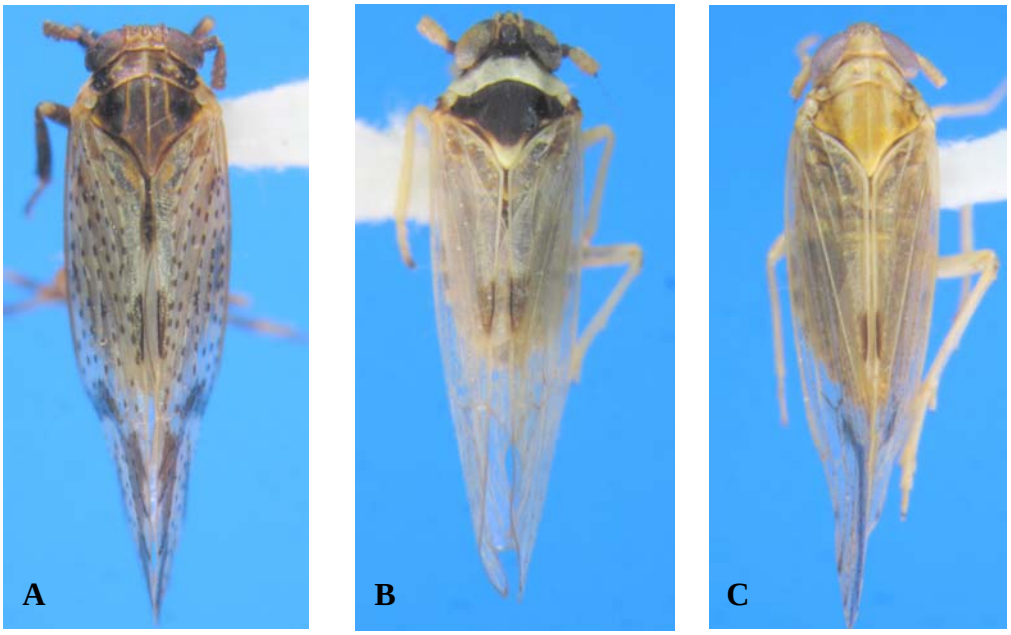


Fig. 6. *Euidella* sp.

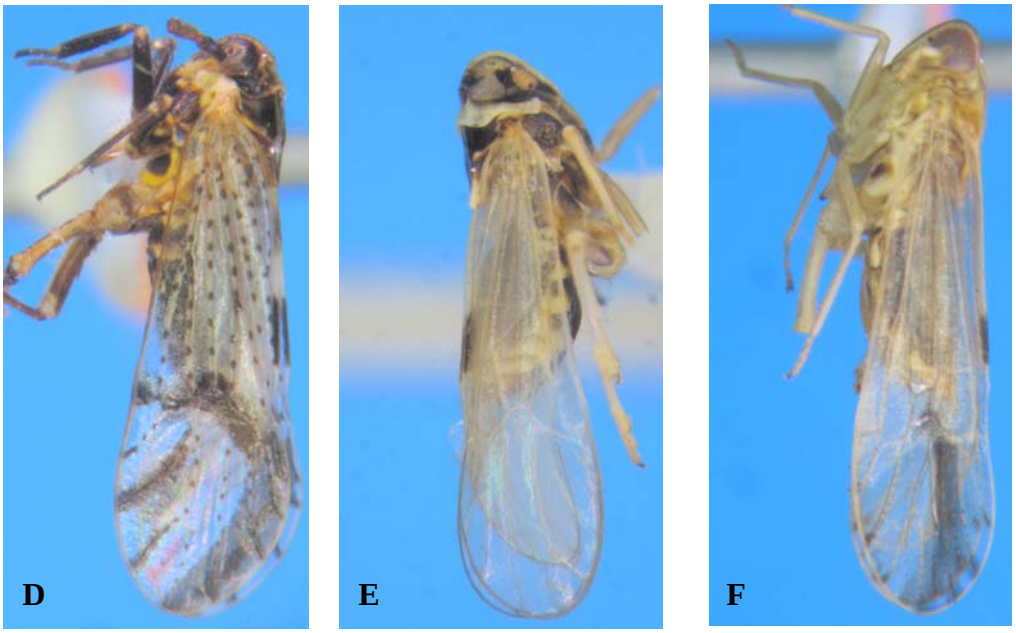
a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 3. Measurements (mm) of the male and female of *Euidella* sp.

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.58 ± 0.08	1.82 ± 0.08
Clypeus	0.38 ± 0.03	0.47 ± 0.03
Forewing	2.51 ± 0.15	2.85 ± 0.15
Frons	0.44 ± 0.03	0.52 ± 0.03
Pedicel	0.31 ± 0.01	0.31 ± 0.01
Pronotum	0.19 ± 0.01	0.19 ± 0.01
Scape	0.14 ± 0.01	0.13 ± 0.01
Scutellum	0.24 ± 0.00	0.26 ± 0.00
Vertex	0.24 ± 0.00	0.25 ± 0.00
Total length	4.24 ± 0.21	4.84 ± 0.21
Width		
Clypeus	0.28 ± 0.03	0.30 ± 0.03
Forewing	0.70 ± 0.04	0.79 ± 0.04
Frons	0.21 ± 0.00	0.25 ± 0.00
Head	0.68 ± 0.03	0.77 ± 0.03
Pedicel	0.11 ± 0.00	0.11 ± 0.00
Pronotum	0.73 ± 0.02	0.82 ± 0.02
Scape	0.11 ± 0.00	0.11 ± 0.00
Vertex	0.25 ± 0.02	0.29 ± 0.02
Distance between eyes	0.21 ± 0.00	0.21 ± 0.00



Cemus sp. **Dorsal view** ***Coronacella sinhalana*** **(Kirkaldy)** ***Euidella*** **sp.**



Cemus sp. **Lateral view** ***Coronacella sinhalana*** **(Kirkaldy)** ***Euidella*** **sp.**

Plate 1: Delphacinae: Tribe Delphacini

areas dark fuscous, longer in middle than width at widest margin, median carina simple. Frons in profile straight. Rostrum not reaching hind coxae. Thorax tricarinate, lateral carina of prothorax not reaching hind margin. Post-tibial spur foliaceous with toothed hind margin. Pygophore slightly ventrally longer than dorsally, lateroapical angles acutely produced. Anal segment moderately long with two spine-like process. Parameres long and broadest at about basal half, apically bilobed, outer lobe broader than inner. Aedeagus cylindrical, moderately long.

***Harmalia* sp.**

(Plate 2: A and D; Fig. 7)

The point of union of vertex to frons acute. Frons with pale carinae. frontoclypeal suture angular, frons in profile straight. Postclypeus wider than frons at frontoclypeal suture, tricarinate with distinct median carina. Antennae stramineous, second segment longer than first segment. Intercarinal area of prothorax and tegulae pale compared to rest of the thorax. Forewing uniformly brownish, veins concolorous. Legs pale, stramineous.

Male genitalia: Pygophore slightly longer on ventral side than dorsal side, lateroapical angles acutely produced. Diaphragm moderately broad, a wedge-shaped lobe protruding at caudo-medially with minute projections on surface. Aedeagus tubular, with teeth-like projections subapically.Gonopore apical. Anal segment moderately long with two spine-like processess.

Measurement: Male 3.38 ± 0.04 mm long, 0.52 ± 0.01 mm wide across head and 0.67 ± 0.02 mm across pronotum. Female 3.86 ± 0.11 mm long, 0.58 ± 0.02 mm wide across head and 0.80 ± 0.05 mm across pronotum (Table 4).

Material examined: INDIA: Karnataka: 8 ♂, 15 ♀, Bangalore, at light, collected on 19.iv.2006 (3 ♀); 2.vii.2006 (1 ♀); 5.ix.2006 (1 ♂); 7.ix.2006 (1 ♀); 8.ix.2006 (1 ♂,2 ♀); 9.ix.2009 (2 ♂, 2 ♀); 11.ix.2006 (1 ♀); 12.x.2006 (1 ♀); 20 x.2006 (1 ♀); 10.i.2007 (1 ♀); 3.iv.2007 (1 ♂); 21.v.2007 (2 ♂, 2 ♀) all collected by Nimisha, K. K. (UASB).

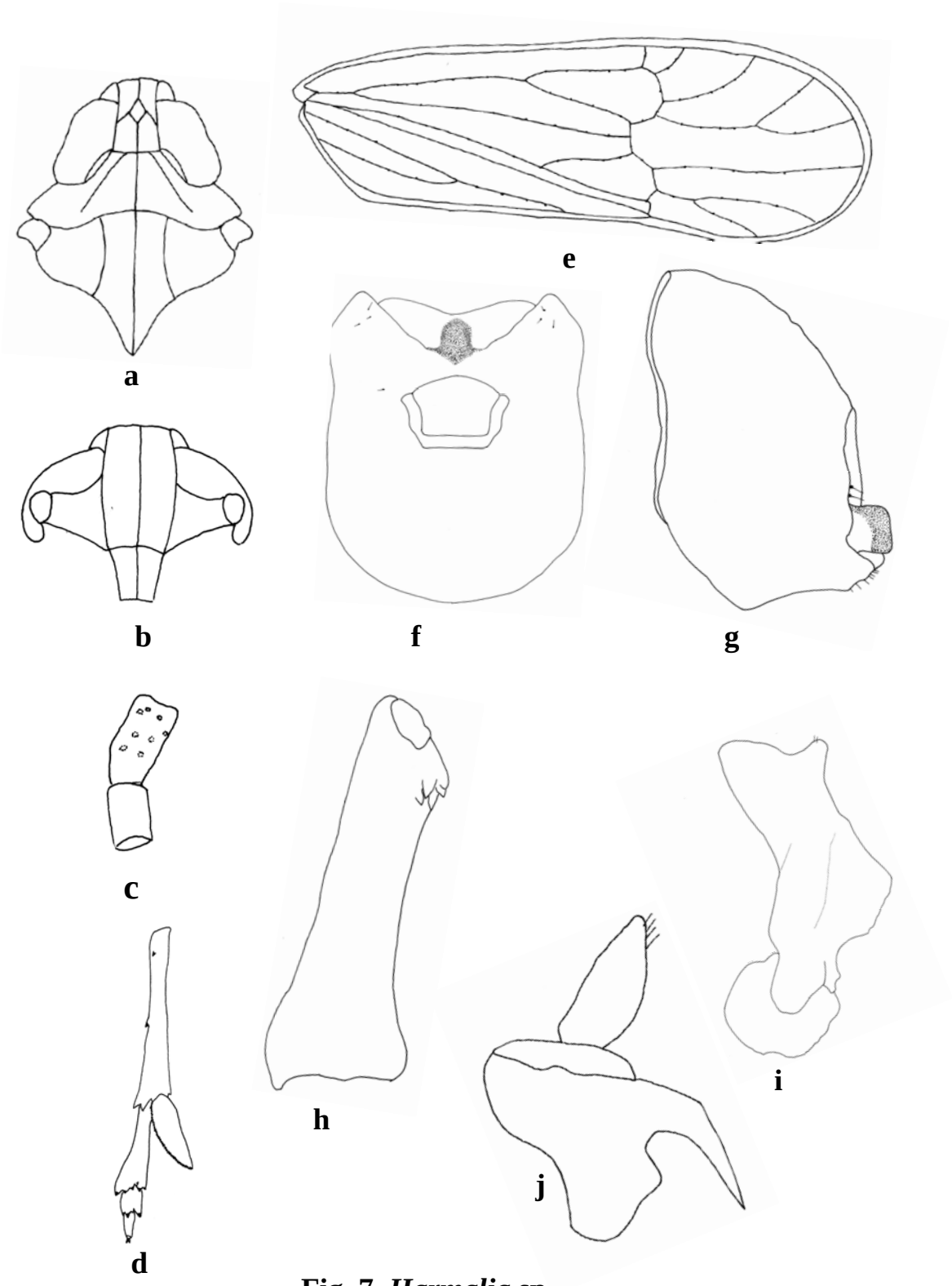


Fig. 7. *Harmalia* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 4. Measurements (mm) of the male and female of *Harmalia* sp.

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.25 ± 0.03	1.48 ± 0.04
Clypeus	0.24 ± 0.00	0.28 ± 0.01
Forewing	1.93 ± 0.05	2.24 ± 0.04
Frons	0.45 ± 0.02	0.49 ± 0.03
Pedicel	0.24 ± 0.00	0.21 ± 0.00
Pronotum	0.18 ± 0.00	0.19 ± 0.02
Scape	0.11 ± 0.01	0.13 ± 0.01
Scutellum	0.23 ± 0.01	0.26 ± 0.03
Vertex	0.22 ± 0.02	0.24 ± 0.00
Total length	3.38 ± 0.04	3.86 ± 0.11
Width		
Clypeus	0.21 ± 0.00	0.27 ± 0.00
Forewing	0.62 ± 0.03	0.69 ± 0.03
Frons	0.19 ± 0.03	0.21 ± 0.00
Head	0.52 ± 0.01	0.58 ± 0.02
Pedicel	0.13 ± 0.00	0.13 ± 0.00
Pronotum	0.67 ± 0.02	0.80 ± 0.05
Scape	0.11 ± 0.00	0.11 ± 0.00
Vertex	0.19 ± 0.01	0.21 ± 0.00
Distance between eyes	0.17 ± 0.01	0.19 ± 0.01

Remarks: This species can easily be recognized by the chocolate brown colour, raised median carina of the vertex, the diaphragm of the male pygophore is moderately broad with a protruding wedge-shaped lobe.

4.1.1.5 Genus *Neycheuma* Fennah

Diamorphic with respect to wing development. Brachypterous form black and macropterous form stramineous. Head almost as wide as pronotum. Vetex broader than long at base, Y-shaped carina with distinct anterior arm and feeble median arm. Frons tricarinate, median carina forked at level of ocelli, longer in middle than at base, widest at level of forking of median carina. Thorax tricarinate, lateral carinae of pronotum not reaching hind margin, pronotum shorter than broad at anterior margin between lateral carina. Pygophore short, ventral margin with median and lateral projection at base of caudal margin. Anal segment with ventrally directed spine-like process, aedeagus compressed.

***Neycheuma coctum* Yang**

(Plate 2: B, C, E and F; Fig. 8)

Brachypterous form: Forewing and abdomen dark brown. Vertex with lateral apical margin obtusely rounded to frons, margin shallowly concave. Frons with lateral margin shallowly convex, in profile straight with truncated frontoclypeal suture, postclypeus and anteclypeus convex in profile with distinct median carina. Rostrum surpassing hind coxae. Face light brown. Antennal scape longer than broad, bordered apically with brown, pedicel brown bordered at base and longer than first. Pro and mesonotum creamy white, posteriolateral parts brown with stramineous suffusion in intercarinal areas. Forewing dark brown (Fig.8 e), veins concolorus, exposing the pygophore. Fore and mesocoxae of first and second pair of legs and basal half of hind femora dark brown, post-tibial spur foliaceous with teeth on hind margin.

Macropterous form: Stramineous. Posterolateral area of basal compartment pallid stramineous. Postclypeus laterad of median carina and anteclypeus fuscous. Rostrum attaining post coxae. Antennal scape cylindrical, longer than broad at apical margin,

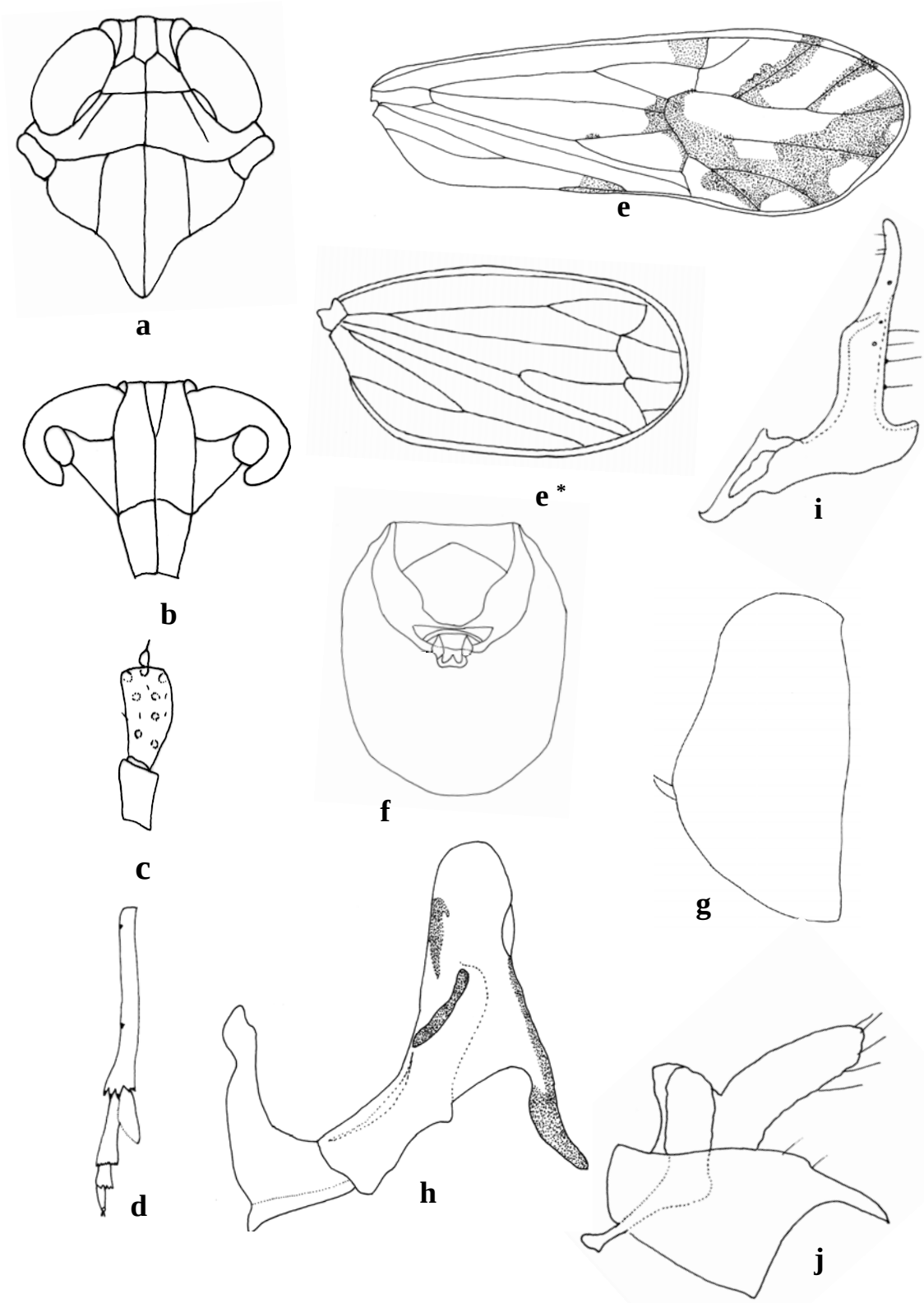


Fig. 8. ***Neycheuma coctum*** **Yang**

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, e*. Brachypterous forewing, f. Pygophore, g. Pygohore -lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 5. Measurements (mm) of the male and female of *Neycheuma coctum* Yang

Wing form	**Macropterous**		**Brachypterous**
Characters	**Male**	**Female**	**Male**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.13 ± 0.06	1.29 ± 0.11	0.61 ± 0.03
Clypeus	0.26 ± 0.01	0.29 ± 0.02	0.26 ± 0.02
Forewing	1.83 ± 0.09	2.17 ± 0.06	0.75 ± 0.02
Frons	0.33 ± 0.00	0.38 ± 0.03	0.35 ± 0.03
Pedicel	0.23 ± 0.01	0.24 ± 0.00	0.21 ± 0.00
Pronotum	0.11 ± 0.01	0.12 ± 0.00	0.12 ± 0.00
Scape	0.13 ± 0.00	0.13 ± 0.00	0.11 ± 0.00
Scutellum	0.18 ± 0.00	0.22 ± 0.01	0.15 ± 0.00
Vertex	0.16 ± 0.02	0.17 ± 0.02	0.13 ± 0.02
Total length	3.22 ± 0.13	3.64 ± 0.13	1.72 ± 0.08
Width			
Clypeus	0.26 ± 0.02	0.28 ± 0.02	0.23 ± 0.01
Forewing	0.65 ± 0.02	0.71 ± 0.03	0.38 ± 0.02
Frons	0.22 ± 0.01	0.22 ± 0.01	0.20 ± 0.02
Head	0.59 ± 0.02	0.65 ± 0.01	0.58 ± 0.02
Pedicel	0.11 ± 0.00	0.11 ± 0.00	0.11 ± 0.00
Pronotum	0.58 ± 0.01	0.62 ± 0.03	0.54 ± 0.00
Scape	0.08 ± 0.00	0.08 ± 0.00	0.08 ± 0.00
Vertex	0.21 ± 0.00	0.26 ± 0.02	0.21 ± 0.00
Distance between eyes	0.20 ± 0.01	0.22 ± 0.01	0.18 ± 0.00

***Harmalia* sp.**

***Neycheuma coctum* Yang**
Macropterous form

***Neycheuma coctum* Yang**
Brachypterous form

Dorsal view

***Harmalia* sp.**

***Neycheuma coctum* Yang**
Macropterous form

***Neycheuma coctum* Yang**
Brachypterous form

Lateral view

Plate 2: Delphacinae: Tribe Delphacini

pedicel longer than scape, brown ring at base of scape and apex of pedicel. Forewing hyaline, venation as in Fig. 8e; claval pterostigma present, apical half of forewing with fuscous area on posterior part of claval region. First and second coxae and basal half of post coxae fuscous. Post tibial spur lamellate with teeth on hind margin.

Male genitalia: Anal segment with ventrally directed spine-like process. Pygophore diaphragm dividing the opening into two parts dorsal large and a small compartment. Paramere with a mesal stout process at base, a lateral angular projection at midlength, apophysis narrow near apex. Aedeagus compressed laterally, with subapical gonopore and subapical longer process directed anteriorly, slightly asymmetrical and curved, short lateral process on left hand side basad of longer process making it strongly asymmetrical.

Measurement: Macropterous form: Male 3.22 ± 0.13 mm long, 0.59 ± 0.02 mm wide across head and 0.58 ± 0.01 mm across pronotum. Female 3.64 ± 0.13 mm long, 0.65 ± 0.01 mm wide across head and 0.62 ± 0.03 mm across pronotum. Brachypterous form: Male 1.72 ± 0.08 mm long, 0.58 ± 0.02 mm wide across head and 0.54 ± 0.00 mm across pronotum (Table 5).

Material examined: INDIA: Karnataka: 3 ♂, 3 ♀, Bangalore, 8. ix.2006; 1 ♂, (Brachypterous form) 2.ix.2006; 9 ♂, 8.ix.2006; 1 ♂, 28.xi.2006, at light; 1 ♀, 19.iv.2006; 1 ♀, 17.vi.2006; 1 ♂, 24.viii.2006; 1 ♂, 26.viii.2006; 1 ♀, 1.ix.2006; 1 ♀, 4.ix.2006; 1 ♀, 5.ix.2006; 1 ♂, 1 ♀, 6.ix.2006; 3 ♀, 9.ix.2006; 1 ♂, 4 ♀, 11.ix.2006; 2 ♀, 19.ix.2006, all collected by Nimisha, K. K. (UASB).

Remarks: This species is characteristic in having black coloured brachypterous form and stramineous macropterous form and in having strongly asymmetrical aedeagus.

4.1.1.6 Genus *Nilaparvata* Distant

Stramineous to dark brown. Head including compound eyes narrower than pronotum. Vertex longer than broad at base, Y-shaped carina distinct, lateral carina subrectangularly rounding into frons. Frons in middle line longer than wide at widest

part. Lateral carina of prothorax not reaching hind margin. Forewing hyaline with distinct claval pterostigma. Rostrum not reaching hind coxa. Post tibial spur lamellate and concave on inner side, hind basitarsomere with one to three spines. Shape of pygophore, aedeagus, paramere varying with species, diaphragm well developed. Only two species of the genus were recorded during study.

Key to the species of *Nilaparvata* (Stål) from Karnataka

1. Caudal margin of pygophore truncate in dorsal half (Fig. 9 g), diaphragm without median process; aedeagus upturned ……..……...***Nilaparvata lugens* (Stål)**

- Caudal margin of pygophore uneven, diaphragm with median process; aedeagus asymmetrical with two rows of lateral marginal teeth….. ***Nilaparvata bakeri* (Muir)**

***Nilaparvata bakeri* (Muir)**

(Plate 3: A and D; Fig. 9)

Testaceous. Vertex with lateral carina parallel sided, rounding to frons, width equal at base and apex; median arm of the Y-shaped carina feeble. Frons slightly converging towards apex, lateral carinae convex, median carina not distinct, forked at level of antennae, frontoclypeal suture arcuate. Post clypeus longer in middle than width at base. Rostrum surpassing mesocoxae. Antennal scape longer than wide, pedicel longer than scape, a brown ring at apex of scape. Forewing venation as shown in Fig. 9e, viens concolorous, darker towards apical half.

Male genitalia: Anal collar with a short process. Pygophore with caudal margin sinuate in dorsal half, with rounded lobe at mid length, serrated process visible in lateral view; in caudal view diaphragm with median process with toothed lateral margins. Paramere rather pincer-like, with bifid apex as in Fig. 9i. Aedeagus cylindrical, asymmetrical with two rows of lateral marginal teeth, hook-like process on dorsal aspect subapically, gonopore apical.

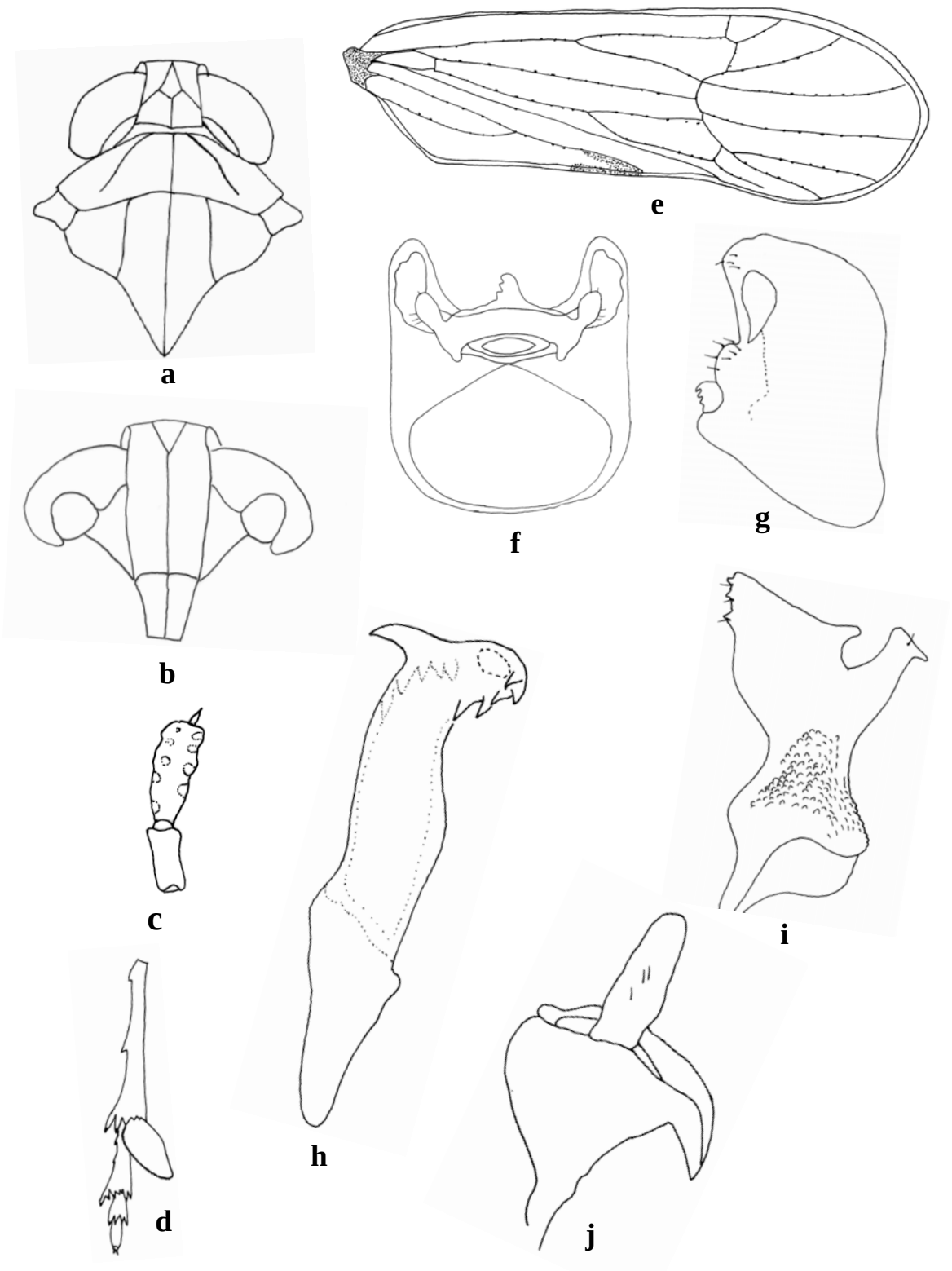


Fig. 9. ***Nilaparvata bakeri*** **(Muir)**

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore, g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Measurement: Male 3.98 ± 0.13 mm long, 0.67 ± 0.03 mm wide across head and 0.82 ± 0.01 mm across pronotum. Female 4.54 ± 0.09 mm long, 0.71 ± 0.0 mm wide across head and 0.97 ± 0.03 mm across pronotum (Table 6).

Material examined: INDIA: Karnataka: 1 ♀, Bangalore, 20.viii.2006, at light; 2 ♂, 1 ♀, 26.viii.2006; 2 ♂, 27.viii.2006; 1 ♂, 28.viii.2006; 4 ♂, 1 ♀, Mudigere, 5.x.2006, at light; 5 ♂, 2 ♀, 6.x.2006, all collected by Nimisha, K. K. (UASB).

Remarks: This species can readily identified by the structure of the pygophore which has a rounded lobe at mid length and serrated process.

***Nilaparvata lugens* (Stål)**

(Plate 3: B and E; Fig. 10)

Vertex with lateral margins obtusely rounding to frons. Frons tricarinate, median carina forked at basal 0.33, constricted medially, broader at base than apex, ocelli distinct, frontoclypeal suture truncate. Post clypeus as long as broad at base, frons, genae and clypeus stramineous. Rostrum surpassing mesocoxae. Antennal scape longer than broad, pedicel longer than scape. Legs stramineous. Forewing veins concolorous, venation as in Fig. 10e.

Male genitalia: Pygophore with oblique dorsal margin, caudal margin rather truncate. Diaphragm well developed without median process. Anal collar with well developed spine-like process. Paramere narrowed in middle section with caudal half of mesal margin bilobed, apically oblique. Aedeagus upturned, broadest at midlength, narrowed and sinuate in apical third, with a short row of teeth near sub-apical gonopore.

Measurement: Male 3.60 ± 0.12 mm long, 0.62 ± 0.04 mm wide across head and 0.71 ± 0.03 mm across pronotum. Female 4.14 ± 0.21 mm long, 0.70 ± 0.03 mm wide across head and 0.82 ± 0.07 mm across pronotum (Table 6).

Material examined: INDIA: Karnataka: 32 ♂, 27 ♀, Bangalore, at light; 1 ♂, 12.x.2006; 2 ♀, 19.iv.2006; 3 ♂, 2 ♀, 17.vi.2006; 1 ♂, 29.vi.2006; 1 ♂, 20.viii.2006; 2

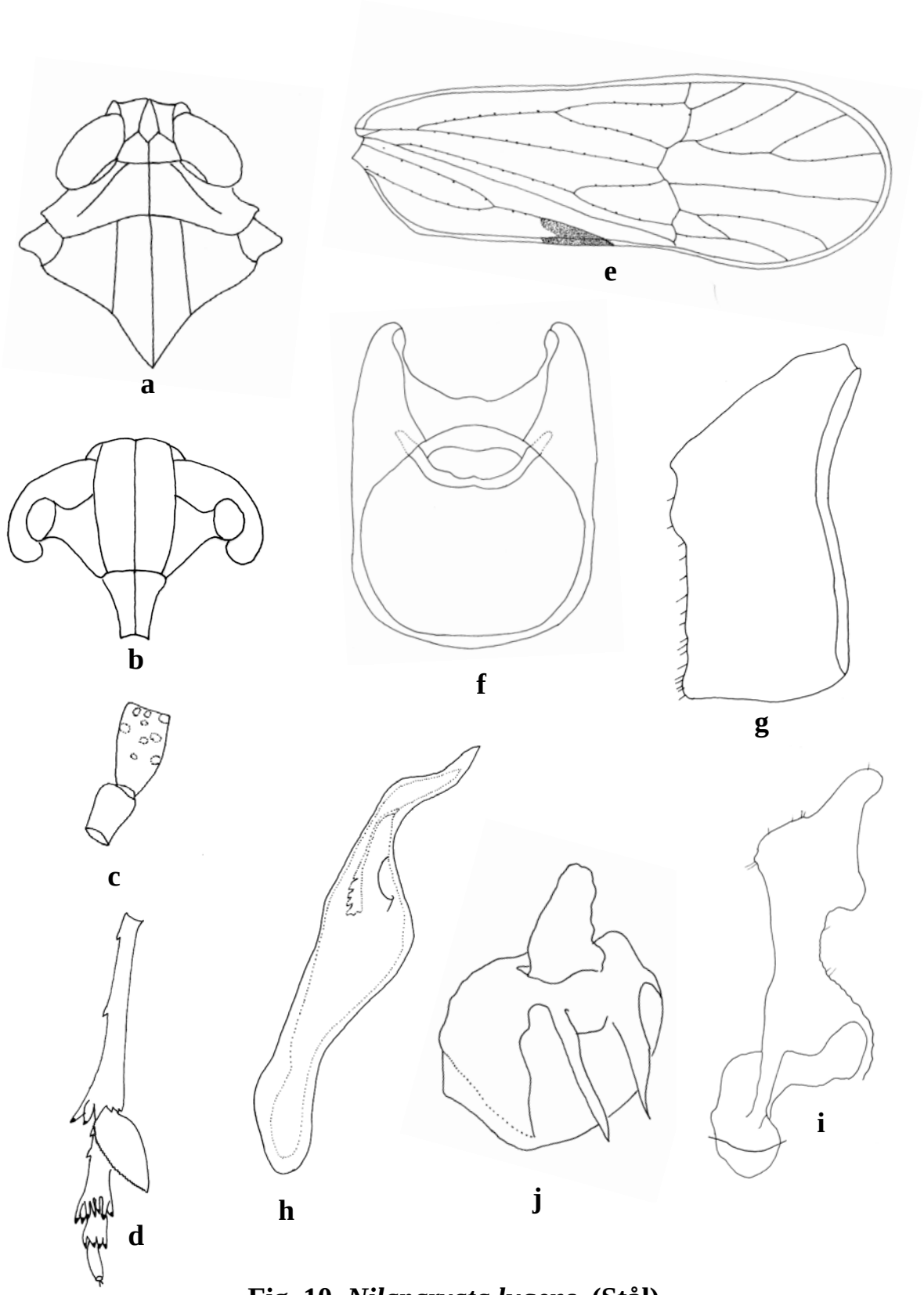


Fig. 10. ***Nilaparvata lugens*** **(Stål)**

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 6. Measurements (mm) of the male and female of the Genus *Nilaparvata* Distant

Species	***lugens* (Stål)**		***bakeri* (Muir)**	
Characters	**Male**	**Female**	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.33 ± 0.02	1.56 ± 0.11	1.49 ± 0.07	1.75 ± 0.03
Clypeus	0.19 ± 0.02	0.24 ± 0.03	0.21 ± 0.02	0.28 ± 0.02
Forewing	2.08 ± 0.07	2.32 ± 0.22	2.34 ± 0.09	2.66 ± 0.04
Frons	0.37 ± 0.04	0.40 ± 0.07	0.46 ± 0.08	0.52 ± 0.04
Pedicel	0.28 ± 0.02	0.29 ± 0.02	0.30 ± 0.02	0.33 ± 0.01
Pronotum	0.17 ± 0.01	0.20 ± 0.02	0.20 ± 0.01	0.22 ± 0.02
Scape	0.14 ± 0.02	0.15 ± 0.02	0.18 ± 0.02	0.22 ± 0.03
Scutellum	0.24 ± 0.00	0.27 ± 0.02	0.26 ± 0.02	0.29 ± 0.01
Vertex	0.19 ± 0.02	0.23 ± 0.03	0.21 ± 0.00	0.26 ± 0.02
Total length	3.60 ± 0.12	4.14 ± 0.21	3.98 ± 0.13	4.54 ± 0.09
Width				
Clypeus	0.18 ± 0.00	0.23 ± 0.03	0.18 ± 0.00	0.22 ± 0.02
Forewing	0.67 ± 0.03	0.72 ± 0.07	0.77 ± 0.03	0.80 ± 0.04
Frons	0.21 ± 0.00	0.26 ± 0.02	0.22 ± 0.02	0.27 ± 0.0
Head	0.62 ± 0.04	0.70 ± 0.03	0.67 ± 0.03	0.71 ± 0.0
Pedicel	0.11 ± 0.01	0.13 ± 0.00	0.13 ± 0.00	0.13 ± 0.00
Pronotum	0.71 ± 0.03	0.82 ± 0.07	0.82 ± 0.01	0.97 ± 0.03
Scape	0.09 ± 0.01	0.11 ± 0.01	0.10 ± 0.01	0.11 ± 0.00
Vertex	0.21 ± 0.00	0.29 ± 0.01	0.25 ± 0.01	0.29 ± 0.01
Distance between eyes	0.19 ± 0.01	0.24 ± 0.00	0.22 ± 0.02	0.25 ± 0.01

♂, 21.viii.2006; 1 ♂, 6 ♀, 24.viii.2006; 5 ♂, 5 ♀, 26.viii.2006; 1 ♂, 27.viii.2006; 7 ♂, 9 ♀, 28.viii.2006; 1 ♂, 7.ix.2006; 1 ♂, 8.ix.2006; 1 ♂, 11.ix.2006; 2 ♂, 1 ♀,13.ix.2006; 3 ♂, 2 ♀, 15.ix.2006; 1 ♂, 19.ix.2006; 1 ♂, 10.i.2007; 3 ♂, 2 ♀, Mandya, 25.i.2007, at light; 1 ♂, 2 ♀, Mudigere, 6.x.2006, at light; 1 ♀, 25.iii.2007, all collected by Nimisha, K. K. (UASB).

Remarks: This species is distinct in having the pygophore with oblique dorsal margin and in the well developed diaphragm without median process along with the distinctly shaped parameres and the upturned aedeagus.

4.1.1.7 Genus: *Nothokalpa* Fennah

Head including compound eye narrower than pronotum, vertex longer than broad at base, lateral carinae of vertex almost straight and sub-rectangularly rounding into frons, slightly wider at base than apex. Frons longer than broad, wider at apex than at base, median carina simple. Clypeus at base as wide as frons at apex. Anal segment short with rather stout short process. Aedeagus asymmetrical, stout, twisted at middle, with forked process at mid-length.

***Nothokalpa salome* Fennah**

(Plate 3: C and F; Fig. 11)

Stramineous. Frons with carinae present with median arm feeble. Frons tricarinate, longer in middle line than wide at widest part, narrow at base than apex, median carina simple, frontoclypeal suture truncate. Post-clypeus tricarinate, longer than broad at base. Rostrum surpassing mesocoxae. Antennae with basal segment longer than broad, second segment longer than first. Thorax tricarinate, lateral carinae of prothorax prominent not attaining hind margin, carinae on mesothorax feeble. Forewing hyaline, veins concolorus, venation as shown in Fig. 11e, veins darker towards apical margin. Post tibial spur lamellate, with toothed hind margin.

*Male genitalia***:** Pygophore with ventral region longer, extended into truncate process in lateral view, diaphragm well developed, ventral cavity small compared to large

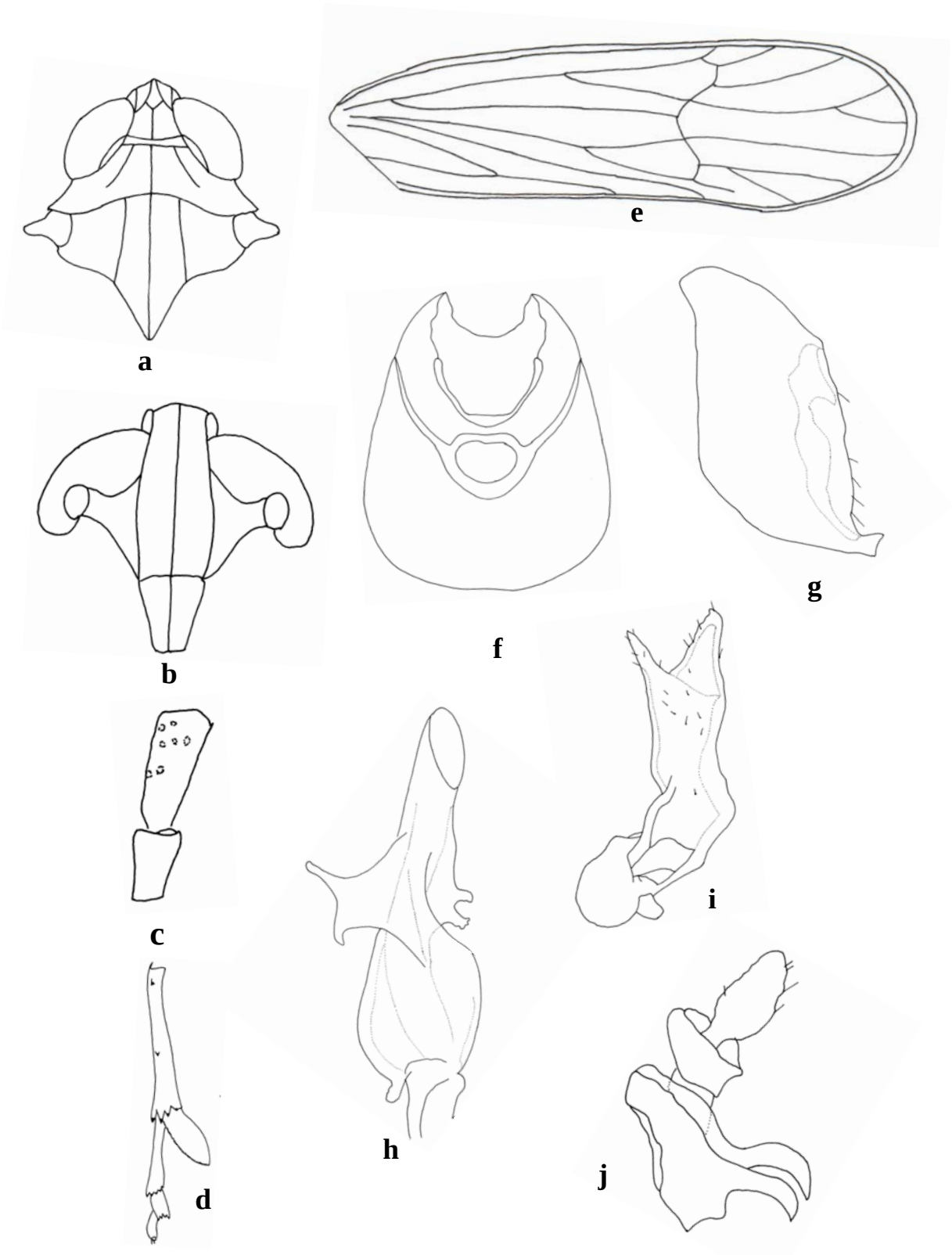


Fig. 11. ***Nothokalpa salome*** **Fennah**

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 7. Measurements (mm) of the male of *Nothokalpa salome* Fennah

Characters	**Male**
Length	**Mean**
Clavus	1.46
Clypeus	0.27
Forewing	2.24
Frons	0.42
Pedicel	0.32
Pronotum	0.21
Scape	0.13
Scutellum	0.24
Vertex	0.24
Total length	3.90
Width	0.00
Clypeus	0.24
Forewing	0.60
Frons	0.21
Head	0.63
Pedicel	0.13
Pronotum	0.75
Scape	0.11
Vertex	0.21
Distance between eyes	0.18

***Nilaparvata bakeri* (Muir)**

***Nilaparvata lugens* (Stål)**

***Nothokalpa salome* Fennah**

Dorsal view

***Nilaparvata bakeri* (Muir)**

***Nilaparvata lugens* (Stål)**

***Nothokalpa salome* Fennah**

Lateral view

Plate 3: Delphacinae: Tribe Delphacini

dorsal cavity. Anal segment with rather stout short process. Paramere large rather constricted in basal 0.33, caudally bifid, outer fork slender, compared to mesal fork. Aedeagus stout, twisted at middle, with forked process at midlength, gonopore large, apical.

Measurement: Male 3.90 mm long, 0.63 mm wide across head and 0.75 mm across pronotum (Table 7).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, at light, 8.ix.2006, Nimisha, K. K. (UASB).

Remarks: This species resembles *Nilaparvata lugens* in appearance, but can easily be distinguished by the absence of the teeth on the basal tarsal segment.

4.1.1.8 Genus *Opiconsiva* Distant

Brown. Head including eyes narrower than pronotum. Vertex broader than long. Frons longer than wide, median carina forked at base of frons. Rostrum surpassing mesocoxae not reaching hind margin. Forewing hyaline with distinct pterostigma. Pronotum tricarinate, lateral carinae not reaching hind margin, light fuscous, paler towards hind margin. Mesonotum shiny black. Aedeagus asymmetrical, tubular with basal fold-like extension.

***Opiconsiva* sp.**

(Plate 4: A and D; Fig. 12)

Vertex with distinct Y-shaped carinae, lateral carinae concave, of equal width at base and apex. Frons with carinae pale, wider just above frontoclypeal suture, intercarinal areas fuscous. Genae, clypeus fuscous. Post clypeus as long as wide at base, carinae pale, intercarinal areas fuscous with distinct median carina. Rostrum surpassing mesocoxae not reaching hind margin. Antennal scape longer than wide, with fuscous ring at apical margin, pedicel longer than scape. Forewing hyaline venation as in Fig. 12e; claval pterostigma distinct. Thorax tricarinate, lateral carinae of prothorax not reaching hind margin, mesonotum shiny black, prothorax light fuscous, paler towards hind margin.

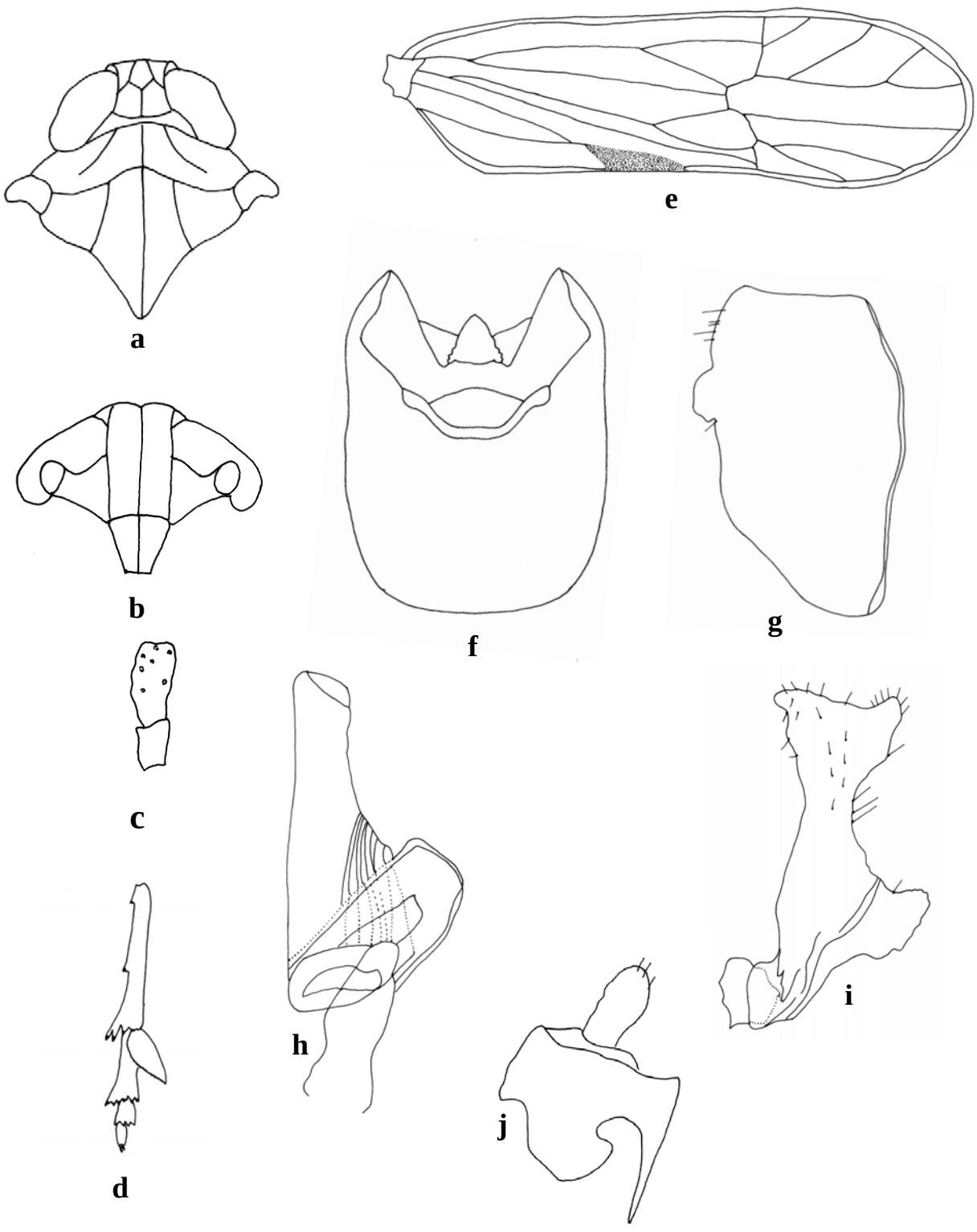


Fig. 12. *Opiconsiva* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 8. Measurements (mm) of the male of *Opiconsiva* sp.

Characters	**Male**
Length	**Mean ± SD**
Clavus	1.05 ± 0.07
Clypeus	0.22 ± 0.01
Forewing	1.63 ± 0.14
Frons	0.34 ± 0.02
Pedicel	0.22 ± 0.01
Pronotum	0.12 ± 0.00
Scape	0.12 ± 0.01
Scutellum	0.17 ± 0.01
Vertex	0.14 ± 0.02
Total length	2.74 ± 0.19
Width	
Clypeus	0.21 ± 0.02
Forewing	0.48 ± 0.06
Frons	0.18 ± 0.00
Head	0.50 ± 0.03
Pedicel	0.11 ± 0.00
Pronotum	0.55 ± 0.04
Scape	0.08 ± 0.00
Vertex	0.17 ± 0.02
Distance between eyes	0.16 ± 0.02

Male genitalia: Anal collar short with two short spine-like processes. Pygophore ventrally longer than dorsally, diaphragm well developed with a lobe-like sclerotised armature. Latero apical angles pointed. Paramere short, mesal margin deeply curved, apex bifurcated. Aedeagus with gonopore apical.

Materials examined: INDIA: Karnataka: 1 ♂, Bangalore, 19.iv.2006, at light; 1 ♂, 1 ♀, 17.vi.2006; 1♀, 13.vii.2006; 1 ♀, 24.viii.2006, all collected by Nimisha, K. K. (UASB).

Measurement: Male 2.74 ± 0.19 mm long, 0.50 ± 0.03 mm wide across head and 0.55 ± 0.04 mm across pronotum (Table 8).

Remarks: This species can be recognized by the tubular asymmetrical aedeagus with basal fold-like extension and peculiar median process of diaphragm of the pygophore.

4.1.1.9 Genus *Peregrinus* Kirkaldy

Stramineous. Head including eyes narrower than prontum. Vertex as long as wide at base, Y-shaped carina distinct. Frons longer than wide, widest at just above level of ocelli. Median carina bifurcates at level of ocelli. Frons, genae, clypeus fuscous including carina, frons wider at apex than base, almost of same width through out length. Rostrum surpassing mesocoxae, not attaining hind coxae. Thorax tricarinate, lateral carinae of pronotum reaching hind margin. Post tibial spur lamellate with teeth on hind margin and inner surface concave.

***Peregrinus maidis* (Ashmaed)**

(Plate 4: B and E; Fig. 13)

Vertex with lateral carinae concave, obliquely rounding to frons. Post clypeus as long as broad at base. Antennal scape longer than broad, darker; pedicel longer than scape, darker. Hind femora, last tarsal segment, fuscous; post tibial spur lamellate with tooth on hind margin, inner surface concave. Tegulae stramineous. Scutellum creamy white, area beyond lateral carina of mesothorax ochraceous, prothorax fuscous.

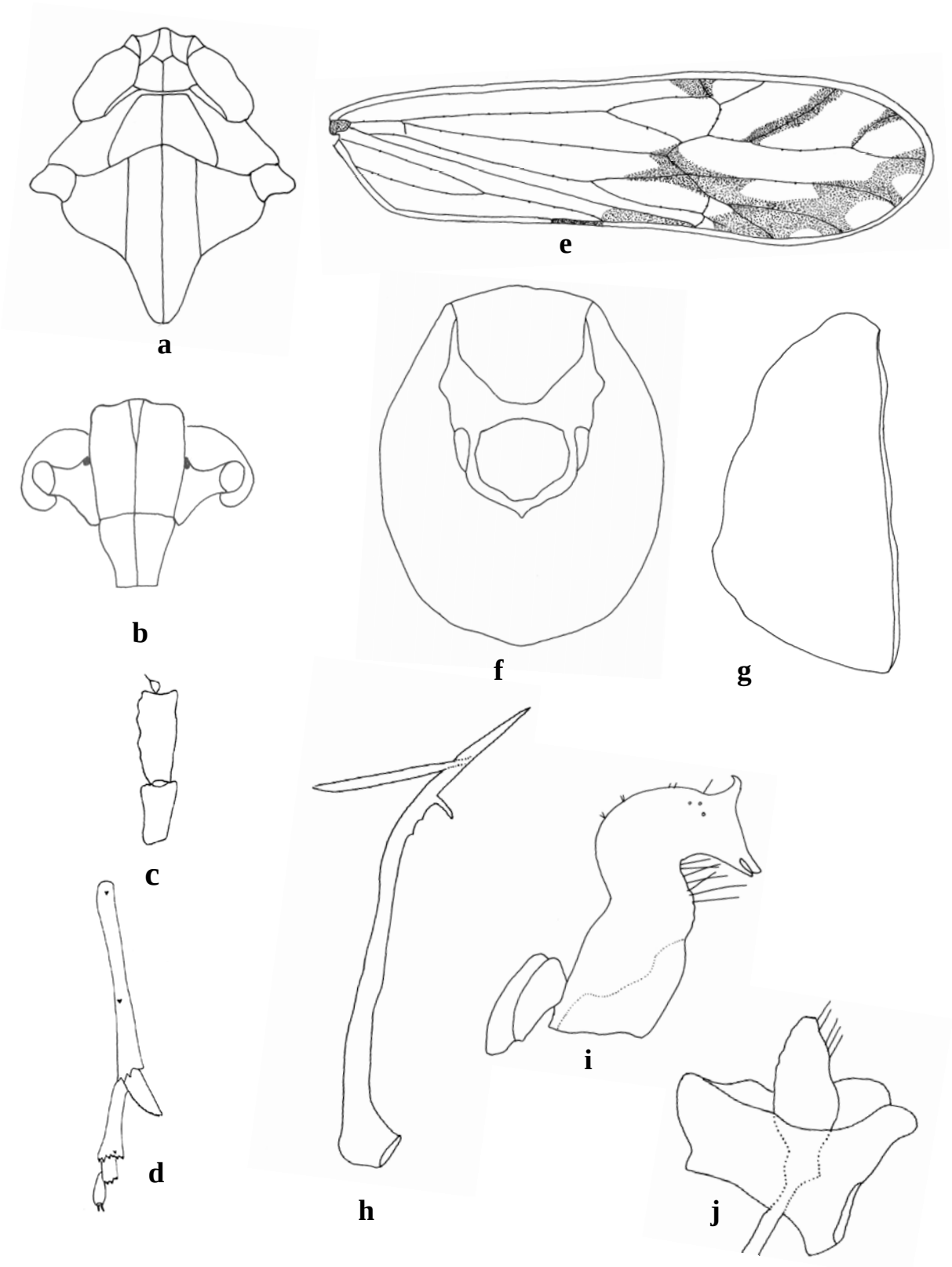
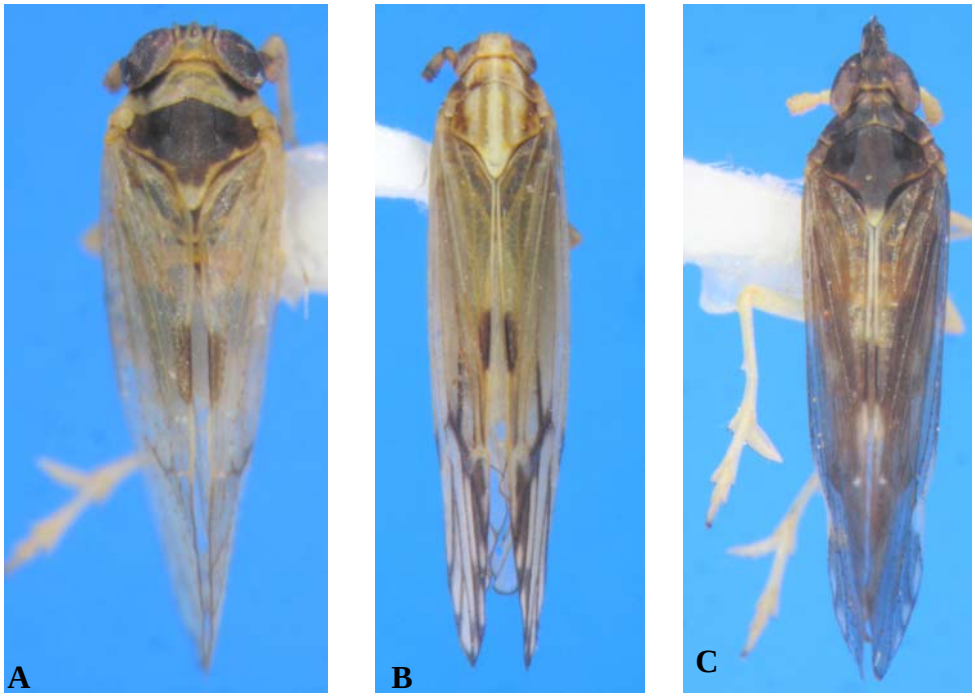


Fig. 13. *Peregrinus maidis* (Ashmaed)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

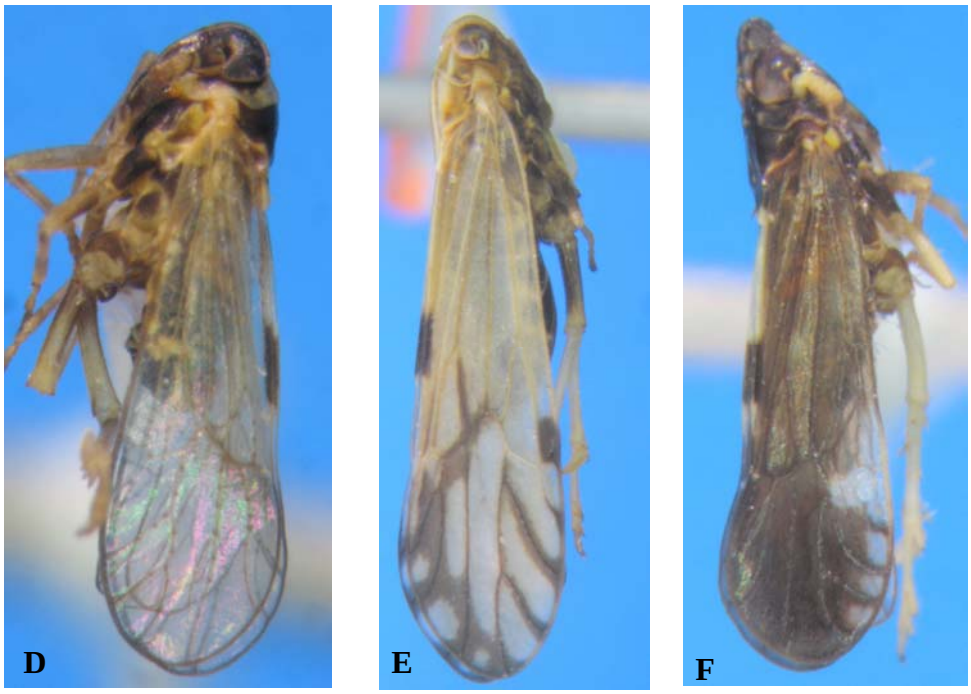
Table 9. Measurements (mm) of the male and female of *Peregrinus maidis* (Ashmaed)

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.53 ± 0.08	1.76 ± 0.12
Clypeus	0.26 ± 0.01	0.31 ± 0.03
Forewing	2.40 ± 0.10	2.90 ± 0.20
Frons	0.37 ± 0.01	0.41 ± 0.03
Pedicel	0.26 ± 0.01	0.32 ± 0.01
Pronotum	0.17 ± 0.01	0.19 ± 0.01
Scape	0.14 ± 0.01	0.17 ± 0.01
Scutellum	0.21 ± 0.00	0.27 ± 0.00
Vertex	0.17 ± 0.01	0.18 ± 0.00
Total length	4.08 ± 0.16	4.82 ± 0.34
Width		
Clypeus	0.27 ± 0.00	0.29 ± 0.01
Forewing	0.65 ± 0.05	0.77 ± 0.04
Frons	0.25 ± 0.01	0.26 ± 0.01
Head	0.54 ± 0.00	0.61 ± 0.02
Pedicel	0.13 ± 0.00	0.13 ± 0.00
Pronotum	0.67 ± 0.01	0.76 ± 0.02
Scape	0.11 ± 0.00	0.11 ± 0.00
Vertex	0.23 ± 0.01	0.27 ± 0.00
Distance between eyes	0.22 ± 0.02	0.24 ± 0.00



***Opiconsiva* sp.** ***Peregrinus maidis* (Ashmaed)** ***Sardia* sp.**

Dorsal view



***Opiconsiva* sp.** ***Peregrinus maidis* (Ashmaed)** ***Sardia* sp.**

Lateral view

Plate 4: Delphacinae: Tribe Delphacini

***Perkinsiella sinensis* Kirkaldy**

***Perkinsiella insignis* (Distant)**

***Syndelphax euroclydon* Fennah**

Dorsal view

***Perkinsiella sinensis* Kirkaldy**

***Perkinsiella insignis* (Distant)**

***Syndelphax euroclydon* Fennah**

Lateral view

Plate 5: Delphacinae: Tribe Delphacini

Forewings hyaline viens concolorous, wing venation as shown in figure (Fig. 13e), claval pterostigma distinct.

Male genitalia: Anal collar without spine-like processes. Paramere of uniform width, strongly curved at caudal 0.33, apex truncate, both ends with forked processes. Aedeagus slender, elongate, with long and short sub apical slender spines, asymmetrical.

Measurement: Male 4.08 ± 0.16 mm long, 0.54 ± 0.00 mm wide across head and 0.67 ± 0.01 mm across pronotum. Female 4.82 ± 0.34 mm long, 0.61 ± 0.02 mm wide across head and 0.76 ± 0.02 mm across pronotum (Table 9).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 12.ix.2006; 2 ♂, 6 ♀, 12.x.2006; 1 ♂, 17.vi.2006, at light; 1 ♂, 2 ♀, 27.vi.2006; 1 ♂, 1 ♀, 29.vi.2006; 4 ♂, 30.vi.2006; 5 ♂, 21.vii.2006; 4 ♂, 2 ♀, 24.vii.2006; 1 ♂, 1 ♀, 20.viii.2006; , 1 ♂, 2 ♀, 24.viii.2006; 1 ♀, 26.viii.2006; 2 ♀, 28.viii.2006; 1 ♂, 29.viii.2006; 1 ♂, 1 ♀, 1.ix.2006; 1 ♂, 1 ♀, 2.ix.2006; 1 ♂, 4 ♀, 6.ix.2006; 2 ♂, 1 ♀, 7.ix.2006; 1 ♂, 1 ♀, 8.ix.2006; 1 ♂, 1 ♀, 9.ix.2006; 2 ♂, 11.ix.2006; 1 ♀ ,18.ix.2006;ollected by all Nimisha, K. K.; 1 ♂, Chinthamani, 16.x.2006; 2 ♀, Dharwad, 29.ix.2006, Girish, K. S.; 2 ♂, 1 ♀, 27.ix.2006; 5 ♂, 11 ♀, 28.ix.2006, 1 ♂, 1 ♀, Mandya , 24.i.2007; 5 ♂, 5 ♀, 25.i.2007, all collected by Nimisha, K. K.; 1 ♀, Mudigere, 14.xi.2003, Prathapan, K. D. (UASB).

Remarks: This species can easily be recognized by the parameres being strongly bent caudally and by the asymmetrical, elongate, slender aedeagus with a long and short processes in addition to the characteristic coloration of the forewings.

4.1.1.10 Genus *Perkinsiella* Kirkaldy

Fairly large planthoppers. Light to dark brown. Head including eyes as wide as or wider than pronotum, vertex not as long as broad at base. Frons longer in middle than broad at widest margin, widest just above level of ocelli. Scutellum, intercarinal areas of prothorax and mesothorax creamy white, lateral areas of pro and mesonotum brown to black, tegulae stramineous. Antennal segments fuscous, scape triangular, longer than broad, pedicel longer than scape. Forewings not hyaline, with light to dark brown patches

towards the apical margin, veins concolorous and granulose. Pygophore dorsally longer than ventrally, diaphragm well developed with sclerotised structure medioventrally. Aedeagus, ornamentation at diaphragm and paramere shape varied across species. Two species of this genus have been recorded during the study.

Key to the species of *Perkinsiella* Kirkaldy of Karnataka

1. Anal collar appendage arises from the cephalo-ventral portion of anal tube; paramere with three lobes; pygophore with bifurcate process; aedeagus with apical spine-like process and a median lobe.....***Perkinsiella sinensis* Kirkaldy**

- Anal collar appendage arises from caudal dorsal part of anal tube; paramere without any lobes; pygophore with two widely separated processes; aedeagus with a long process apically which bends in an acute angle…...…***Perkinsiella insignis* (Distant)**

***Perkinsiella sinensis* Kirkaldy**

(Plate 5: A and D; Fig. 14)

Testaceous. Vertex with distinct Y- shaped carinae, median arm evanescent, lateral carinae obtusely rounding to frons. Median carina of frons forked at level of ocelli, frons wider at base than apex, lateral carinae highly convex in basal half. Genae, apical half of frons pale, basal half of frons lightly fuscous. Post clypeus longer than broad at base with distinct median carinae. Rostrum reaching hind coxae. Antennal segments darker on dorsal side. Legs stramineous with longtitudinal fuscous line on femora, tarsal segments of first and second pair of leg fuscous, post tibial spur with tooth on hind margin. Thorax tricarinate, tegulae, lateral areas of pro and mesothorax light brown, lateral carinae of prothorax not reaching hind margin. Forewing light brown, apical half darker except at costal margin, venation as Fig.14e, veins with fuscous granulation, no claval pterostigma.

Male genitalia: Anal segment short with two short spine-like processes arising on cephalo-ventral angle, directed dorsally. Ventral margin of pygophore sinuate in lateral view, diaphragm well developed, medioventrally produced forked process. Paramere

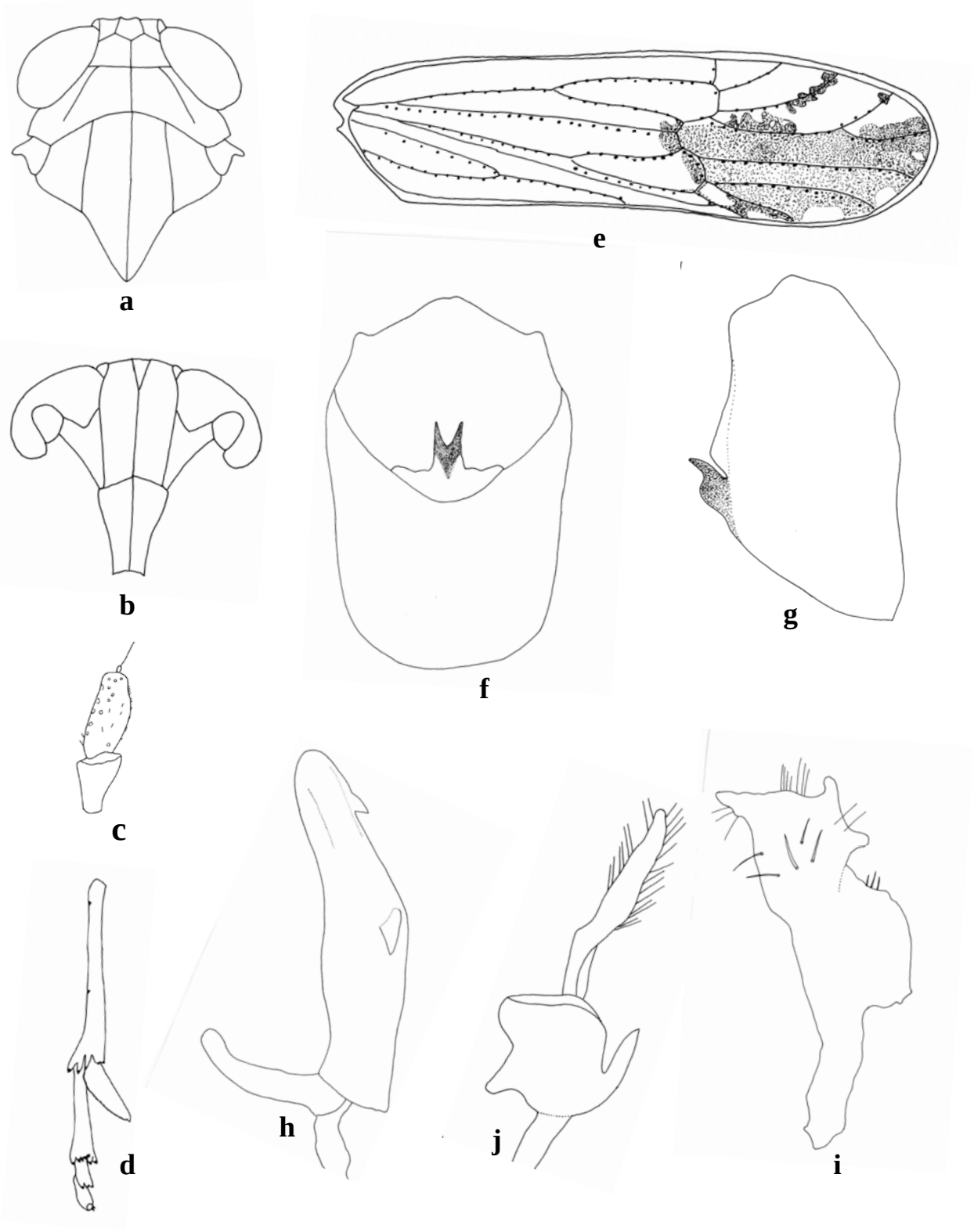


Fig. 14. *Perkinsiella sinensis* Kirkaldy

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

short and broad, with two short processes on mesal margin and pointed lobe on outer margin directed laterally.

Measurement: Male 5.14 ± 0.09 mm long, 0.93 ± 0.02 mm wide across head and 0.89 ± 0.02 mm across pronotum. Female 5.66 ± 0.23 mm long, 1.02 ± 0.02 mm wide across head and 0.97 ± 0.03 mm across pronotum (Table 10).

Material examined: INDIA: Karnataka: 1 ♀, Bangalore, 19.iv.2006, at light; 1 ♂, 18.vi.2006; 2 ♂, 20.viii.2006; 2 ♂, 1 ♀, 28.viii.2006; 1 ♀, 9.ix.2006; 1 ♂, 1 ♀, 7.xi.2006; 1 ♀, 18.ix.2006, all collected by Nimisha, K. K.; 1 ♂, Kolar, 16.x.2006, Girish, K.S. (UASB).

Remarks: This species is characteristic in having the following combination of characters. The ventral margin of pygophore is sinuate in lateral view with well developed diaphragm having bifurcate process produced medioventrally. The aedeagus is elongated with pair of lateral lobes.

***Perkinsiella insignis* (Distant)**

(Plate 5: Band E; Fig. 15)

Dark brown. Vertex with basal compartment creamy white, rest fuscous, lateral carinae concave, obtusely rounding to frons. Compound eyes large. Frons with lateral carinae convex, median carinae forked above level of ocelli, frontoclypeal suture arcuate, fuscous with intermittent testaceous patches. Postclypeus longer than broad at base, convex in profile, tricarinate with distinct median carinae. Rostrum reaching hind coxae. Thorax tricarinate, lateral areas of pro and mesonotum black, lateral carinae not reaching hind margin. Forewing brownish, apical area darker, wing venation as in Fig.15e, with distinct claval pterostigma. Coxa and femora fuscous, posterior tibiae, tarsi, post tibial spur stramineous with tooth on hind margin

Male genitalia: Pygophore in lateral view with triangular lobe with acute tip, diaphragm well developed, ventral margin with two triangular lobes, posterior opening larger than anterior one. Anal segment short with elongated spine-like process directed

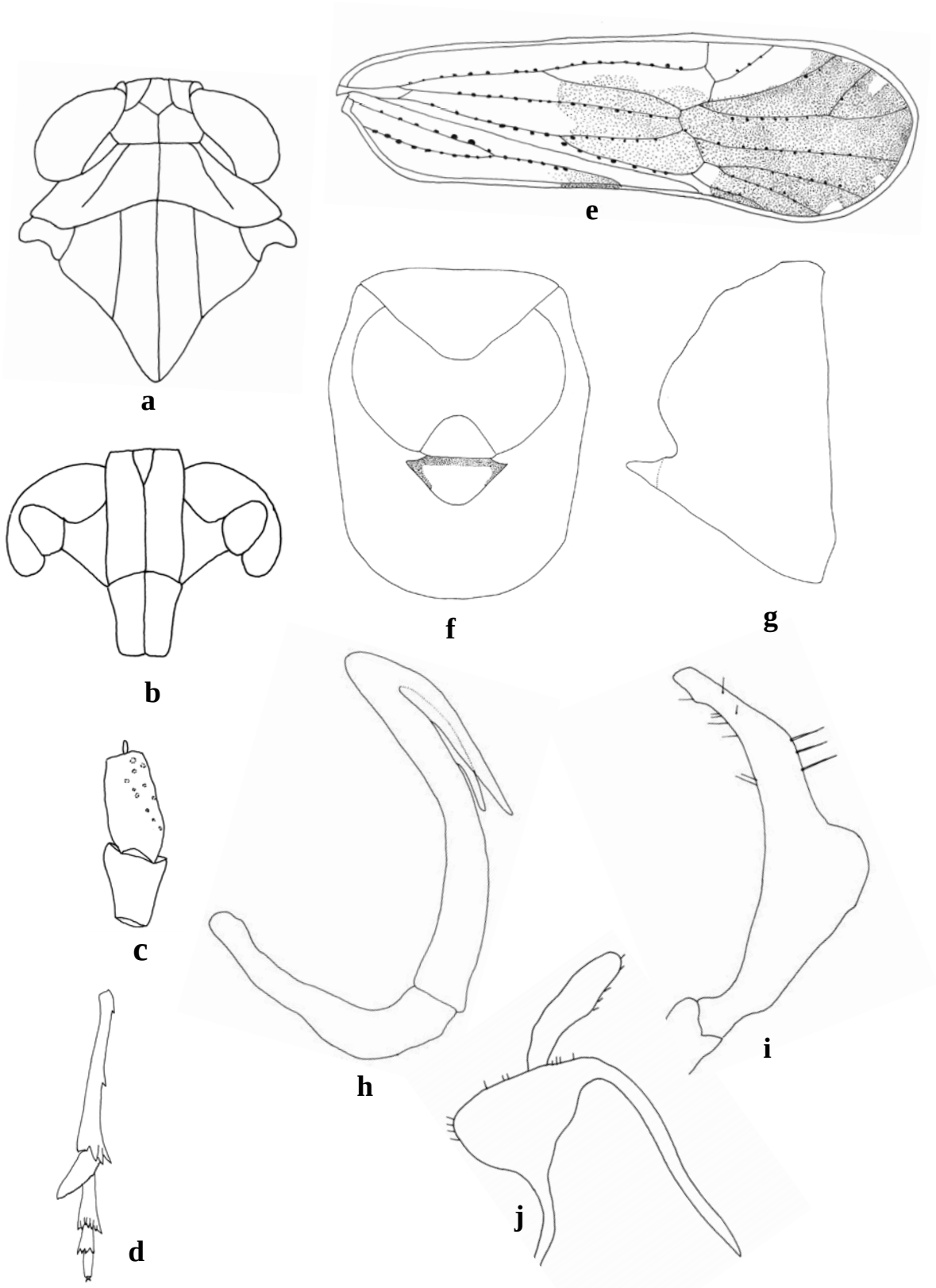


Fig. 15. *Perkinsiella insignis* (Distant)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 10. Measurements (mm) of the male and female of the Genus *Perkinsiella* Kirkaldy

Species	***insignis* (Distant)**		***sinensis* Kirkaldy**	
Characters	**Male**	**Female**	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.63 ± 0.07	1.95 ± 0.12	1.90 ± 0.05	2.15 ± 0.13
Clypeus	0.39 ± 0.04	0.46 ± 0.02	0.46 ± 0.02	0.52 ± 0.03
Forewing	2.54 ± 0.12	2.92 ± 0.17	3.00 ± 0.04	3.37 ± 0.20
Frons	0.43 ± 0.03	0.49 ± 0.03	0.52 ± 0.05	0.57 ± 0.04
Pedicel	0.40 ± 0.02	0.43 ± 0.02	0.46 ± 0.03	0.50 ± 0.05
Pronotum	0.17 ± 0.01	0.18 ± 0.00	0.21 ± 0.00	0.23 ± 0.01
Scape	0.22 ± 0.03	0.27 ± 0.03	0.26 ± 0.01	0.33 ± 0.06
Scutellum	0.25 ± 0.02	0.29 ± 0.02	0.29 ± 0.01	0.32 ± 0.03
Vertex	0.20 ± 0.03	0.21 ± 0.00	0.24 ± 0.00	0.26 ± 0.02
Total length	4.24 ± 0.22	4.92 ± 0.23	5.14 ± 0.09	5.66 ± 0.23
Width				
Clypeus	0.30 ± 0.02	0.36 ± 0.00	0.35 ± 0.03	0.37 ± 0.02
Forewing	0.77 ± 0.03	0.85 ± 0.07	0.81 ± 0.04	0.87 ± 0.04
Frons	0.25 ± 0.01	0.28 ± 0.02	0.31 ± 0.02	0.34 ± 0.01
Head	0.67 ± 0.07	0.89 ± 0.02	0.93 ± 0.02	1.02 ± 0.02
Pedicel	0.18 ± 0.01	0.20 ± 0.01	0.22 ± 0.01	0.23 ± 0.01
Pronotum	0.75 ± 0.06	0.86 ± 0.01	0.89 ± 0.02	0.97 ± 0.03
Scape	0.19 ± 0.01	0.21 ± 0.02	0.25 ± 0.01	0.26 ± 0.02
Vertex	0.30 ± 0.00	0.31 ± 0.02	0.34 ± 0.02	0.38 ± 0.02
Distance between eyes	0.25 ± 0.03	0.27 ± 0.00	0.30 ± 0.00	0.32 ± 0.02

***Perkinsiella sinensis* Kirkaldy**

***Perkinsiella insignis* (Distant)**

***Syndelphax euroclydon* Fennah**

Dorsal view

***Perkinsiella sinensis* Kirkaldy**

***Perkinsiella insignis* (Distant)**

***Syndelphax euroclydon* Fennah**

Lateral view

Plate 5: Delphacinae: Tribe Delphacini

caudo-ventrally. Paramere elongate, broad at base tapering distally. Aedeagus elongate, curved, with two subequal appendages deflexed antero-ventrally, gonopore apical.

Measurement: Male 4.24 ± 0.22 mm long, 0.67 ± 0.07 mm wide across head and 0.75 ± 0.06 mm across pronotum. Female 4.92 ± 0.23 mm long, 0.89 ± 0.02 mm wide across head and 0.86 ± 0.01 mm across pronotum (Table 10).

Material examined: INDIA: Karnataka: 1 ♀, Bangalore, 3.viii.2006, at light; 2 ♀, 21.viii. 2006; 2 ♀, 28.viii.2006; 1 ♂, 9.ix.2006; 1 ♂, 11.ix.2006; 1 ♂, 13.ix.2006; 2 ♂, 2 ♀, 11.x.2006; 1 ♂, 6.xi.2006; 1 ♂, 28.xi.2006; all collected by Nimisha, K. K.; , 7 ♂, Dodballapura, 16.viii.2007, David, K.J.; 1 ♀, Mudigere, 14.xi.2003, Prathapan, K. D. (UASB).

Remarks: This species can be easily recognized by the elongate paramere which is broad at base then tapered distally and by the structure of pygophore process.

4.1.1.11 Genus *Sardia* Melichar

Chocolate brown. Head distinctly narrower than pronotum. Vertex narrow, elongated, produced anteriorly between compound eyes. Frons tricarinate, constricted at basal one third or at level of ocelli, broadened towards postclypeous, median carina forked at base of frons. Post-tibial spur with teeth at hind margin. Forewing chocolate brown with well developed claval pterostigma, darker on apical area. Pygophore long, ventral margin longer than dorsal, dorsal margin of diaphragm with a bilobed process directed caudally.

***Sardia* sp.**

(Plate 4: C and F; Fig. 16)

Lateral carinae of vertex almost parallel sided, Y-shaped carina with strong median arm, posterior compartment elongate, basal compartment almost rectangular, with few paler spots posteriorly and laterally, median carina forked at apex. Ocelli distinct. Clypeus fuscous with light brown lateral carina, post and anteclypeous with distinct median carina, anteclypeous fuscous, in profile convex with creamy white apex. Thorax

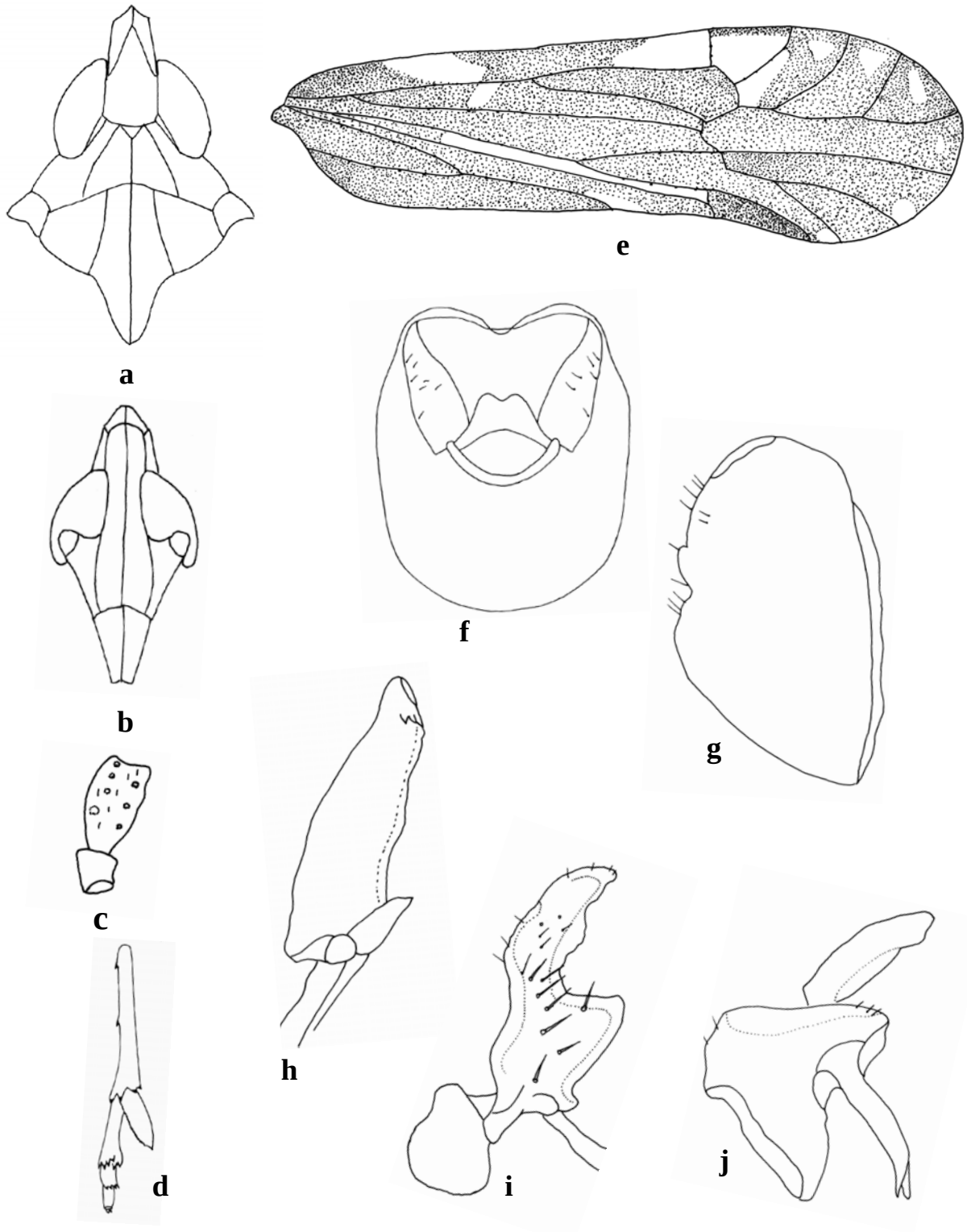


Fig. 16. *Sardia* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 11. Measurements (mm) of the male and female of *Sardia* sp.

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.34 ± 0.05	1.53 ± 0.10
Clypeus	0.19 ± 0.02	0.19 ± 0.03
Forewing	2.12 ± 0.09	2.31 ± 0.12
Frons	0.54 ± 0.03	0.60 ± 0.02
Pedicel	0.24 ± 0.03	0.23 ± 0.01
Pronotum	0.18 ± 0.00	0.19 ± 0.02
Scape	0.08 ± 0.00	0.08 ± 0.02
Scutellum	0.22 ± 0.02	0.23 ± 0.01
Vertex	0.39 ± 0.03	0.46 ± 0.03
Total length	3.86 ± 0.18	4.28 ± 0.23
Width		
Clypeus	0.18 ± 0.00	0.18 ± 0.00
Forewing	0.62 ± 0.04	0.67 ± 0.02
Frons	0.18 ± 0.00	0.20 ± 0.01
Head	0.47 ± 0.03	0.52 ± 0.03
Pedicel	0.12 ± 0.01	0.11 ± 0.01
Pronotum	0.59 ± 0.01	0.65 ± 0.03
Scape	0.09 ± 0.01	0.09 ± 0.01
Vertex	0.17 ± 0.01	0.20 ± 0.02
Distance between eyes	0.15 ± 0.00	0.17 ± 0.01

tricarinate, pronotum fuscous with pale margin along hind margin, lateral carina not reaching hind margin; median carina, anterior margin between lateral carinae and mesonotum fuscous. Scutellum with creamy white apex. Forewing chocolate brown with well developed claval pterostigma, pale areas between ends of viens, venation as in figure (Fig.16 e); claval margin creamy white up to pterostigma. Antennal segments creamy white, first antennal segment cylindrical, of same width through out length, second segment longer than first. Legs creamy white with fuscous pro and meso coxae. Post-tibial spur not solid, lamellate.

Male genitalia: Anal collar process directed ventrally, spine-like process arising before caudal apex. Pygophore ventral margin concave. Parameres with well developed mesal preapical lobe, apophysis with triangular lobe along mesal margin. Aedeagus compressed, simple without any process, dorsal margin abruptly narrowed before apex, with a few subapical teeth.

Measurement: Male 3.86 ± 0.18 mm long, 0.47 ± 0.03 mm wide across head and 0.59 ± 0.01 mm across pronotum. Female 4.28 ± 0.23 mm long, 0.52 ± 0.03 mm wide across head and 0.65 ± 0.03 mm across pronotum (Table 11).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 27.ii.2006, at light, Kengegowda, N.; 1 ♂, 2 ♀, 11.ix.2006; 2 ♀, 7.xi.2006; 2 ♂,1 ♀, 28.xi.2006; 1 ♂, 14.xii.2006; 1 ♂, 28.xii.2006; 1 ♀, 11.i.2007; 1 ♂, 1 ♀, Mandya, 24.i.2007, at light; 14♂ , 8 ♀, 25.i.2007, all collected by Nimisha, K. K.; 1♂, Mudigere, 24.iii.2007, at light, Nagaraju, D. K. (UASB).

Remarks: This species can at once be recognized by its elongate pointed head projecting beyond compound eyes.

4.1.1.12 Genus *Sogatella* Fennah

Pale stramineous. Fairly small slender planthoppers. Head including compound eyes narrower than pronotum. Vertex longer than broad at base. Lateral carina of pronotum not reaching hind margin, intercarinal areas of mesothorax including scutellum

pale giving cream band-like appearance. Claval pterostigma present or absent. Rostrum not reaching hind coxae. Post-tibial spur foliaceous with toothed hind margin. Pygophore with a U-shaped process on mediodorsal margin. Anal segment short with two spine-like processes. Aedeagus twisted with two rows of teeth.

Remarks: Coloration of vertex, frons, clypeus, and thorax vary with the species. Three species of this genus were recorded during the study.

Key to the species of *Sogatella* Fennah of Karnataka

1. Forewing hyaline with distinct claval pterostigma.....***Sogatella furcifera* (Horváth)**

- Claval pterostigma absent……..……..……**2**

2. Frons, genae and clypeus stramineous ; forewing with a light brown suffusion at the apical margin; paramere deeply curved apically, outer lobe longer and blunt compared to inner lobe …….. ***Sogatella kolophon* (Kirkaldy)**

- Frons and clypeus pale with dark fuscous genae; forewing hyaline without any markings, paramere bifid with outer lobe slender compared to inner lobe…….……..……..……...….***Sogatella vibix* (Haupt)**

***Sogatella furcifera* (Horváth)**

(Plate 6: A, B and C; Fig. 17)

Vertex with lateral carinae of vertex parallel, posterior and basal compartment pale or creamy, intercarinal areas fuscous, Y-shaped carina present, median arm not distinct. Frons longer in middle line than width at widest part, fuscous, carinae pale, median carina forked at base of frons. Genae dark brown, frons wider at basal one third from frontoclypeal suture, width of frons same as clypeus at frontoclypeal suture, clypeus brown except at carinae, postclypeus as long as broad. Rostrum not reaching hind coxae. Thorax tricarinate, prothorax creamy white with dark brown fasciae below posterior margin of compound eyes, mesothorax dark brown except scutellum and lateral areas. Tegulae creamy white. Forewing hyaline, venation as shown in Fig. 17e, veins concolorous, claval pterostigma present, with light brown suffusion beyond clavus, but

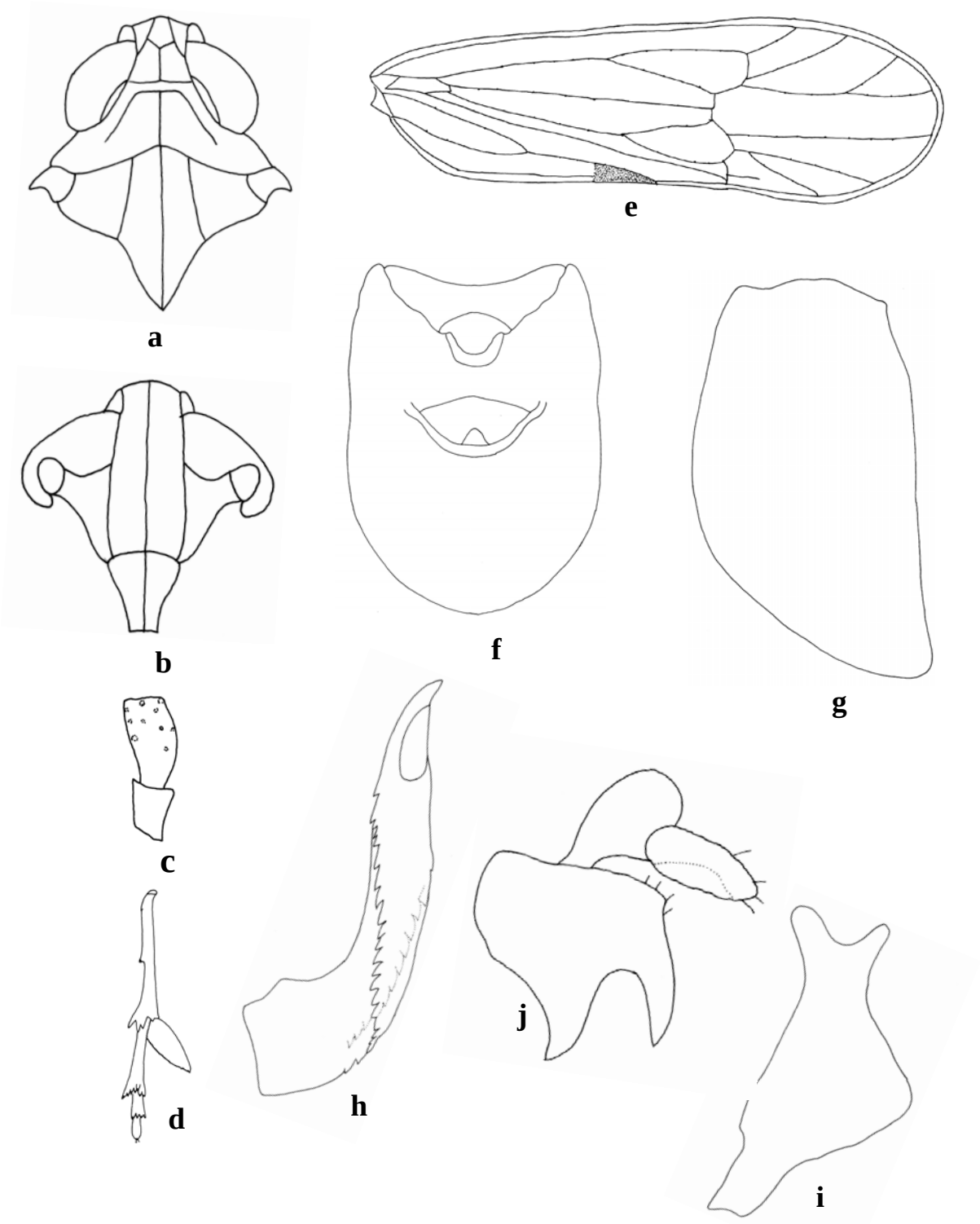


Fig. 17. *Sogatella furcifera (*Horváth)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

not prominent in females. Antennal segments creamy white, second segment longer and wider than the first segment. Legs creamy, post-tibial spur foliaceous, with toothed hind margin.

Male genitalia: Dorsal margin of diaphragm with a median broad U-shaped structure. Parameres strongly dilated at base, apex relatively small, bifurcated. Aedeagus moderately long, twisted, with two rows of teeth on both sides. Anal segment with two spine-like processes.

Measurement: Male 3.62 ± 0.13 mm long, 0.54 ± 0.00 mm wide across head and 0.64 ± 0.02 mm across pronotum. Female 4.22 ± 0.18 mm long, 0.61 ± 0.02 mm wide across head and 0.74 ± 0.05 mm across pronotum (Table 12).

Material examined: INDIA: Karnataka: 3 ♂, 13 ♀, Bangalore, 13.ix.2006, at light; 1 ♂, 29.viii.2006; 3 ♀,12.x.2006; 1 ♂, 3 ♀, 8.ix.2006, at light; 1 ♀, 9.ix.2006; 3 ♀, 11.ix.2006; 1 ♀,13.ix.2006; 1 ♂, 19.ix.2006; 3 ♂, 7.xi.2006; 1♂, Devanahalli, 16.x.2006; 1 ♀, Mandya, 25.i.2007, all collected by Nimisha, K. K.; 1 ♀, Mandya, 25.i.2007, Nagaraju, D. K.; 1 ♀, Mudigere, 14.xi.2003, Prathapan, K. D. (UASB).

Remarks: This species can easily be identified by the prominent cream coloured band extending from the vertex to the scutellum along the intercarinal areas of the thorax and by the frons, genae being dark fuscous except the carinae. The forewing has distinct claval pterostigma.

***Sogatella kolophon* (Kirkaldy)**

(Plate 6: D, E and F; Fig. 18)

Vertex obtusely rounding to frons, Y-shaped carina present, median arm not distinct. Frons in middle line longer than broad at widest part. Frons, genae and clypeus stramineous, frons wider at apex than base. Ocelli distinct, median carina forked at basal 0.25, frontoclypeal suture arcuate. Rostrum reaching mesocoxae. Antennal scape longer than broad, pedicel longer than scape. Thorax tricarinate; mesothorax ochraceous towards laterad of lateral carinae, intercarinal areas, scutellum pale. Forewing hyaline, veins

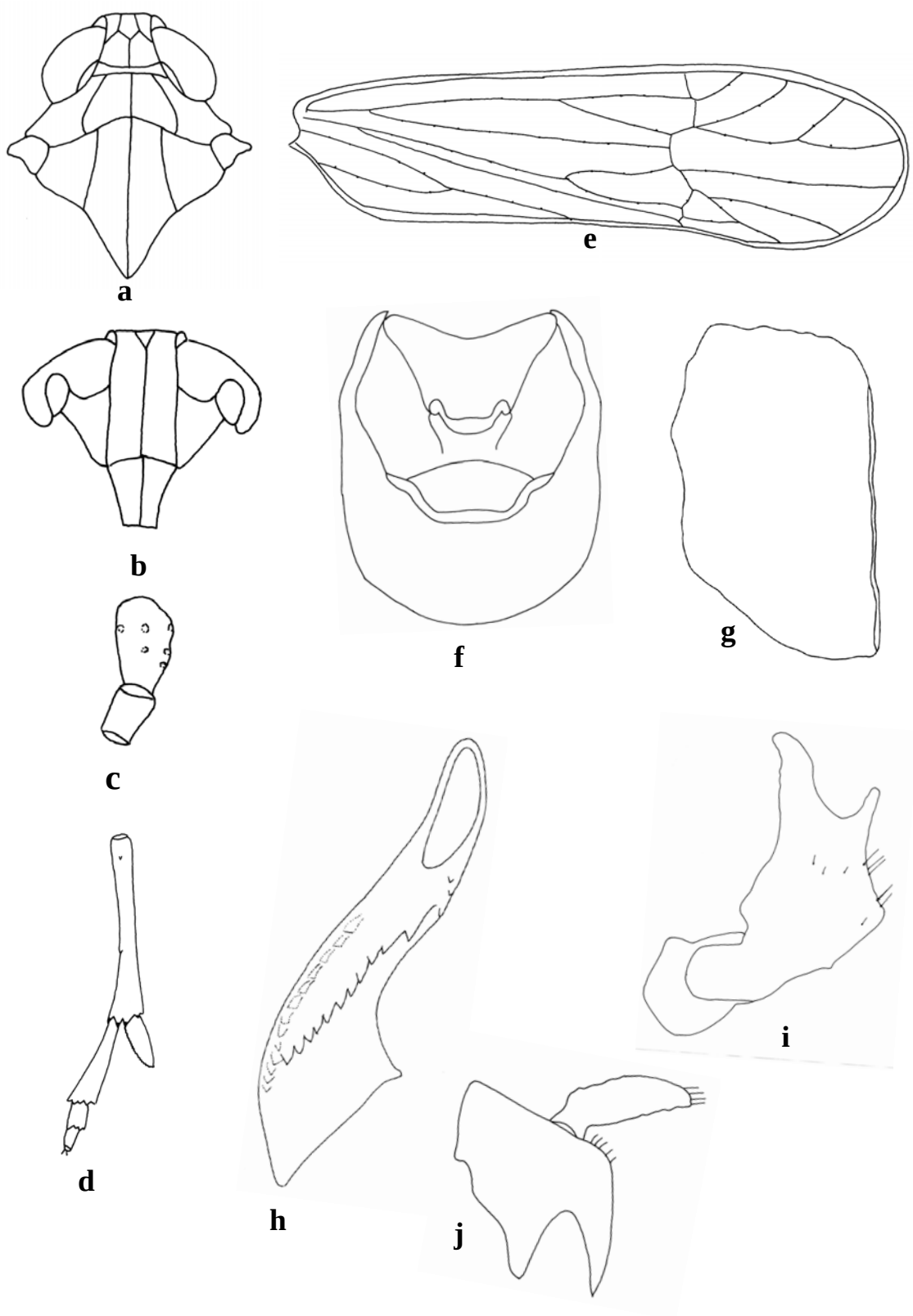


Fig. 18. *Sogatella kolophon (*Kirkaldy)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Dorsal view | Lateral view | Ventral view

***Sogatella furcifera* (Horváth)**

Dorsal view | Lateral view | Ventral view

***Sogatella kolophon* (Kirkaldy)**

Plate 6: Delphacinae: Tribe Delphacini

concolorous, venation as Fig.18e, claval pterostigma absent, a brown suffusion along the wing from the apical margin.

Male genitalia: Pygophore with U-shaped process on the mediodorsal margin, ventrally as long as dorsally. Paramere short, mesal margin shorter than outer margin, deeply curved apically, outer lobe longer with blunt tip, inner lobe short and pointed. Aedeagus with gonopore apical, twisted in basal 0.25. Anal segment short, with two spine-like processes.

Measurement: Male 3.10 ± 0.07 mm long, 0.47 ± 0.02 mm wide across head and 0.55 ± 0.01 mm across pronotum. Female 3.38 ± 0.13 mm long, 0.52 ± 0.01 mm wide across head and 0.61 ± 0.03 mm across pronotum (Table 12).

Material examined: INDIA: Karnataka: Bangalore: 1♀, 29.viii.2006, at light, Nimisha, K. K.; 1 ♂, 24.vii.2006; 1 ♀, 29.viii.2006; 1 ♀, 8.ix.2006; 1♀, 9.ix.2006; 6 ♀, 20.ix.2006; 1♂, 7.xi.2006; 4 ♂, 3 ♀, 28.x.2006, Girish, K. S.; 1 ♀, Chinthamani, 16.x.2006; 1 ♂, Devanahalli, 16.x.2006; 1 ♂, 3 ♀, Mandya, 24.i.2007; 2 ♂, 1 ♀, 25.i.2007 all collected by Nimisha, K. K.(UASB).

Remarks: This species can be distinguished from *S. vibix* and *S.furcifera* by the ochraceous colour. It may be confused with the genus *Stenocranus*. However, these genera have very distinctive male genitalia.

***Sogatella vibix* (Haupt)**

(Plate 7: A, B and C; Fig. 19)

Vertex creamy white, obtusely rounding into frons, lateral carinae parallel sided; Y-shaped carina present, median arm not distinct. Frons in middle line longer than wide at widest part, wider at apex than at base, median carinae forked at basal 0.25, frons from level of ocelli to apex of equal width, genae black. Antennal scape longer than wide, pedicel longer than scape. Thorax tricarinate, prothorax with creamy white, tegulae, scutellum pale, intercarinal areas of mesothorax creamy white, lateral areas fuscous. Forewing hyaline, veins concolorous, venation as shown in figure, pterostigma absent.

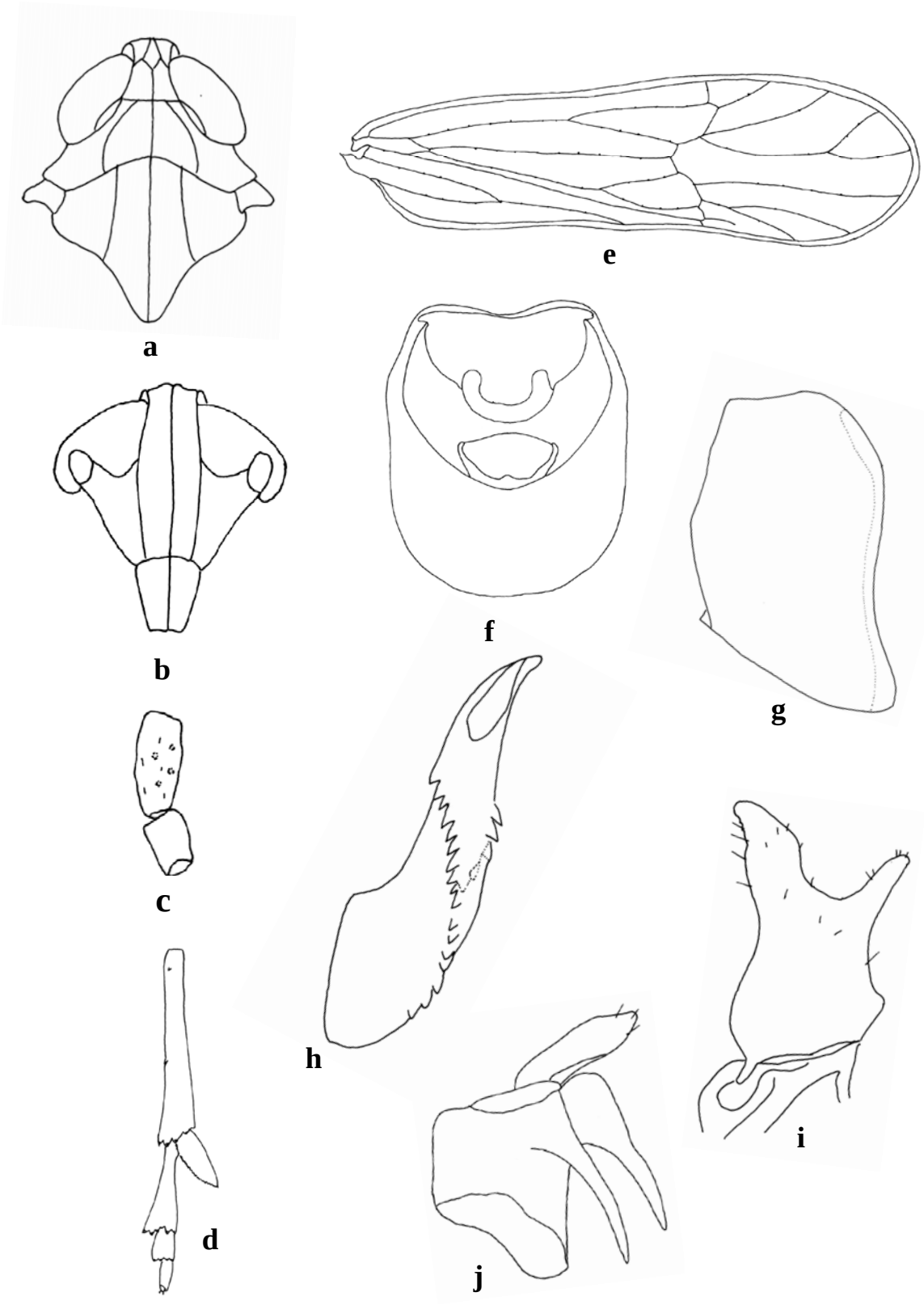


Fig. 19. *Sogatella vibix* (Haupt)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 12. Measurements (mm) of the males and females of the Genus *Sogatella* Fennah

Species	***furcifera* (Horvath)**		***kolophon* (Kirkaldy)**		***vibix* (Haupt)**	
Characters	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.34 ± 0.05	1.63 ± 0.04	1.16 ± 0.05	1.30 ± 0.07	1.24 ± 0.04	1.26 ± 0.11
Clypeus	0.27 ± 0.00	0.33 ± 0.02	0.22 ± 0.02	0.26 ± 0.02	0.25 ± 0.01	0.30 ± 0.02
Forewing	2.08 ± 0.09	2.43 ± 0.15	1.83 ± 0.05	1.99 ± 0.08	1.90 ± 0.04	1.90 ± 0.15
Frons	0.47 ± 0.03	0.53 ± 0.04	0.38 ± 0.03	0.41 ± 0.01	0.41 ± 0.03	0.43 ± 0.03
Pedicel	0.24 ± 0.00	0.26 ± 0.01	0.22 ± 0.01	0.22 ± 0.01	0.24 ± 0.00	0.23 ± 0.01
Pronotum	0.17 ± 0.01	0.20 ± 0.01	0.14 ± 0.01	0.16 ± 0.01	0.16 ± 0.02	0.16 ± 0.02
Scape	0.11 ± 0.00	0.11 ± 0.00	0.12 ± 0.01	0.12 ± 0.01	0.11 ± 0.00	0.11 ± 0.00
Scutellum	0.21 ± 0.00	0.27 ± 0.00	0.18 ± 0.00	0.21 ± 0.00	0.20 ± 0.01	0.21 ± 0.02
Vertex	0.22 ± 0.02	0.26 ± 0.02	0.16 ± 0.02	0.17 ± 0.01	0.19 ± 0.01	0.23 ± 0.03
Total length	3.62 ± 0.13	4.22 ± 0.18	3.10 ± 0.07	3.38 ± 0.13	3.32 ± 0.08	3.32 ± 0.20
Width						
Clypeus	0.26 ± 0.01	0.32 ± 0.02	0.21 ± 0.00	0.24 ± 0.00	0.23 ± 0.01	0.24 ± 0.02
Forewing	0.62 ± 0.02	0.70 ± 0.02	0.53 ± 0.02	0.56 ± 0.03	0.55 ± 0.02	0.55 ± 0.05
Frons	0.21 ± 0.00	0.23 ± 0.02	0.18 ± 0.00	0.18 ± 0.00	0.17 ± 0.01	0.18 ± 0.00
Head	0.54 ± 0.00	0.61 ± 0.02	0.47 ± 0.02	0.52 ± 0.01	0.48 ± 0.00	0.51 ± 0.02
Pedicel	0.11 ± 0.00	0.13 ± 0.00	0.11 ± 0.00	0.11 ± 0.00	0.11 ± 0.00	0.11 ± 0.00
Pronotum	0.64 ± 0.02	0.74 ± 0.05	0.55 ± 0.01	0.61 ± 0.03	0.56 ± 0.02	0.62 ± 0.07
Scape	0.08 ± 0.00	0.11 ± 0.00	0.08 ± 0.00	0.08 ± 0.00	0.08 ± 0.00	0.08 ± 0.00
Vertex	0.16 ± 0.02	0.20 ± 0.01	0.15 ± 0.00	0.18 ± 0.00	0.16 ± 0.01	0.17 ± 0.01
Distance between eyes	0.17 ± 0.01	0.20 ± 0.01	0.15 ± 0.00	0.16 ± 0.02	0.15 ± 0.00	0.16 ± 0.01

Male genitalia: Pygophore with short caudal projection on ventral margin, diaphragm well developed with arcuate sclerotized area. Anal collar with well developed ventrally prlonged process. Paramere broad at base, narrower at middle section, apically bifid with outer fork stouter than the inner. Aedeagus slightly curved, cylindrical with lateral obliquely marginal teeth.

Measurement: Male 3.32 ± 0.08 mm long, 0.48 ± 0.00 mm wide across head and 0.56 ± 0.02 mm across pronotum. Female 3.32 ± 0.20 mm long, 0.51 ± 0.02 mm wide across head and 0.62 ± 0.07 mm across pronotum (Table 12).

Material examined: INDIA: Karnataka: 2 ♂Bangalore, 6.xi.2006, at light; 1 ♂, 7.xi.2006; 1 ♂, 11.i.2007; 1 ♂, Chinthamani, 16.x.2006; 1 ♂, Mudigere, 25.iii.2007, all collected by Nimisha, K.K.; 2 ♂, Dodballapura, 16.viii.2007, David, K. J. (UASB).

Remarks: This species can be readily distinguished from all other species of *Sogotella* by its genae being dark fuscous.

Genus *Syndelphax* Fennah

Stramineous. Head including compound eye narrower than pronotum. Vertex little longer than broad at base. Frons wider than long, tricarinate, median carinae forked at base. Rostrum not reaching hind coxae. Thorax tricarinate, lateral carinae of prothorax not reaching hind margin. Posttibial spur foliaceous with serrated hind margin. Forewing hyaline without pterostigma. Pygophore moderately long, dorsal margin of diaphragm deeply concave Anal segment with spine-like process.

4.1.1.13 *Syndelphax euroclydon* Fennah

(Plate 5: C and F; Fig. 20)

Vertex with lateral carinae shallowly concave, obtusely rounding to frons. Eyes fuscous. Ocelli distinct. Lateral carinae of frons shallowly convex, frontoclypeal suture arcuate. Post clypeus triangular, anteclypeus with median carinae not distinct. Length of

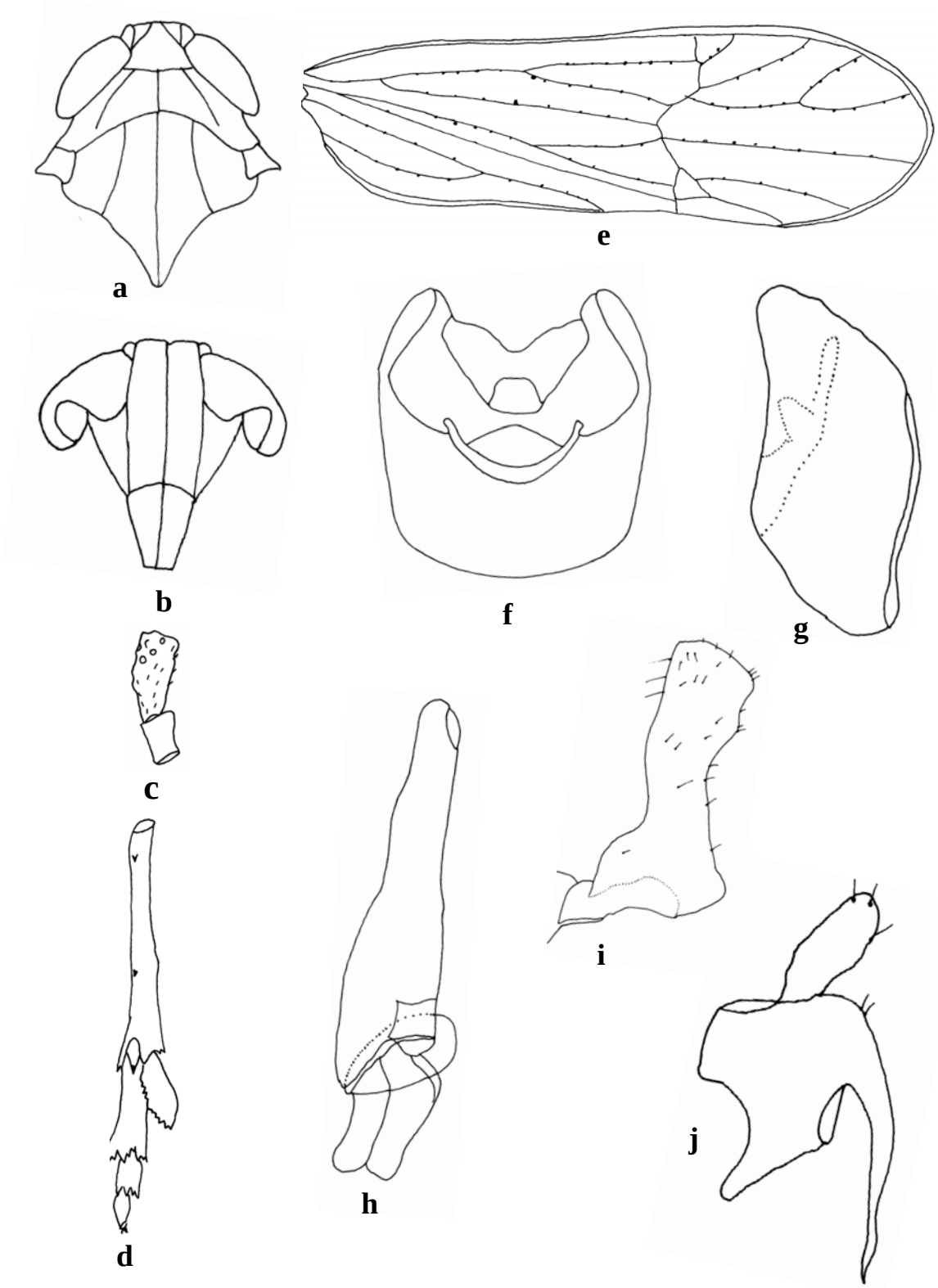


Fig. 20. *Syndelphax euroclydon* Fennah

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 13. Measurements (mm) of the males and females of *Syndelphax euroclydon* Fennah

Characters	**Male**	**Female**
Length	**Mean**	**Mean ± SD**
Clavus	1.07	1.18 ± 0.06
Clypeus	0.21	0.29 ± 0.02
Forewing	1.70	1.85 ± 0.08
Frons	0.39	0.41± 0.02
Pedicel	0.27	0.26 ± 0.01
Pronotum	0.12	0.15 ± 0.00
Scape	0.13	0.11 ± 0.01
Scutellum	0.18	0.21 ± 0.00
Vertex	0.12	0.19 ± 0.02
Total length	3.00	3.15 ± 0.10
Width		
Clypeus	0.21	0.25 ± 0.02
Forewing	0.46	0.57 ± 0.03
Frons	0.18	0.21 ± 0.00
Head	0.54	0.61 ± 0.02
Pedicel	0.13	0.13 ± 0.00
Pronotum	0.57	0.67 ± 0.02
Scape	0.11	0.11 ± 0.00
Vertex	0.18	0.21 ± 0.00
Distance between eyes	0.15	0.18 ± 0.00

pronotum less than width at anterior margin. Forewing venation as Fig. 20e, veins concolorous.

Male genitalia: Anal segment short collar like, with an elongate spine-like slender process on either side. Pygophore with posterior opening as broad as long, dorsolateral angles broadly produced, dorsal margin of diaphragm mesally produced into quadrate lobe with rounded angles, dorsolateral angles broadly produced. Paramere with broad base, apophysis with shallow constriction at midlength. Adeagus tubular with terminal gonopore without any process or teeth.

Measurement: Male 3.00 mm long, 0.54 mm wide across head and 0.57 mm across pronotum. Female 3.15 ± 0.10 mm long, 0.61 ± 0.02 mm wide across head and 0.67 ± 0.02 mm across pronotum (Table 13).

Material examined: INDIA: Karnataka: 2 ♀**,** Bangalore, 1.ix.2006, at light; 1 ♂, 2.ix.2006; 2 ♀, 8.ix.2006, all collected by Nimisha, K. K. (UASB).

Remark: This species can be easily recognized by the dorsal margin of diaphragm which is deeply concave and mesally produced into a quadrate lobe.

4.1.1.14 Genus *Tagosodes* Asche & Wilson

Stramineous. Head including eyes narrower than pronotum. Vertex longer than broad at base, with lateral carinae parallel, rectangularly rounding to frons. Frons longer than wide, median carinae simple. White band extending from anterior margin of pronotum to apex of scutellum. Thorax tricarinate, lateral carinae reaching hind margin, Forewings hyaline. Male pygophore ventrally longer than dorsally, with lobe medially in lateral view, lateroapical angles acute or pointed. Diaphragm medially produced into triangular lobe with small sclerotised eruptions. Aedeagus tubular.

***Tagosodes pusanus* Asche & Wilson**

(Plate 7: D and E; Fig. 21)

Vertex of equal width at apex and base, tip of vertex to basal compartment pale. Frons tricarinate, intercarinal areas and genae fuscous. Frontoclypeal suture arcuate. Frons and postclypeus in profile straight. Rostrum surpassing meso coxae, not reaching hind coxae. Antennal scape longer than broad, pedicel longer than scape. Latero-posterior margin of pronotum, tegulae stramineous, rest dark brown. Forewing veins concolorous, wing venation as in Fig. 21e, claval pterostigma distinct.

Male genitalia: Anal collar short with ventrally directed short spine-like process. Paramere short, constricted medially, distally bifurcated outer lobe rounded. Aedeagus tubular with a lateral row of teeth, gonopore apical.

Measurement: Male 3.16 ± 0.13 mm long, 0.47 ± 0.02 mm wide across head and 0.57 ± 0.00 mm across pronotum (Table 14).

Material examined: INDIA: Karnataka: 2 ♂, Bangalore, 7.xi.2006, at light; 1 ♂, 9.xi. 2006, Nimisha, K. K.; 1 ♂, Makuta, 10.i.2007, Srinivas, Y. B. (UASB).

Remarks: This species resembles the species of the genus *Sogatella* in appearance but the male genital characters are very different. The male pygophore lacking broad U-shaped structure at the mediodorsal margin of diaphragm and aedeagus not twisted and lacks two rows of tooth distinguishes this species from the species of *Sogatella*. The colour pattern of the forewing easily distinguishes the species from *Sogatella*.

4.1.1.15 Genus *Toya* Distant

Stramineous. Small planthoppers. Head including eyes not distinctly narrower than pronotum, lateral carinae of vertex shallowly concave, short, obtusely rounding to frons, Y-shaped carinae present, median arm not distinct. Frons in middle line longer than wide. Rostrum surpassing mesocoxae. Post tibial spur lamellate with toothed hind margin. Forewings hyaline veins concolorous, darker towards apical margin. Male

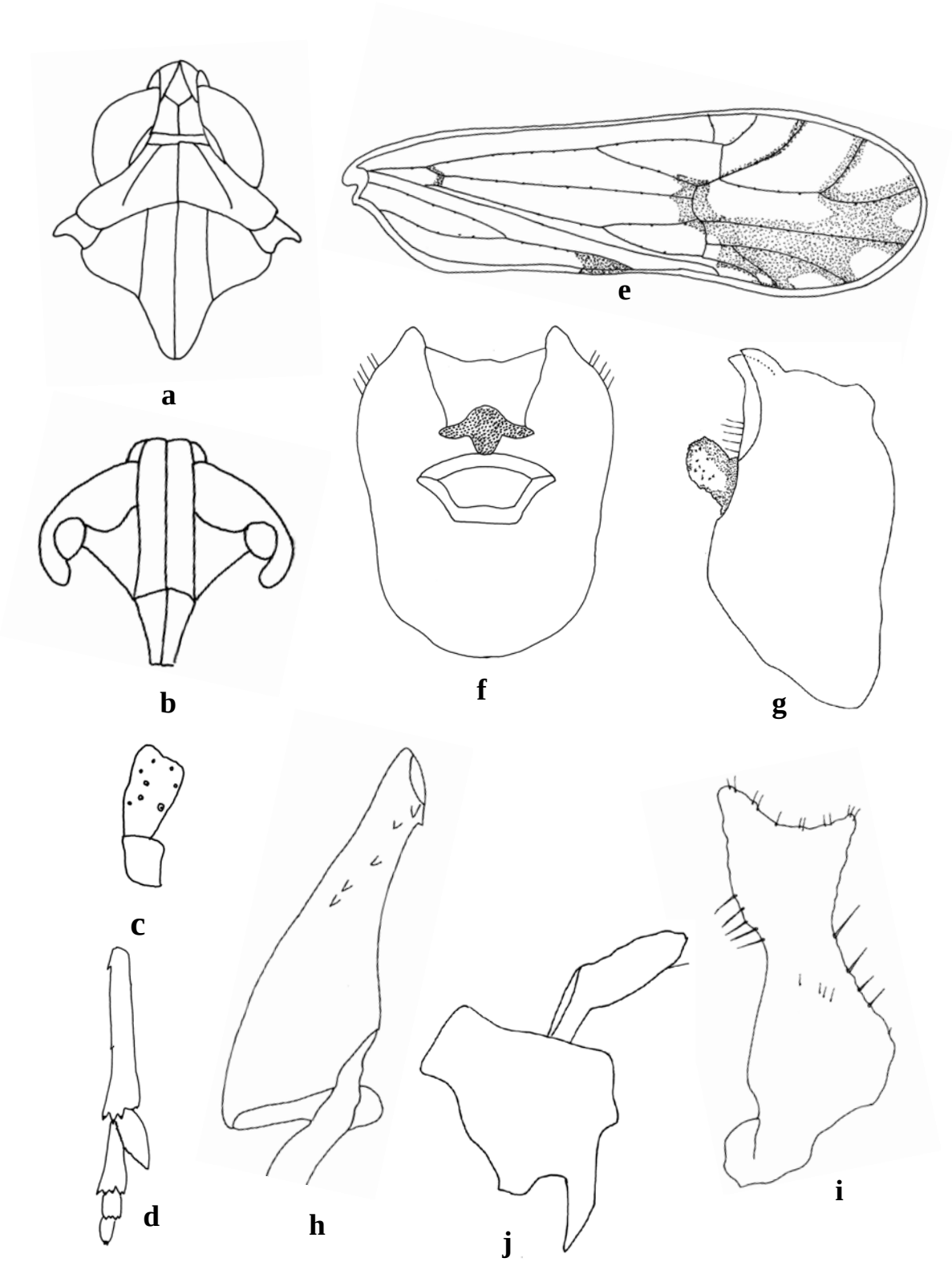
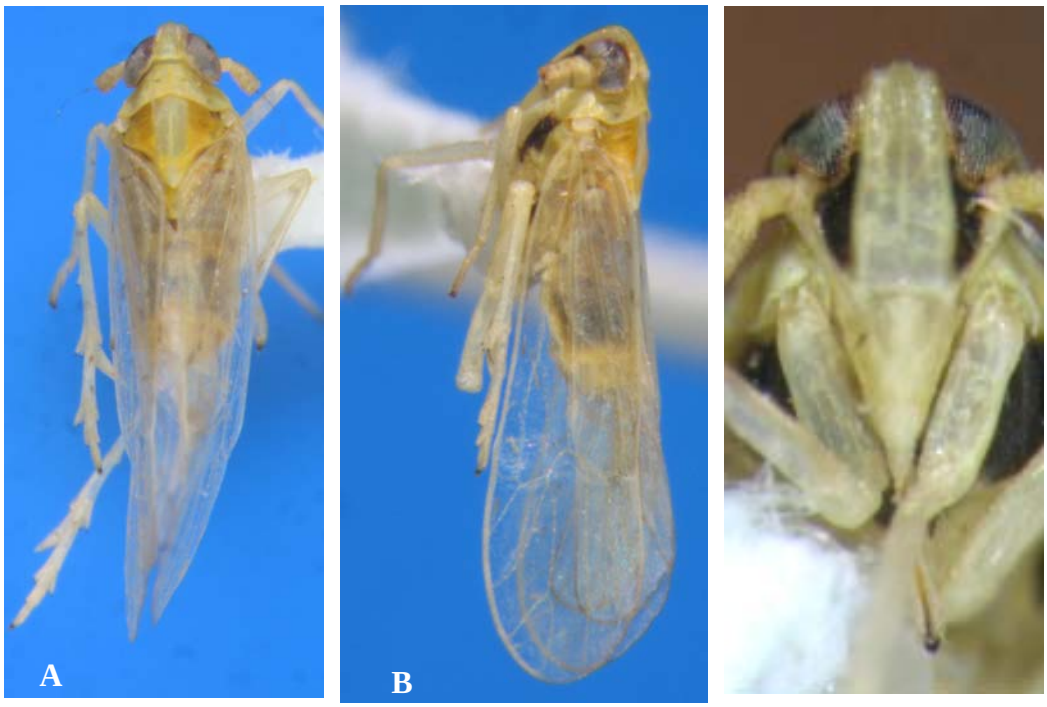


Fig. 21. *Tagosodes pusanus* Asche & Wilson

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

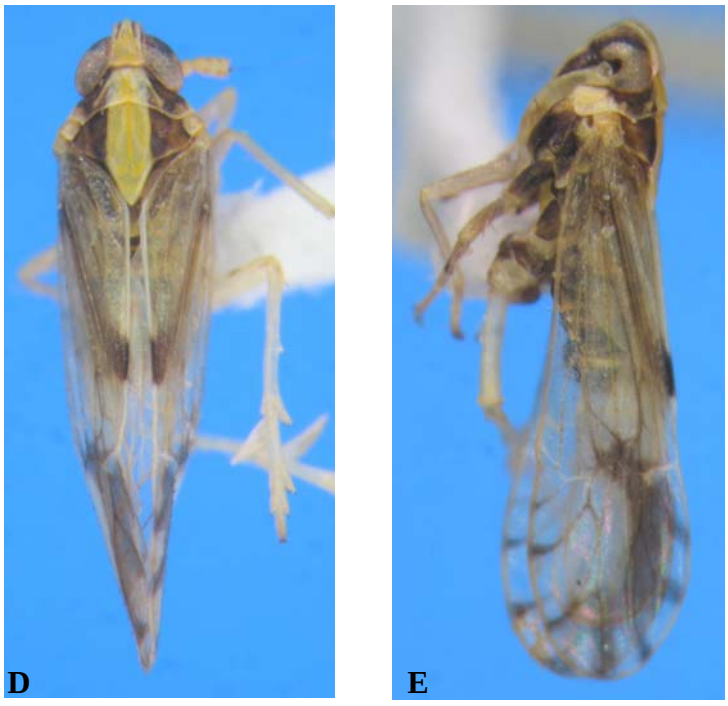
Table 14. Measurements (mm) of the male of *Tagosodes pusanus* Asche & Wilson

Characters	**Male**
Length	**Mean ± SD**
Clavus	1.16 ± 0.05
Clypeus	0.20 ± 0.01
Forewing	1.81 ± 0.06
Frons	0.41 ± 0.02
Pedicel	0.23 ± 0.01
Pronotum	0.17 ± 0.01
Scape	0.11 ± 0.01
Scutellum	0.19 ± 0.01
Vertex	0.21 ± 0.02
Total length	3.16 ± 0.13
Width	
Clypeus	0.21 ± 0.00
Forewing	0.55 ± 0.02
Frons	0.17 ± 0.02
Head	0.47 ± 0.02
Pedicel	0.11 ± 0.00
Pronotum	0.57 ± 0.00
Scape	0.08 ± 0.00
Vertex	0.15 ± 0.00
Distance between eyes	0.14 ± 0.01



Dorsal view | Lateral view | Ventral view

***Sogatella vibix* (Haupt)**



Dorsal view | Lateral view

***Tagosodes pusanus* Asche & Wilson**

Plate 7: Delphacinae: Tribe Delphacini

pygophore with well developed diaphragm. Paramere and aedeagus shape variable. Two species of this genera were recorded during the study.

Key to the species of *Toya* Distant of Karnataka

1. Intercarinal areas of frons, carinae of genae postclypeus light fuscous; pygophore diaphragm with Y-shaped process at the mediodorsal margin, paramere apically ends in two short forks, aedeagus tubular with teeth toward apex...***Toya propinqua*** **(Fieber)**

- Pygophore diaphragm without Y-shaped process, aedeagus not tubular, have series of teeth……...……..**2**

2. Pygophore diaphragm well developed with a three lobed structure medially, paramere with a blunt apex, not forked apically ……...…….....……...… ***Toya*** **sp**

- Pygophore diaphragm with two outer lobes, paramere quandrangular with a tooth like projection mesoapically……..……..... ***Toya bridwelli*** **(Muir)***

Toya propinqua **(Fieber)**

(Plate 8: A and C; Fig. 22)

Vertex long as broad at base, basal compartment, carinae pale, posterior compartment, intercarinal areas fuscous. Carinae of genae, frons, postclypeus pale, intercarinal areas light fuscous, frons almost same length through out the length, median carina forked at base of frons, frontoclypeal suture truncate, frons in profile convex. Rostrum surpassing meso coxae not reaching hind coxae. Antennal scape long as wide, pedicel longer than scape, a brown ring at apex and base of scape and pedicel respectively. Tarsal segments of first and second pair pair of leg fuscous. Forewing venation as shown in figure (Fig. 22e), claval pterostigma not distinct.

Male genitalia: Pygophore ventrally longer than dorsally, lateroapical angles broadly produced, diaphragm well developed, with mediodorsal margin produced into Y-shaped process. Anal segment short with two spine-like processes. Paramere short, broad basally, constricted basally, apex forked. Aedeagus tubular, gonopore apical.

* Species not included in the study

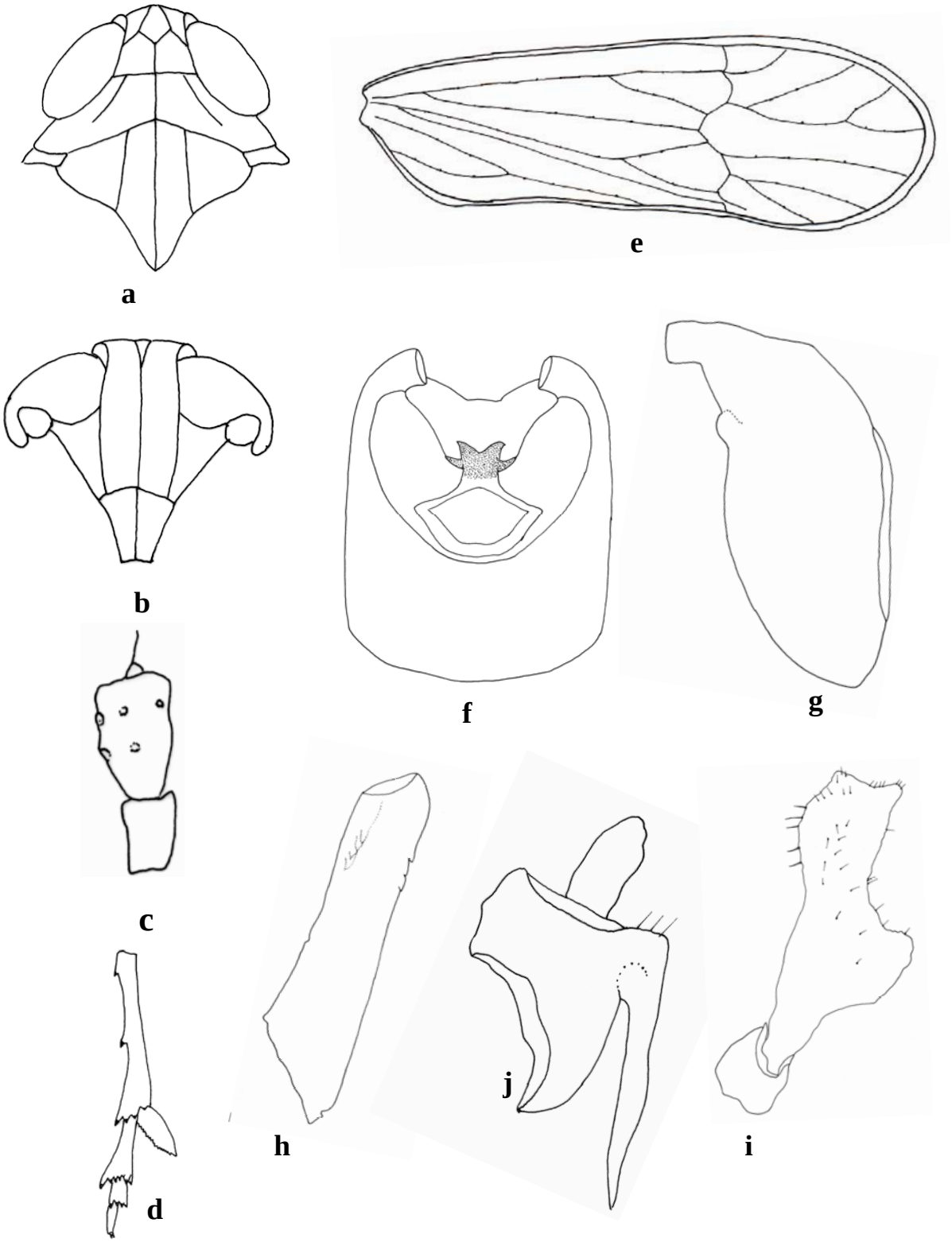


Fig. 22. *Toya propinqua* (Fieber)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Measurement: Male 3.08 ± 0.09 mm long, 0.55 ± 0.01mm wide across head and 0.60 ± 0.03 mm across pronotum. Female 3.53 ± 0.19 mm long, 0.62 ± 0.02 mm wide across head and 0.67 ± 0.03 mm across pronotum (Table 15).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 12.x.2006, at light, Nimisha, K. K.; 1 ♂, 15.v.2007, , 2 ♂, 17.vi.2006; 1 ♂, 21.vii.2006; 1 ♂, 24.vii.2006; 2 ♀, 26.viii.2006; 1 ♂, 28.viii.2006; 3 ♀, 8.ix.2006; 1 ♂, 18.ix.2006, Salini, S.; , 1 ♂, Devanahalli,16.x.2006; 1 ♂, Mandya, 24.i.2007; at light; 3 ♂, Dharwad, 27.ix.2006; 3 ♂, 28.ix.2006, all collected by Nimisha, K. K. (UASB).

Remark: This is a very widely distributed species with well developed diaphragm with a Y-shaped structure at the mediodorsal margin.

***Toya* sp.**

(Plate8: B and D; Fig. 23)

Vertex longer than broad at base, tip of vertex to hind margin of basal compartment stramineous, intercarinal area fuscous. Frons with carinae creamywhite, intercarinal areas dark fuscous, median carina forked at base, lateral carinae convex. Frons wider at level of ocelli, genae fuscous, frontoclypeal suture truncate. Post clypeus tricarinate, carinae creamy, intercarinal areas fuscous. Rostrum surpassing meso coxae. Antennal scape longer than wide, pedicel dark, twice as long as scape, base of pedicel and apex of scape brown ringed. Legs with fuscous stripes over femora and tibiae. outer surface of post tibial spur concave. Thorax tricarinate. Lateral carinae of prothorax not reaching hind margin. Forewing venation as in Fig. 23e.

Male genitalia: Anal segment short with short prong-like process on either side spine-like processes. Pygophore ventrally shorter than dorsally in lateral view, latero apical angles slightly curved inwards, diaphragm well developed with three-lobed structure medially, outer lobe well developed. Paramere short, broad at base, converging distally, apex blunt. Aedeagus twisted with series of teeth dorsoventrally, gonopore apical.

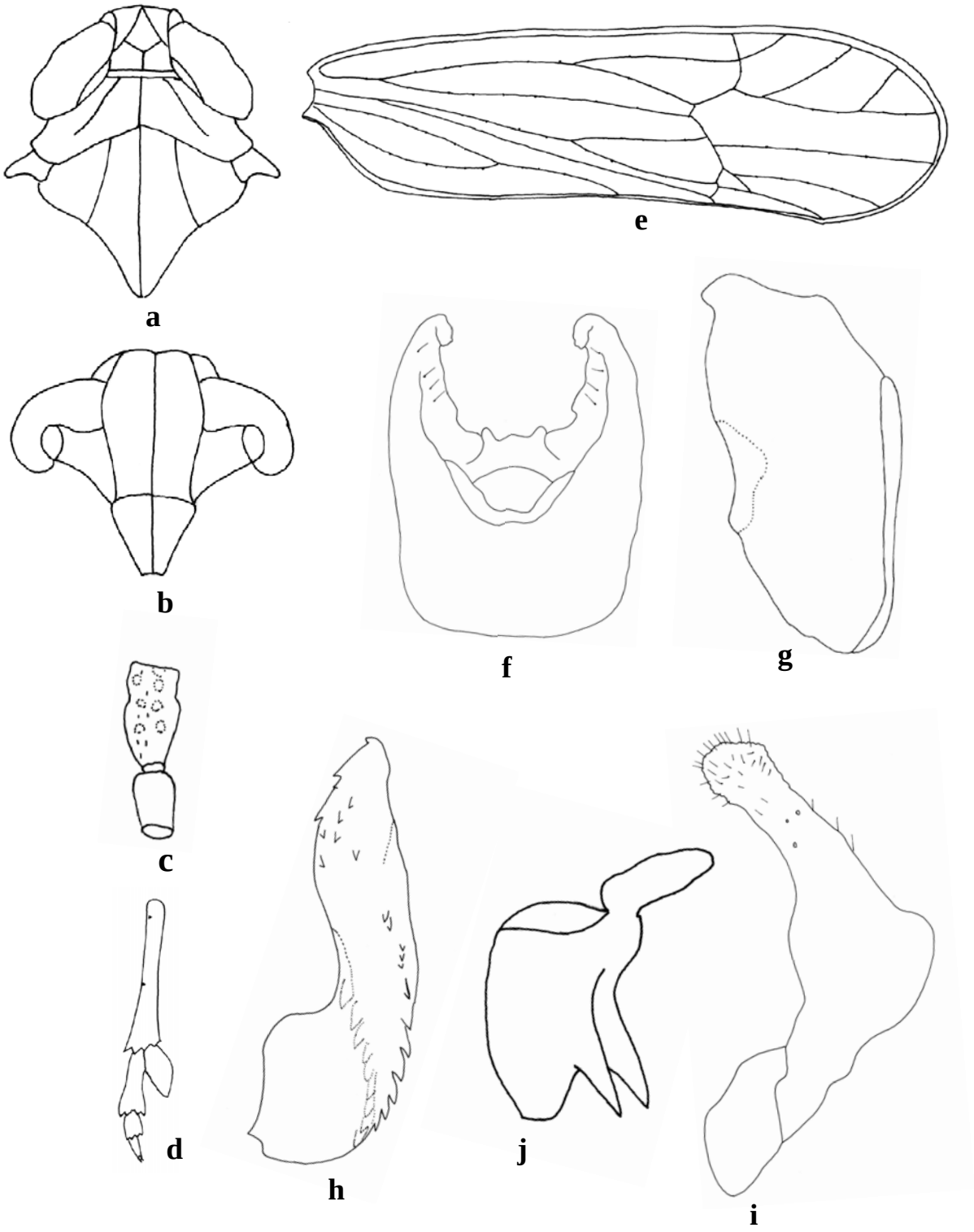


Fig. 23. *Toya* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 15. Measurements (mm) of the males and females of the Genus *Toya* Distant

Species	***propinqua* (Fieber)**		**sp.**	
Characters	**Male**	**Female**	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.17 ± 0.05	1.39 ± 0.07	1.16 ± 0.06	1.37 ± 0.07
Clypeus	0.25 ± 0.00	0.28 ± 0.01	0.24 ± 0.00	0.27 ± 0.02
Forewing	1.78 ± 0.07	2.06 ± 0.07	1.78 ± 0.08	2.04 ± 0.07
Frons	0.36 ± 0.01	0.42 ± 0.11	0.37 ± 0.01	0.40 ± 0.11
Pedicel	0.23 ± 0.01	0.24 ± 0.08	0.23 ± 0.01	0.21 ± 0.08
Pronotum	0.15 ± 0.01	0.16 ± 0.00	0.14 ± 0.01	0.15 ± 0.00
Scape	0.11 ± 0.01	0.13 ± 0.06	0.11 ± 0.01	0.13 ± 0.06
Scutellum	0.21 ± 0.00	0.25 ± 0.01	0.21 ± 0.00	0.23 ± 0.01
Vertex	0.16 ± 0.02	0.19 ± 0.02	0.16 ± 0.02	0.20 ± 0.02
Total length	3.08 ± 0.09	3.53 ± 0.19	3.06 ± 0.09	3.50 ± 0.19
Width				
Clypeus	0.23 ± 0.02	0.24 ± 0.06	0.22 ± 0.02	0.23 ± 0.07
Forewing	0.57 ± 0.04	0.61 ± 0.03	0.55 ± 0.05	0.60 ± 0.03
Frons	0.19 ± 0.00	0.24 ± 0.02	0.18 ± 0.00	0.24 ± 0.04
Head	0.55 ± 0.01	0.62 ± 0.02	0.55 ± 0.01	0.62 ± 0.02
Pedicel	0.11 ± 0.00	0.11 ± 0.00	0.11 ± 0.00	0.11 ± 0.00
Pronotum	0.60 ± 0.03	0.67 ± 0.03	0.59 ± 0.03	0.67 ± 0.03
Scape	0.08 ± 0.00	0.09 ± 0.01	0.08 ± 0.00	0.09 ± 0.01
Vertex	0.20 ± 0.00	0.25 ± 0.06	0.18 ± 0.00	0.25 ± 0.07
Distance between eyes	0.17 ± 0.01	0.20 ± 0.01	0.17 ± 0.01	0.20 ± 0.01

Toya propinqua Dorsal view ***Toya* sp.**

Toya propinqua Lateral view ***Toya* sp.**

Plate 8: Delphacinae: Tribe Delphacini

Measurement: Male 3.06 ± 0.09 mm long, 0.55 ± 0.01mm wide across head and 0.59 ± 0.03 mm across pronotum. Female 3.50 ± 0.19 mm long, 0.62 ± 0.02 mm wide across head and 0.67 ± 0.03 mm across pronotum (Table 15).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 17.vi.2006, at light; 1 ♂, 20.vii.2006; 1 ♂, 20.viii.2006; 2 ♂, 28.viii.2006; 1 ♂, 4.ix.2006; 1 ♂, 6.ix.2006; 1 ♂, 7.ix.2006; 7 ♀, 8.ix.2006; 1 ♂, 11.ix.2006; 2 ♂, 13.ix.2006; 1 ♂, 14.ix.2006; 1 ♂, 18.ix.2006; 1 ♂, Mandya, 25.i.2007, at light; 1 ♂, Mudigere, 22.iii.2007, all collected by Nimisha, K. K. (UASB).

Remark: This species is similar to *T. propinqua* but differs in the structure of diaphragm of the pygophore which is well developed with a three lobed structure medially and the structure of aedeagus.

4.1.2 Tribe Tropidocephalini

Three species of this tribe were recorded during the study.

Key to the genera of the tribe Tropidocephalini of Karnataka

1. Antennae elongate, foliaceous with a median ridge, pedicel of antennae shorter than scape (Fig. 25c)…….……..……..……***Purohita*** **Distant**

- Antennae short, not foliaceous …..……..….**2**

2. Head distinctly narrower than pronotum, basal compartment of vertex triangular antennae not elongated .....***Tropidocephala*** **Stål**

- Head almost as broad as pronotum; basal compartment of vertex trapezoidal…….……...……..……..……..……..***Arcofasciella*** **Fennah**

4.1.2.1 Genus *Arcofasciella* Fennah

Stramineous. Head including compound eyes almost as wide as pronotum. Vertex shorter than broad at hind margin, basal compartment trapezoidal, lateral carinae of vertex obtusely rounding to frons. Frons longer in middle line than wide at widest margin, wider just above level of ocelli, median carina forked at base. Post clypeus in

profile convex, anteclypeus bent downwards at right angles. Thorax tricarinate, prothorax, short with lateral carina diverging outward, almost reaching hind margin. Forewing hyaline, apical margin shallowly undulate. Post-tibial spur without teeth on hind margin. Male pygophore ventrally longer than dorsally. Aedeagus laterally compressed. Anal segment large, short without process.

***Arcofasciella* sp.**

(Plate 9: A and D; Fig. 24)

Region of transition from vertex to frons truncate. Rostrum dark not reaching hind coxae. Antennal scape shorter than pedicel, brown ring at apex and base of scape and pedicel, respectively. Forewing veins concolorous, wing venation as in figure Fig. 24e. Anal angle pointed. Post-tibial spur solid, without teeth.

Male genitalia: Anal segment large, short, without processes. Diaphragm projecting mesally at basal half of opening. Paramere broad at base, slightly narrowing till 0.75 length then broadened, lateroapical angle rounded, mesoapical region broadly produced with truncate margin. Aedeagus laterally compressed, with hump-like projection dorsally at midlength, directed caudally, lower angle of apex produced ventrally, hook-like, dorsal angle produced dorsally but very short, aedeagus guide well developed, broad, hood-like, gonopore apical.

Measurement: Male 3.78 ± 0.27 mm long, 0.86 ± 0.02 mm wide across head and 0.75 ± 0.00 mm across pronotum. Female 4.70 ± 0.32 mm long, 0.98 ± 0.03 mm wide across head and 0.86 ± 0.03 mm across pronotum (Table 16).

Material examined: INDIA: Karnataka: 2 ♀, Mysore, 31.vii.1972; 2 ♂, 4 ♀, 2.viii.1972, Viraktamath, C. A.; 1 ♀, Mudigere, 23.iii.2007; 1 ♂, 2 ♀, 24.iii.2007, Nimisha, K. K. (UASB).

Remarks: This species can be easily recognized by its head including compound eyes being almost as wide as pronotum; the vertex is shorter than greatest interocular

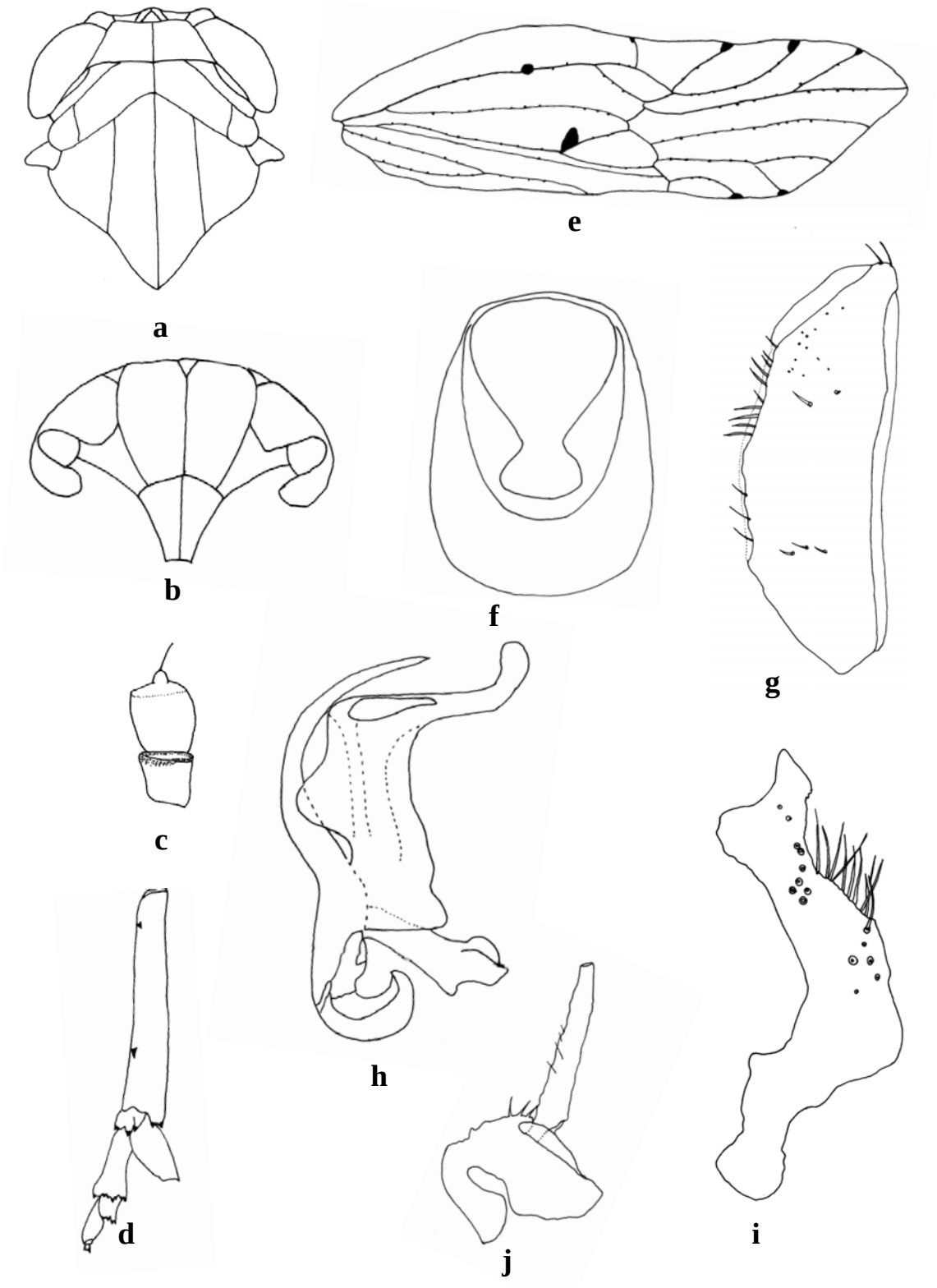


Fig. 24. *Arcofasciella* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 16. Measurements (mm) of the males and females of *Arcofasciella* sp.

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.40 ± 0.03	1.55 ± 0.10
Clypeus	0.24 ± 0.00	0.28 ± 0.03
Forewing	2.11 ± 0.49	2.83 ± 0.18
Frons	0.38 ± 0.01	0.38 ± 0.06
Pedicel	0.22 ± 0.02	0.23 ± 0.01
Pronotum	0.12 ± 0.00	0.12 ± 0.00
Scape	0.11 ± 0.00	0.11 ± 0.00
Scutellum	0.27 ± 0.00	0.28 ± 0.02
Vertex	0.19 ± 0.03	0.23 ± 0.04
Total length	3.78 ± 0.27	4.70 ± 0.32
Width		
Clypeus	0.26 ± 0.01	0.28 ± 0.03
Forewing	0.77 ± 0.04	0.84 ± 0.04
Frons	0.41 ± 0.03	0.44 ± 0.01
Head	0.86 ± 0.02	0.98 ± 0.03
Pedicel	0.13 ± 0.00	0.13 ± 0.00
Pronotum	0.75 ± 0.00	0.86 ± 0.03
Scape	0.11 ± 0.00	0.11 ± 0.00
Vertex	0.44 ± 0.03	0.50 ± 0.01
Distance between eyes	0.36 ± 0.02	0.42 ± 0.02

width with trapezoidal basal compartment and the forewings are hyaline with shallowly undulating apical margins.

4.1.2.2 Genus *Purohita* Distant

Stramineous. Large planthoppers. Head including eyes distinctly narrower than pronotum. Lateral carinae of vertex raised or excavated. Frons in middle line longer than wide at widest part, median carina forked at base, frons diverging towards apex from level of ocelli. Eyes in dorsal view, reniform; ocelli distinct at posterior margin of eye. Antennal segments foliaceous, scape longer and wider than short and flattened pedicel. Forewing hyaline, veins concolorous, venation as in Fig: 25e, veins granulate with minute hairs. Male pygophore dorsal margin is longer than ventral, in lateral view triangular, anal collar elongate without spine-like process.

***Purohita* sp.**

(Plate 9: B and E; Fig.25)

Vertex extended beyond anterior margin of eye, vertex shorter than broad at base, lateral carinae subacutely rounded to frons, Y-shaped carinae present, basal compartment cover 0.75 area of vertex, lateral carinae highly convex. Frons fuscous towards basal half, genae, frons beyond ocelli pale, frons and postclypeus of equal width at arcuate frontoclypeal suture. Post clypeus in profile convex, median carina distinct, rostrum surpassing mesocoxae, not reaching hind margin. Thorax tricarinate, carinae raised reaching hind margin. Legs with fuscous longtitudinal stripes, post tibial spur without spines on hind margin.

Male genitalia: Caudal margin of pygophore with two pointed tooth-like processes. Anal collar elongate without spine-like process. Paramere with basal half broad, apical half curved outwards terminating in pointed apex. Aedeagus grooved, gonopore subapical, apex rounded.

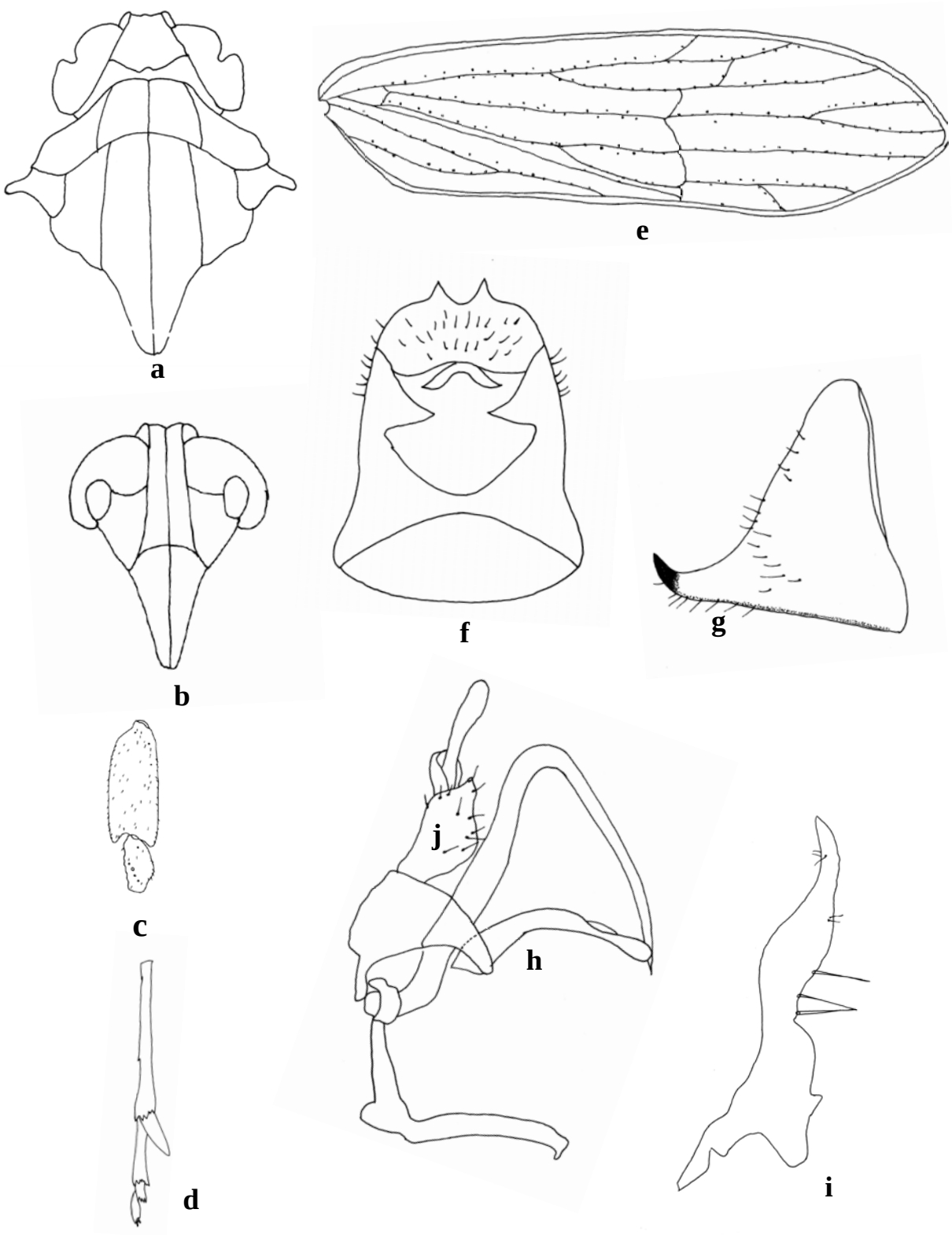


Fig. 25. *Purohita* sp.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 17. Measurements (mm) of the male and female of *Purohita* sp.

Characters	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**
Clavus	1.53 ± 0.08	1.68 ± 0.13
Clypeus	0.27 ± 0.02	0.28 ± 0.01
Forewing	2.60 ± 0.10	2.77 ± 0.17
Frons	0.36 ± 0.02	0.36 ± 0.02
Pedicel	0.37 ± 0.05	0.38 ± 0.06
Pronotum	0.18 ± 0.02	0.19 ± 0.01
Scape	0.89 ± 0.06	1.03 ± 0.05
Scutellum	0.29 ± 0.02	0.30 ± 0.02
Vertex	0.15 ± 0.00	0.16 ± 0.01
Total length	4.42 ± 0.16	4.72 ± 0.16
Width		
Clypeus	0.26 ± 0.03	0.28 ± 0.01
Forewing	0.74 ± 0.02	0.79 ± 0.04
Frons	0.21 ± 0.00	0.22 ± 0.01
Head	0.59 ± 0.02	0.62 ± 0.02
Pedicel	0.21 ± 0.02	0.22 ± 0.02
Pronotum	0.73 ± 0.01	0.79 ± 0.03
Scape	0.34 ± 0.01	0.36 ± 0.04
Vertex	0.25 ± 0.02	0.28 ± 0.01
Distance between eyes	0.13 ± 0.01	0.15 ± 0.00

Measurement: Male 4.42 ± 0.16 mm long, 0.59 ± 0.02 mm wide across head and 0.73 ± 0.01 mm across pronotum. Female 4.72 ± 0.16 mm long, 0.62 ± 0.02 mm wide across head and 0.79 ± 0.03 mm across pronotum (Table 17).

Material examined: INDIA: Karnataka: 3 ♂, 15 ♀, Bangalore, 17.vi.2006, at light, 1 ♂,18.ix.2006; 1 ♂, 19.ix.2006, all collected by Nimisha, K. K.; 3 ♂, 1 ♀, 16.x.2006, Chinthamani, Girish, K. S.; 4 ♂, 10 ♀; 2 ♂, 1 ♀, Nandi hills, 26.ix.2006; 1 ♂, 9 ♀, 13.x.2006; 2 ♂, 16♀, Mudigere, 23.iii.2006, all collected by Nimisha, K. K. (UASB).

Remarks: The genus is in dire need of revision based on the male genitalia of types of the known species and hence no name for the species was given.

4.1.2.3 Genus *Tropidocephala* Stål

Colour variable from light green to dark brown across the species. Head including compound eyes distinctly narrower than pronotum; lateral carina of vertex raised, lateral carina of pronotum reaching hind margin. Frons in middle longer than wide at widest part, median carina not forked. Rostrum not reaching hind coxae. Posttibial spur without teeth on hind margin. Antennal segments with oblique dark brown lines. Male genitalia characters with wide variation in shapes of pygophore, paramere and aedeagus. Aedeagus asymmetrical, aedeagus guide present. Anal collar without spine-like process. Three species of this genus were recorded and one of these was not identified beyond the generic level.

Key to the species of Genus *Tropidocephala* Stål of Karnataka

1. Vertex distinctly longer than width at base (Fig. 26a), body pale green, apical region of forewing beyond cross vein bent.….***Tropidocephala saccharivorella* Matsumura**

- Vertex as long as or shorter than width at base (27a, 28a), body ochraceous to brownish black, forewing not as above....……...…….……**2**

2. Body dark brown; lateral carinae of frons parallel except a slight constriction halfway before apex of frons; paramere broad at base tapers towards pointed apex (Fig. 26i) ……...……..… ***Tropidocephala* sp**

- Ochraceous; lateral carinae of frons convex; paramere with sclerotized area in mesal and apical end wider towards apical end, shape as shown in figure (Fig. 27i)…….……..…….....***Tropidocephala serendiba* (Melichar)**

***Tropidocephala saccharivorella* Matsumura**

(Plate 10: A, B and C; Fig. 26)

Pale green. Vertex longer than broad at base with simple median carina, transition of vertex to frons angular. Compound eyes reniform. Frons tricarinate with simple median carina raised, lateral carinae outwardly curved. Ocelli distinct. Basal half of gena, area just above and below of truncated frontoclypeal suture with black patch. Clypeus tricarinate with a feeble median carina and anteclypeus sloping down. First antennal segment shorter than second, bordered with black ring, second segment medially obliquely ringed with black. Thorax tricarinate with lateral carinae reaching hind margin of respective notum, a black patch on mesonotum. Forewing hyaline, venation as in Fig. 26e, a median spot before the transverse cross veins, inner three veins and a spot on fourth vein at base near apex, dark fuscous; a few oblique lines in apical half of fuscous, apical region beyond cross vein bent or depressed. Legs creamy white, post-tibial spur solid not lamellate.

Male genitalia: Pygophore in lateral view with angular projection along caudal margin, digitate process directed caudally, diaphragm as in Fig.26f. Parameres with a horn-like projection at base, distal end with distinct angle, dark pigmented. Aedeagus with strongly ventrally recurved tubular shaft, with a lateral process directed caudally at base, gonopore subapical on dorsal surface, aedeagus guide curved spine-like.

Measurement: Male 3.42 ± 0.11mm long, 1.03 ± 0.03 mm wide across head and 1.21 ± 0.04 mm across pronotum. Female 3.92 ± 0.19 mm long, 0.46 ± 0.02 mm wide across head and 0.53 ± 0.03 mm across pronotum (Table 18).

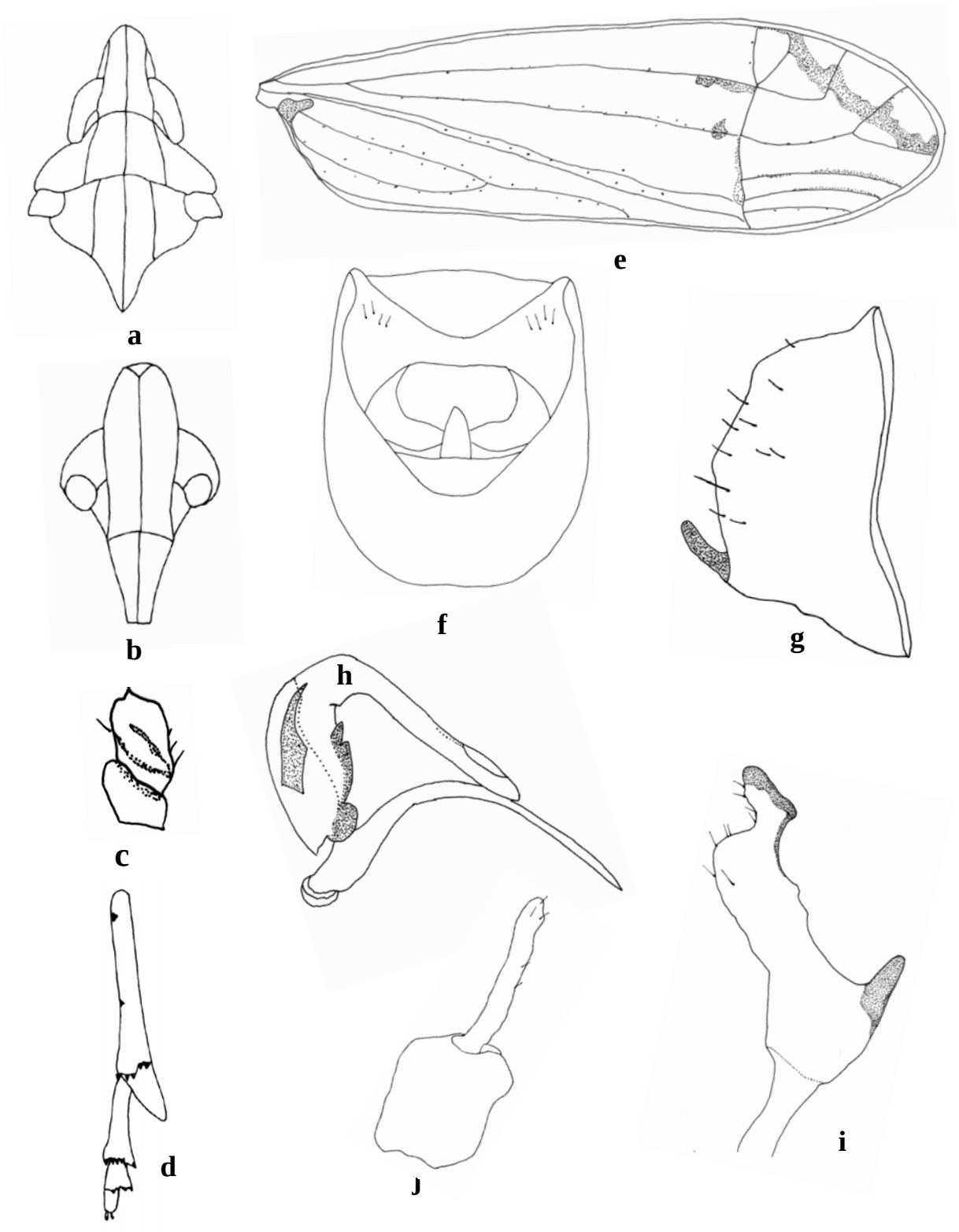


Fig. 26. *Tropidocephala saccharivorella* Matsumura

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Material examined: INDIA: Karnataka: 3 ♂, 3 ♀, Mandya, 24.i.2007; 17 ♀, 25.i.2007, all collected by Nimisha, , K. K.; 5 ♀, 1 ♀, Shobarani, S.R.; 1♀, 28.i.2007, Nimisha, , K. K.; 3 ♂, 9.ii.2007; 2 ♀, 21.ii.2007, all collected by Patel, V. N. (UASB).

Remarks: This species is green in life with elongated head and spotted with black on head, face and pronotum. Lateral carinae of vertex are raised; apical region of hyaline forewing beyond cross vein is bent or depressed along with the oblique lines in the apical half.

***Tropidocephala serendiba* (Melichar)**

(Plate 9: C and F; Fig. 27)

Ochraceous. Vertex as long as broad at base, Y- shaped carinae absent. Compound eyes reniform. Frons tricarinate, oval, lateral carinae highly convex, post clypeus sloping downwards with distinct median carinae. Rostrum surpassing mesocoxae. Antennal scape and pedicel short. Thorax tricarinate, ochraceous, lateral sides of thorax and tegulae pale, carinae margined by black lines. Forewing yellowish, veins concolorous, venation as in Fig. 27e, minute hairs arising on cream coloured granules, with two black fasciae. Claval pterostigma not distinct. Legs stamineous.

Male genitalia: Pygophore longer along ventral margin in lateral view with conical lobe-like projection, diaphragm in lower half of caudal opening with very small, dark pigmented lobe. Paramere with sclerotised area in mesal and apical area, shape as in Fig. 27i. Aedeagus complex, caudo-ventrally directed, asymmetrical, aedeagus guide well developed.

Measurement: Male 3.94 ± 0.15 mm long, 0.53 ± 0.01 mm wide across head and 0.53 ± 0.03mm across pronotum. Female 4.12 ± 0.20 mm long, 0.55 ± 0.02 mm wide across head and 0.58 ± 0.02 mm across pronotum (Table 18).

Material examined: INDIA: Karnataka: 1 ♂, Bangalore, 11.viii.2006, at light; 1 ♀, 20.viii.2006; 1 ♂, 21.viii.2006; 2 ♂, 24.viii.2006; 1 ♀, 26.viii.2006; 1 ♂, 2 ♀, 28.viii.2006; 1 ♀, 6.ix.2006; 1 ♂, 9.ix.2006; 1 ♂, 20.x.2006; 1 ♂, 6.xi.2006; 2 ♂,

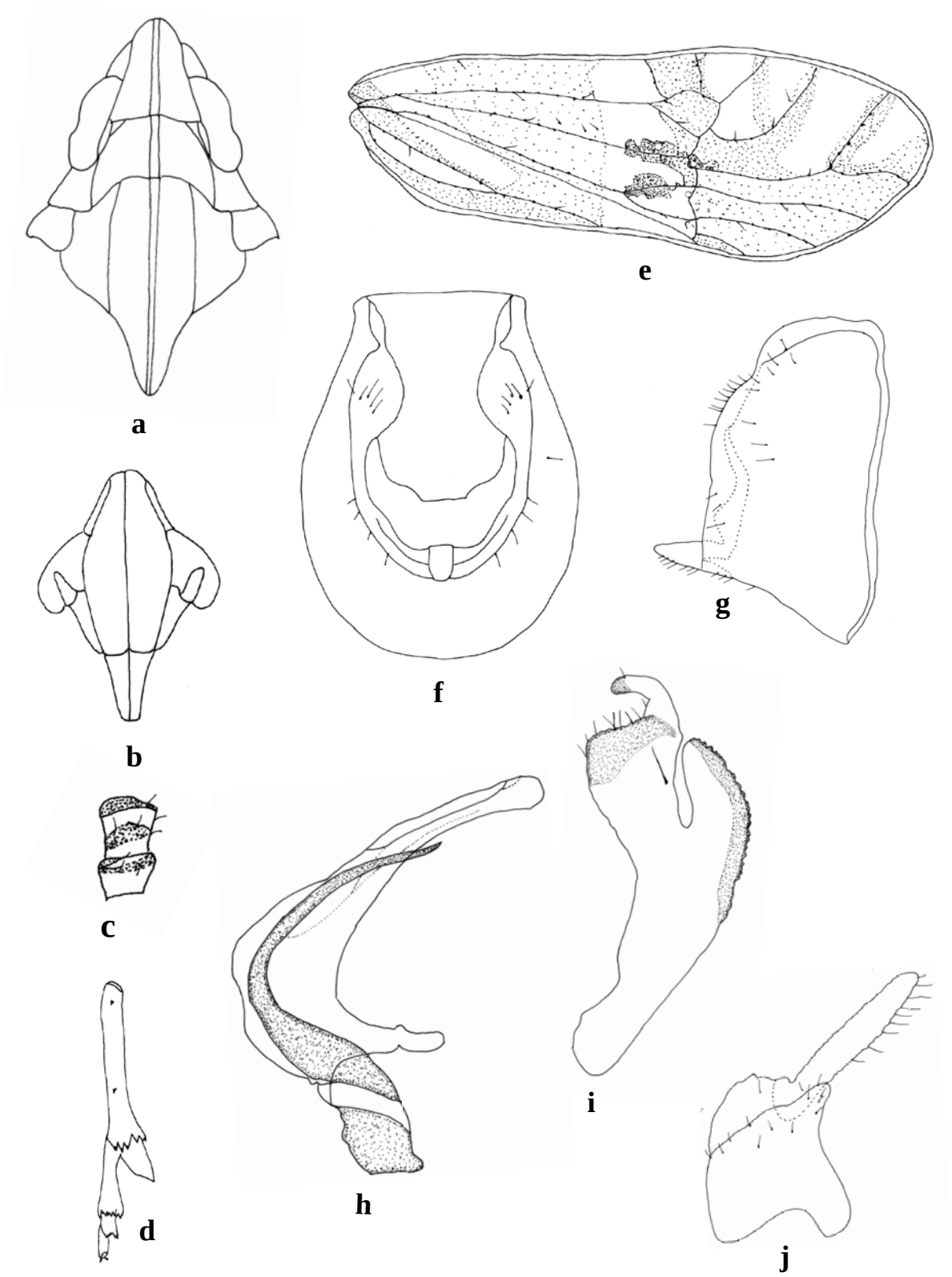


Fig. 27. *Tropidocephala serendiba* (Melichar)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

***Arcofasciella* sp.**

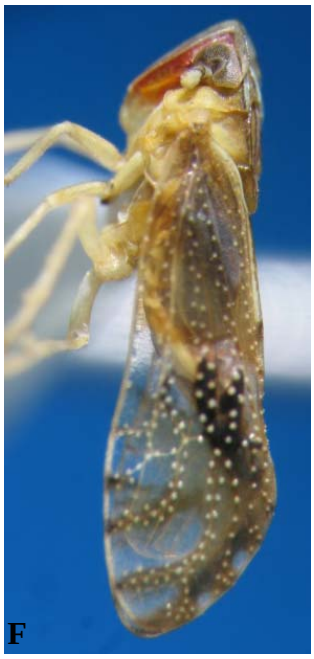
Puroihita sp.

***Tropidocephala serendiba* (Melichar)**

Dorsal view

***Arcofasciella* sp.**

Puroihita sp.



***Tropidocephala serendiba* (Melichar)**

Lateral view

Plate 9: Delphacinae: Tribe Tropidocephalini

7.xi.2006; 1 ♂, 14.xii.2006; 1 ♀, 20.xii.2006; 1 ♂, 10.i.2007; 2 ♀, 12.i.2007; 1 ♀, Dharwad, 28.ix.2006; 6 ♂, 6 ♀, Mandya, 24.i.2007, all collected by Nimisha, K. K.; 5 ♂, 6 ♀, 25. i. 2007; 1 ♂, 9.ii.2007; 1 ♂, 21.ii.2007, Patel, V. N. (UASB).

Remark: This species is bright orange coloured with lateral carina of frons strongly convex. This species is commonly found on sugarcane and maize.

***Tropidocephala* sp.**

(Plate 10: D and E; Figs 28)

Brown small planthopper. Vertex longer than broad at base, median and lateral carina pale margined by brown, transition of vertex and frons almost angular. Frons tricarinate, carinae pale, lateral carinae parallel sided except slight constriction halfway before truncated frontoclypeal suture. Postclypeus with distinct pale median carina, lateral carinae pale, anteclypeus bent at right angles. Rostrum surpassing mesocoxae. First segment of antenna shorter than second, bordered with black ring at apex, second segment ringed with black both apically and medially. Genae with carinae pale; intercarinal areas of frons and clypeus dark brown. Thorax tricarinate, lateral carinae of prothorax reaching hind margin, pro and mesonotum laterad of median carinae light brown, pronotal carinae margined with dark brown. Tegulae and posteriolateral part of pronotum creamy. Forewing with patches of dark brown and hyaline areas, veins for most part brown except those reaching costal margin, creamy; granulation on veins paler, forewing with small hair-like projections, venation as in Fig. 28e.

Malegenitalia: Pygophore in lateral view triangular with ventral region projecting forward, caudal margin concave with median lobe, diaphragm short along lateral margin, ventral margin without transverse connection. Parameres rather triangular, each with tooth on mesal margin near base, apophysis of style narrowed finger-like with a few setae, anal segment without process. Aedeagus S-shaped with lateral flanges, gonopore large on dorsal margin almost at midlength; aedeagus with tooth-like projection at base.

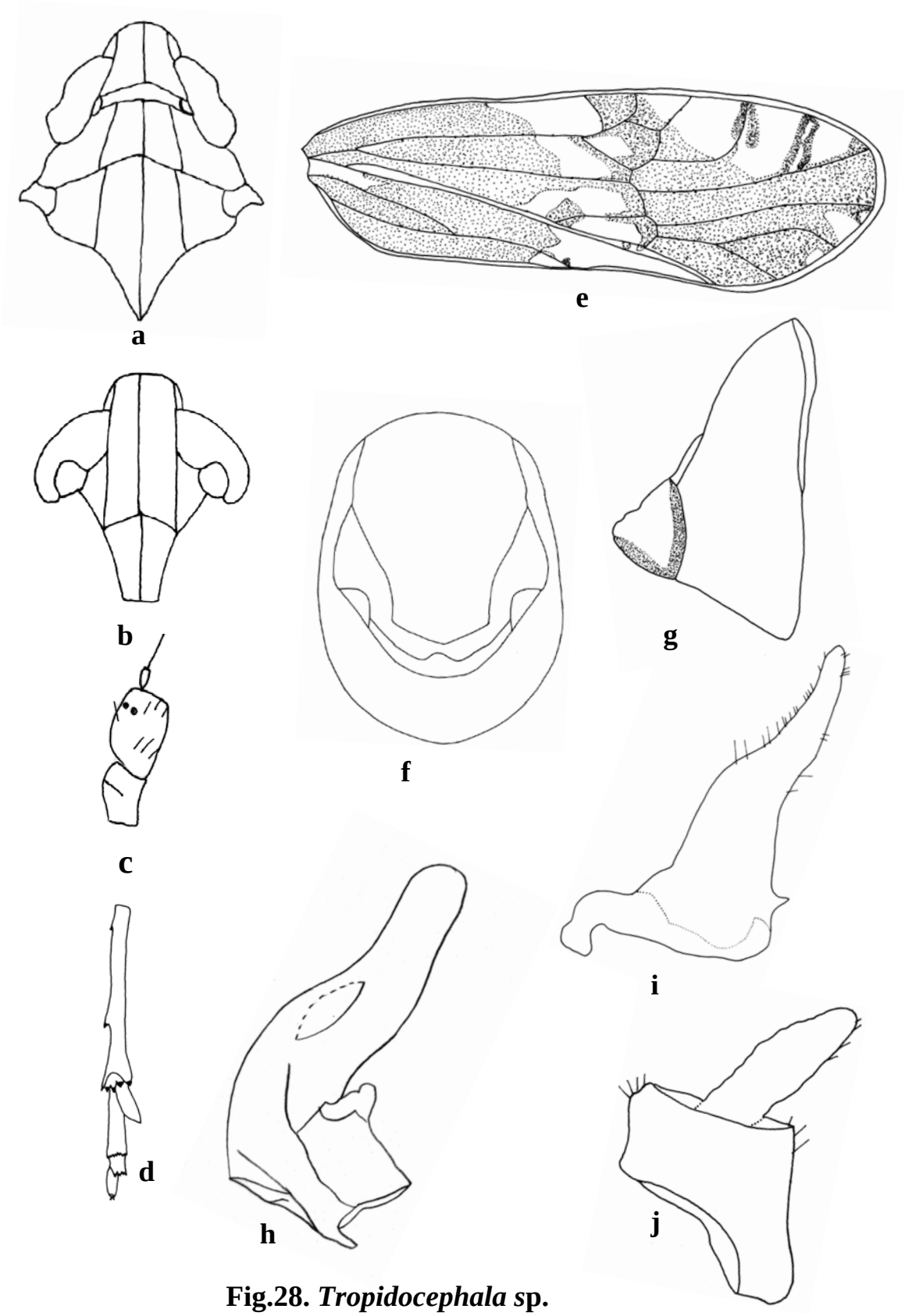


Fig.28. *Tropidocephala s*p.

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

Table 18. Measurements (mm) of the male and female of the Genus *Tropidocephala* Stål

Species	***serendiba* (Melichar)**		***saccharivorella* Matsumura**		**sp**	
Characters	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.40 ± 0.04	1.47 ± 0.05	1.21 ± 0.04	1.53 ± 0.08	1.06 ± 0.04	1.22 ± 0.02
Clypeus	0.27 ± 0.00	0.27± 0.00	0.91 ± 0.03	0.29 ± 0.01	0.23 ± 0.02	0.22 ± 0.02
Forewing	2.18 ± 0.05	2.21 ± 0.03	1.21 ± 0.04	2.07 ± 0.08	1.58 ± 0.05	1.90 ± 0.05
Frons	0.62 ± 0.01	0.58 ± 0.08	1.03 ± 0.03	0.50 ± 0.06	0.33 ± 0.07	0.38 ± 0.03
Pedicel	0.15 ± 0.01	0.14 ± 0.01	0.91 ± 0.03	0.13 ± 0.00	0.20 ± 0.01	0.21 ± 0.00
Pronotum	0.22 ± 0.02	0.22 ± 0.01	1.03 ± 0.03	0.24 ± 0.00	0.18 ± 0.00	0.18 ± 0.00
Scape	0.11 ± 0.00	0.11 ± 0.01	0.91 ± 0.03	0.09 ± 0.01	0.12 ± 0.01	0.12 ± 0.01
Scutellum	0.27 ± 0.00	0.27 ± 0.00	1.03 ± 0.03	0.25 ± 0.01	0.21 ± 0.00	0.23 ± 0.02
Vertex	0.27 ± 0.00	0.27 ± 0.00	1.03 ± 0.03	0.37 ± 0.03	0.15 ± 0.00	0.17 ± 0.01
Total length	3.94 ± 0.15	4.12 ± 0.20	3.42 ± 0.11	3.92 ± 0.19	2.90 ± 0.07	3.34 ± 0.09
Width						
Clypeus	0.19 ± 0.02	0.20 ± 0.02	0.91 ± 0.03	0.23 ± 0.01	0.21 ± 0.00	0.21 ± 0.00
Forewing	0.77 ± 0.03	0.82 ± 0.04	1.21 ± 0.04	0.62 ± 0.03	0.57 ± 0.00	0.67 ± 0.03
Frons	0.28 ± 0.01	0.30 ± 0.02	1.03 ± 0.03	0.24 ± 0.00	0.18 ± 0.00	0.19 ± 0.01
Head	0.53 ± 0.01	0.55 ± 0.02	1.03 ± 0.03	0.46 ± 0.02	0.48 ± 0.00	0.52 ± 0.02
Pedicel	0.13 ± 0.01	0.12 ± 0.01	0.91 ± 0.03	0.11 ± 0.00	0.10 ± 0.01	0.10 ± 0.01
Pronotum	0.53 ± 0.03	0.58 ± 0.02	1.21 ± 0.04	0.53 ± 0.03	0.53 ± 0.03	0.59 ± 0.01
Scape	0.11 ± 0.00	0.11 ± 0.00	0.91 ± 0.03	0.09 ± 0.01	0.08 ± 0.00	0.08 ± 0.00
Vertex	0.28 ± 0.03	0.30 ± 0.00	1.03 ± 0.03	0.24 ± 0.00	0.24 ± 0.00	0.26 ± 0.02
Distance between eyes	0.16 ± 0.01	0.18 ± 0.00	1.03 ± 0.03	0.18 ± 0.00	0.18 ± 0.00	0.18 ± 0.00

Measurement: Male 2.90 ± 0.07 mm long, 0.48 ± 0.00 mm wide across head and 0.53 ± 0.03 mm across pronotum. Female 3.34 ± 0.09 mm long, 0.52 ± 0.02 mm wide across head and 0.59 ± 0.01mm across pronotum (Table 18).

Material examined: INDIA: Karnataka: 3 ♂, 4 ♀, Mudigere, 22.iii.2007, Nimisha, K. K. (UASB).

Remarks: This species can be recognized by the dark brown colour, carinae on the vertex, thorax, frons, genae and post-clypeus are creamy white against the ground colour of body. This species is common on bamboo. In some specimens the lateral carina of mesonotum is concolorus with ground colour. Judging by the structure and male genitalia this could be a new species that could be decided after consultation with specialists.

4.2 Subfamily Stenocraninae

4.2.1 *Genus Stenocranus* Fieber

Stramineous to occhraceous. Head including compound eyes distinctly narrower than pronotum. Vertex longer than broad at base with distinct Y-shaped carina, broader at base than apex, lateral carinae shallowly concave. Frons tricarinate, with simple median carinae, wider at apex than base with arcuate frontoclypeal suture. Thorax tricarinate, lateral carinae of prothorax almost reaching the hind margin. Wings hyaline, claval pterostigma absent, veins concolorus. Post-tibial spur lamellate with teeth on hind margin. Aedeagus asymmetrical, an aedeagal process at base. Paramere shape and pygophore varies across the species.

Key to the species of Genus *Stenocranus* (Fieber) of Karnataka

1. Stramineous, frons, genae and clypeus not fiuscous; caudal margin of pygophore with a lobe-like projection near lower ventral half……..…….. ***Stenocranus* sp1**

- Ochraceous, intercarinal areas of frons fuscous, white narrow band present from prothorax to the tip of scutellum; pygophore with well developed diaphragm without any armature……..…….……..…. ***Stenocranus* sp.2**

***Stenocranus* sp.1**

(Plate 11: A and D; Fig. 28)

Stramineous. Vertex with basal compartment half as long as vertex, lateral carinae obtusely rounding to frons. Frons longer than wide, widest at arcuate frontoclypeal suture. Width of clypeus at frontoclypeal suture same as frons. Rostrum surpassing mesotrochanter. Scape very short, second segment almost three times as long as first segment. Forewing without any dark patches, veins concolorus, venation as in Fig. 28e.

Male genitalia: Anal collar with a mesally directed appendage on either side. Pygophore with height longer than length in lateral view, caudal margin with a lobe-like projection near ventral half, in caudal view ventral opening smaller than dorsal, lateral margin with pigmented pair of teeth, diaphragm well developed. Paramere slightly curved, elongate, more or less of uniform width in apical half. Aedeagus distally U-shaped, dorsal arm much longer.

Measurement: Male 4.08 ± 0.08 mm long, 0.51 ± 0.02 mm wide across head and 0.62 ± 0.03 mm across pronotum. Female 4.46 ± 0.11 mm long, 0.57 ± 0.00 mm wide across head and 0.66 ± 0.00 mm across pronotum (Table 19).

Material examined: INDIA: Karnataka: 3 ♂, 6 ♀, Bangalore, 1.ii.2007, Nimisha, K. K.; 2 ♂, 5 ♀, 12.i.2007, David, K.J. (UASB).

Remarks: This species can be recognized from other species of *Stenocranus* by the paired pigmented teeth on lateral margin of pygophore.

***Stenocranus* sp.2**

(Plate11: B and E; Fig. 29)

Ochraceous. Vertex with Y-shaped carina, intercarinal areas laterad of posterior compartment fucous. Frons longer than wide, wider at apex than at base, intercarinal areas fuscous, median carina creamywhite, forked at base, widest at basal 0.33 portion. Frontoclypeal suture slightly arcuate. Ocelli distinct. Postclypeus longer than wide at

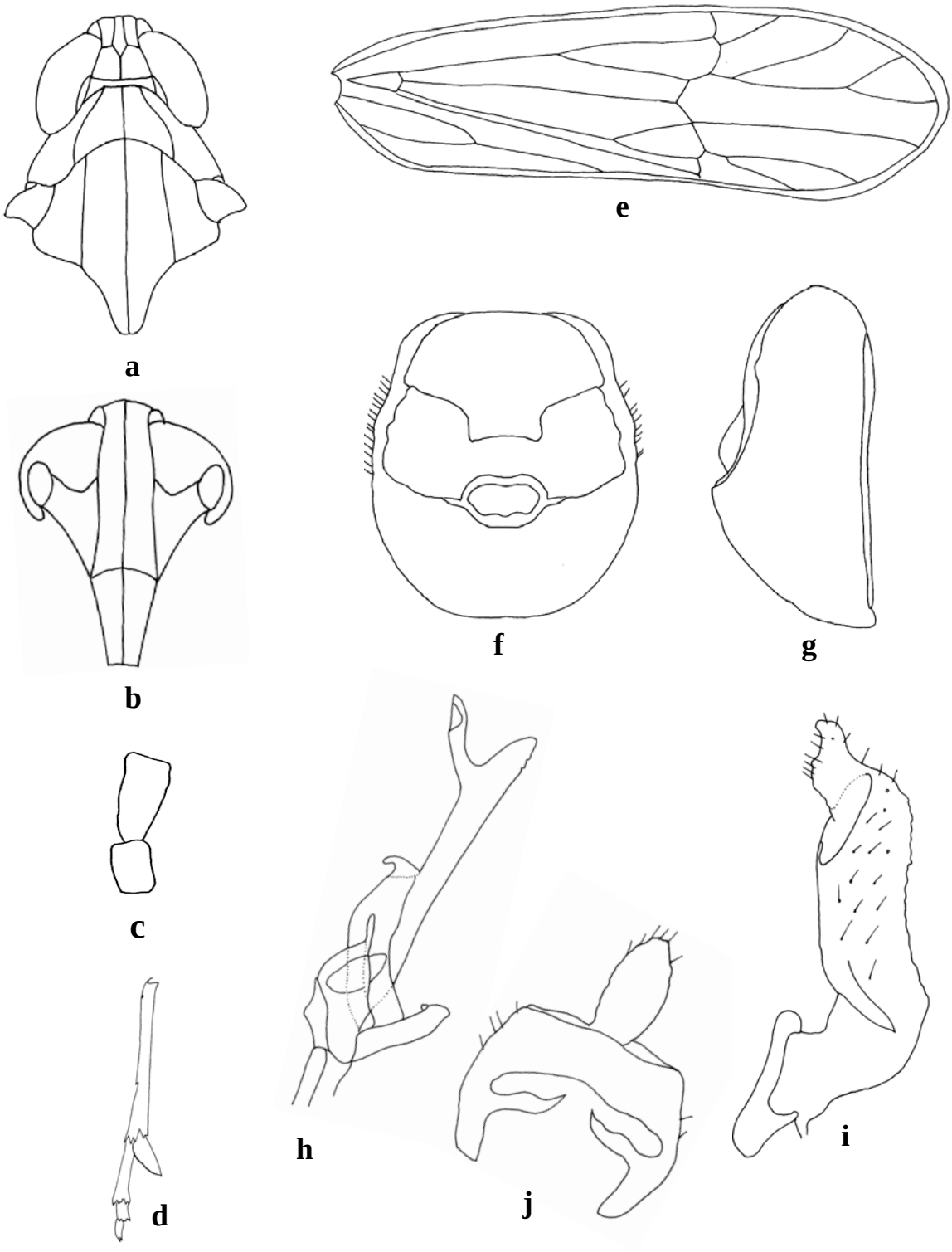


Fig. 29. *Stenocranus* sp. 2

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore,
g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

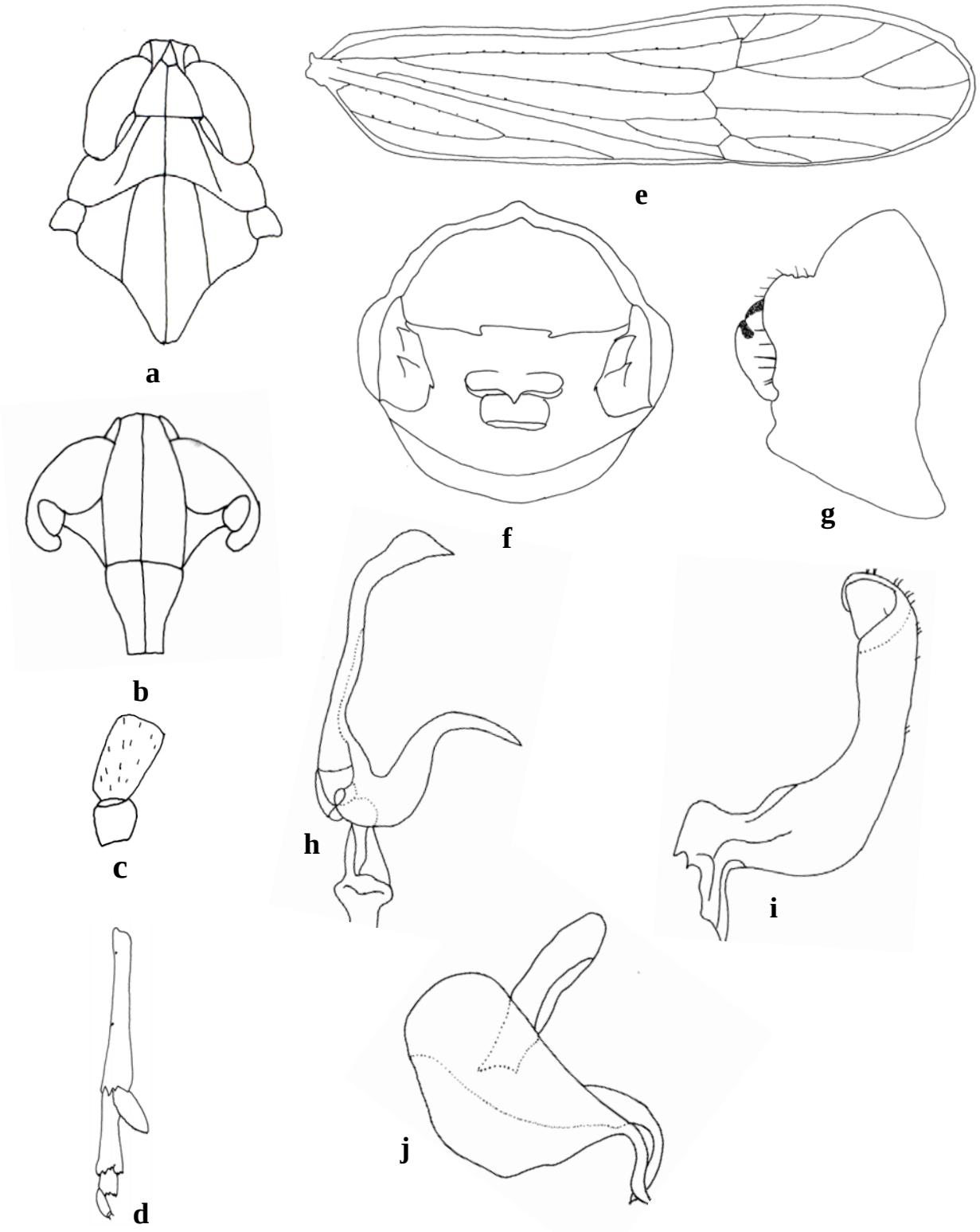
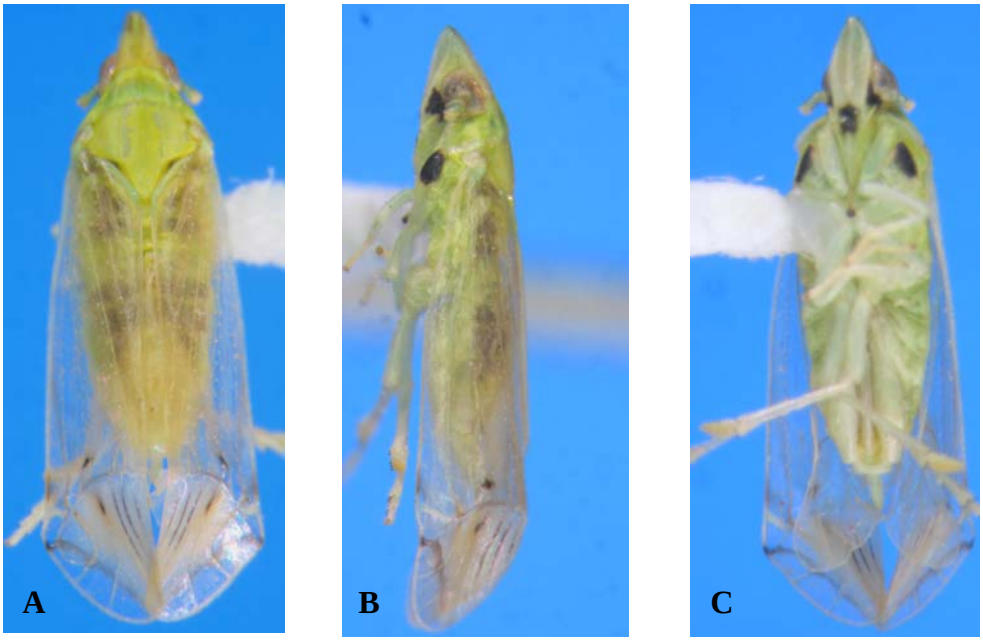


Fig. 30. *Stenocranus* sp. 1

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing, f. Pygophore, g. Pygohore - lateral view, h. aedeagus, j. anal tube, i. Paramere

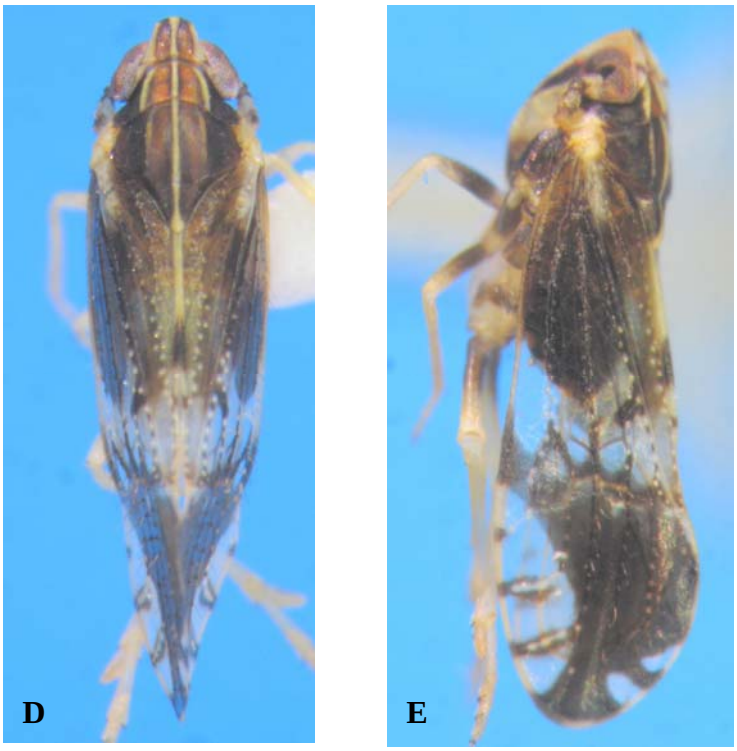
Table 19. Measurements (mm) of the male and female of the Genus *Stenocranus* Fieber

Species	**sp. 1**		**sp. 2**	
Characters	**Male**	**Female**	**Male**	**Female**
Length	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Clavus	1.48 ± 0.05	1.65 ± 0.10	1.52 ± 0.09	1.87 ± 0.05
Clypeus	0.30 ± 0.00	0.34 ± 0.07	0.38 ± 0.04	0.45 ± 0.00
Forewing	2.37 ± 0.08	2.59 ± 0.11	2.49 ± 0.13	3.00 ± 0.08
Frons	0.38 ± 0.03	0.46 ± 0.03	0.53 ± 0.07	0.58 ± 0.02
Pedicel	0.21 ± 0.02	0.23 ± 0.01	0.29 ± 0.01	0.32 ± 0.00
Pronotum	0.19 ± 0.02	0.22 ± 0.01	0.19 ± 0.01	0.20 ± 0.02
Scape	0.07 ± 0.01	0.08 ± 0.00	0.11 ± 0.01	0.15 ± 0.01
Scutellum	0.22 ± 0.02	0.26 ± 0.01	0.22 ± 0.01	0.26 ± 0.01
Vertex	0.22 ± 0.02	0.26 ± 0.02	0.20 ± 0.01	0.24 ± 0.02
Total length	4.08 ± 0.08	4.46 ± 0.11	4.16 ± 0.18	5.20 ± 0.14
Width				
Clypeus	0.28 ± 0.02	0.28 ± 0.02	0.25 ± 0.01	0.25 ± 0.02
Forewing	0.55 ± 0.03	0.60 ± 0.05	0.75 ± 0.04	0.87 ± 0.02
Frons	0.22 ± 0.01	0.24 ± 0.00	0.18 ± 0.00	0.19 ± 0.01
Head	0.51 ± 0.02	0.57 ± 0.00	0.55 ± 0.01	0.62 ± 0.01
Pedicel	0.11 ± 0.00	0.13 ± 0.00	0.11 ± 0.01	0.13 ± 0.00
Pronotum	0.62 ± 0.03	0.66 ± 0.00	0.67 ± 0.04	0.78 ± 0.00
Scape	0.08 ± 0.00	0.08 ± 0.00	0.09 ± 0.01	0.11 ± 0.00
Vertex	0.22 ± 0.01	0.24 ± 0.00	0.17 ± 0.01	0.21 ± 0.00
Distance between eyes	0.15 ± 0.00	0.19 ± 0.02	0.15 ± 0.00	0.17 ± 0.02



Dorsal view Lateral view Ventral view

***Tropidocephala saccharivorella* Matsumura**



Dorsal view Lateral view

***Tropidocephala* sp.**

Plate 10: Delphacinae: Tribe Tropidocephalini

base, convex in profile. Rostrum reaching hind coxae. Antennal scape longer than wide, pedicel longer than scape. Outer surface of post tibial spur convex. Thorax tricarinate, a white narrow band from prothorax to tip of scutellum, lateral carinae of prothorax reaching hind margin. Forewing hyaline, venation as in figure (Fig.29e), veins darker.

Male genitalia: Anal collar short with two short sclerotised spine-like processes. Pygophore ventrally longer, diaphragm well developed without any armature, ventral margin of posterior opening sinuate. Paramere elongate, of equal width along length, abruptly tapering subapically, with pointed sclerotised tip. Aedeagus tubular, asymmetrical, basal portion bulged, produced into lateral process subapically, gonopore apical.

Measurement: Male 4.16 ± 0.18 mm long, 0.55 ± 0.01 mm wide across head and 0.67 ± 0.04 mm across pronotum. Female 5.20 ± 0.14 mm long, 0.62 ± 0.01mm wide across head and 0.78 ± 0.00 mm across pronotum (Table 19).

Material examined: INDIA: Karnataka: 1 ♀, Bangalore, 17.vi.2006, at light, 1 ♂, 18.vi.2006; 1 ♂, 1 ♀, 20.viii.2006; 1 ♂, 6.xi.2006, 1 ♀, 12.i.2007, all collected by Nimisha, K. K.; 11 ♂, 10 ♀, Dodballupura, 16,viii,2007, David, K.J. (UASB).

Remarks: This species can be recognized by the white narrow band extending from prothorax to apex of scutellum, the structure of the parameres and by the asymmetrical aedeagus.

4.3 Subfamily: Vizcayinae

4.3.1 Genus *Vizcaya* Muir

Moderately large planthoppers, slender, with relatively long, slender, narrow forewings. Head distinctly narrower than thorax, well developed compound eyes and ocelli. Vertex longer than broad at base. Frons narrow at apex. Rostrum reaching hind coxae. Antennal segments elongate. Forewing conspicuously surpassing abdomen. Pronotum tricarinate, mesonotum unicarinate. Post-tibial spur with prominent teeth on hind margin.

***Vizcaya vindaloa* Asche**

(Plate 11: C and F; Fig. 31)

Female ochraceous. Vertex black except at base of basal compartment, obtusely rounding to frons, lateral carinae concave. Frons longer in middle than width at widest part, basal half black, apical half stramineous, median carina not distinct, frontoclypeal suture arcuate, post clypeus shiny balck, anteclypeus pale, rostrum not reaching hind coxae. Antennae with scape broader but half as long as rod-like pedicel. Legs elongate slender, post tibial spur solid, conical with nine teeth. Wings hyaline with distinct claval pterostigma, wing venation as in Fig.30e. Abdomen black. Thorax ochraceous, tricarinate, carinae on prothorax not distinct, fuscous area on prothorax just below posterior margin of eye, tip of scutellum pale.

Measurement: Female 6.20mm long, 0.66 mm across head and 0.96 mm across pronotum (Table 20).

Material examined: INDIA: Karnataka: 2 ♀, Balehunnur, 5.vi.2007, Salini, S. (UASB).

Remarks: This species is easily distinguished by the elongate antennal segments with short hairs. The antennal scape is half as long as rod-like pedicel. The narrow forewings are long and conspicuously surpassing the abdomen. This is the first record of the genus and species from Karnataka.

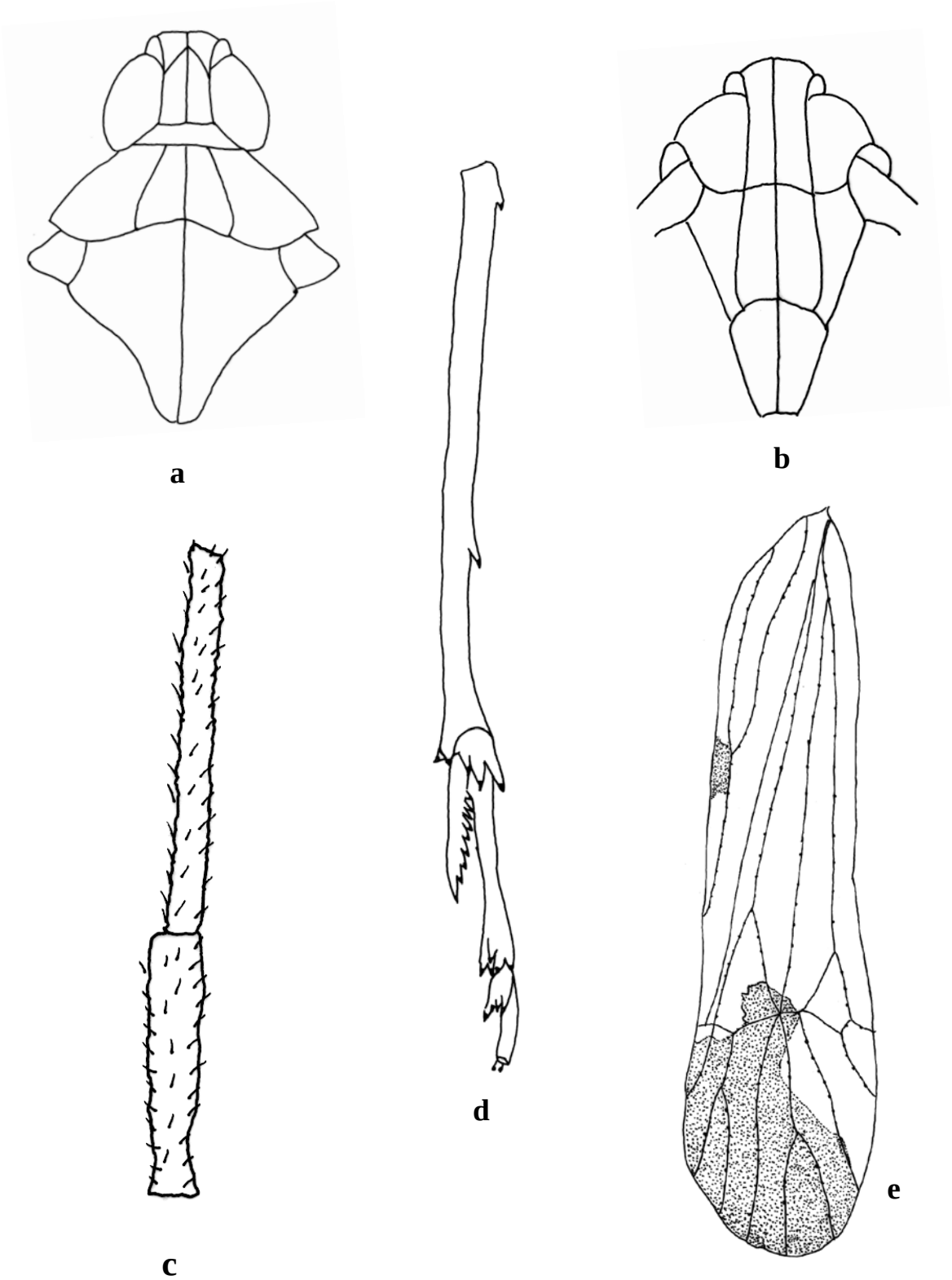


Fig. 31. *Vizcaya vindaloa* (Asche)

a. Head, b. Face, c. Antenna, d. Leg, e. Forewing

Table 20. Measurements (mm) of female of *Vizcaya vindaloa* Asche

Characters	**Female**
Length	**Mean**
Clavus	2.45
Clypeus	0.30
Forewing	3.44
Frons	0.69
Pedicel	1.39
Pronotum	0.33
Scape	0.96
Scutellum	0.33
Vertex	0.36
Total length	6.20
Width	0.00
Clypeus	0.30
Forewing	0.92
Frons	0.27
Head	0.66
Pedicel	0.13
Pronotum	0.96
Scape	0.21
Vertex	0.24
Distance between eyes	0.21

***Stenocranus* sp1**

***Stenocranus* sp2**

***Vizcaya vindaloa* (Asche)**

Dorsal view

***Stenocranus* sp1**

***Stenocranus* sp2**

***Vizcaya vindaloa* (Asche)**

Lateral view

Plate 11: Stenocraninae and Vizcayinae

DISCUSSION

V. DISCUSSION

The results of the present taxonomic studies on the family Delphacidae comprising 818 specimens from Karnataka revealed the presence of three subfamilies, 20 genera and 28 species. The results of these studies are discussed in the following pages. Six subfamilies and nine tribes are recognized in Delphacidae and from Karanataka only the subfamily Delphacinae has been reported. Present study contributed one more subfamily, Vizcayinae to the Karnataka's Delphacid fauna.

5.1 Subfamily Delphacinae

The first comprehensive study on Indian Delphacinae was done by Distant (1906, 1916) where in he dealt with 18 genera and 50 species from India and Sri Lanka. Rao and Chalam (2007) recorded 17 genera 23 species from south India and of these 15 genera and 10 species were studied during this study. Three tribes: Delphacini, Tropidocephalini and Saccharosydnini are included in Delphacinae. Only two tribes Delphacini, Tropidocephalini have been reported from Karnataka.

5.1.1 Tribe Delphacini and its generic and species affinities

The dark brown to black body with the darkly pigmented granulations on the forewing with a fuscous crescent shaped marking at its apical end makes the genus *Cemus* Fennah a distinct one. This genus is represented by a single species. This particular species is similar to *Cemus leviculus* Fennah reported from Seychelles island, Mahe but differs in the shape of the subapical process of the aedeagus and the shape of the paramere. In *C. leviculus*, the apical process of the aedeagus is shorter compared to the species under study. The paramere has sinuate outer margin in *C. leviculus* compared to more or less convex outer margin of the species of the *Cemus* found in this study (Fennah, 1964).

The genus *Coronacella* Metcalf is easily recognized by the white horizontal band on the posterior three fourth of the pronotum. The species of this genus are commonly found in the ragi ecosystem. *Coronacella sinhalana* superficially resembles *Laodelphax*

striatellus however, the central carina of the frons is black and the first antennal segment is darker pigmented in *C. sinhalana* compared to these structures in where as in *L. striatellus* (Wilson and Claridge, 1991).

Genus *Euidella* Puton can be mistaken for the genus *Peregrinus* Kirkaldy because of close similarity in their external appearance and coloration. They differ in the structure of the male genitalia. *Euidella* has L-shaped elongate paramere, asymmetrical flattened aedeagus having beak shaped apex with two subapical lobes directed dorsally, the outer lobe is ribbon shaped and the inner lobe is short and twisted (Rao and Chalam, 2007). Parameres of *Peregrinus* are of uniform width which strongly curved caudally with its apex truncate with forked ends. The aedeagus is elongate and slender with a long and short sub apical process in *Euidella.*

Genus *Harmalia* Fennah can be readily recognized by dark chocolate brown coloration and by way the vertex and frons are joined. A single representative species studied is very similar to *Harmalia heitensis* (Matsumura and Ishihara) in the external morphology but differs from it in the blunt inner angle of paramere. Therefore, this species is considered different from *Harmalia heitensis* (Fennah, 1973-75).

The genus *Nilaparvata* Distant resembles the genus *Nothokalpa* Fennah in external appearance and coloration. *Nothokalpa* can be differentiated from *Nilaparvata* by the relatively longer and anteriorly narrowed vertex and by the absence of spines on the basal segment of the hind tarsus (Fennah, 1973-75).

5.1.1.1 Relationship between the species of the genus *Nilaparvata* Distant

Among the two species, *N. bakeri* (Muir) and *Nilaparvata lugens* (Stål), *N. bakeri* (Muir) is a new record for India. *N. bakeri* can readily be recognized by the structure of pygophore. It has a rounded lobe at mid length and serrated process (better seen in the lateral view) whereas *N. lugens* lacks this process (Wilson and Claridge, 1991).

The species of these genus *Nothokalpa* Fennah is similar to *Syndelphax euroclydon* Fennah in body coloration, larger body size and the lateral carinae of vertex

being almost straight and not concave as in the species of the other genera. The forewing veins are darker towards the apical area. The genus *Nothokalpa* is represented by a single species *Nothokalpa salome* Fennah from Sri Lanka, it is theefore a new record for India. (Fennah, 1973-75).

Genus *Neycheuma* Fennah shows distinct alary dimorphism. Brachypterous forms have dark brown forewings whereas the macropterous forms are stramineous. It is represented by a single species in the world. The species studied is similar to *Neycheuma coctum* Yang except for the proportion of length of spines on the ventral margin of pygophore (Yang, 1989). The species have been recorded for the first time from India.

Genus *Opiconsiva* Distant differs from other genera of Delphacinae in the characters of male genitalia and the shiny black mesonotum. The species recorded during the study is similar to *Opiconsiva albicollis* (Motschulsky) but differs in having the outer and apical angles of distal ends of paramere blunt whereas they are pointed in the latter species (Fennah, 1973-75).

The genus *Perkinsiella* Kirkaldy is characterized by the head almost as broad as the pronotum, the antennal scape is triangular in shape and the forewings are thickly granulated (Rao and Chalam, 2007 and Yang, 1989).

5.1.1.2 Relationship of the species of the genus *Perkinsiella* Kirkaldy

Four species of *Perkinsiella* Kirkaldy were reported from India, *P. dorsata* Distant, *P fascialis* Distant, *P. insignis* (Distant) *P. sinensis*. Among these, two species *P. sinensis* and *P. insignis* (Distant) were recorded during the study. *P. sinensis* can be recognised by the forked process present on the diaphragm of pygophore and by the elongate aedeagus having two short lobes (Rao and Chalam, 2007). *Perkinsiella insignis* is dark brown with two triangular lobes on ventral margin of pygophore, the paramere tapers distally with broad base and the aedeagus has two subequal lobes.

The genus *Sardia* Melichar is unique among the genera of Delphacidae in having dark colored forewing and thorax in addition to the elongate head projecting beyond the

compound eyes (Asche, 1990) and pointed vertex. This genus is represented by a single species, *Sardia* sp. which resembles *S. rostrata* Melichar in coloration (Distant, 1906) but differs from *S. rostrata* in having sinuate outer margin of the paramere compared to the outer margin of paramere in the latter (Joseph, 1961).

The species recorded under the study agrees with the description of *Syndelphax euroclydon* Fennah (Fennah, 1973-75) except for the forking of the median carina. But the male genitalia study indicates that both the species are one and the same. *Syndelphax euroclydon* Fennah is similar to *Syndelphax eunymus* Fennah but differs in the shape of paramere and also lacks a M-shaped lobe on diaphragm which is unique to *Syndelphax eunymus* Fennah. It is differentiated from *S. agametor* Fennah by aedeagus character. Aedeagus is tubular in *S. euroclydon* but in *S agametor* a dorsal acuminate process is present at the apex of adeagus. It is almost similar to *S. disonymos* (Kirkaldy) even in the shape of paramere and aedeagus but differs in the diaphragm. *S. disonymos* has a long process medially with a blunt apex on the diaphragm instead of the quadrate lobe-like process in the *S. euroclydon.* All the species were earlier recorded from Sri Lanka (Fennah, 1973-75) and *Syndelphax euroclydon* Fennah is a new record for India.

The genus *Tagosodes* Asche & Wilson is often confused with the genus *Sogatella* especially species *S. furcifera* (Horváth) as they resemble each other closely but differ in the structure of male genitalia. In the genus *Tagosodes* the diaphragm never forms a broad U-shape as in *Sogatella*, the aedeagus is much less compressed and never twisted but forms a simple more or less straight tube (Asche, 1990). *Tagosodes* may be separated from *Matutinus* Distant and *Latristria* Huang *et al* mainly by the shape of the diaphragm of the male genitalia forming a shoe-shaped structure in *Matutinus* and a bilobed cross plate *Latristria. Tagosodes pusanus* Acshe & Wilson is the only representative species under this genus (Asche and Wilson, 1990).

The genus *Sogatella* Fennah is unique among the genera of Delphacidae in having a U-shaped process on mediodorsal margin of pygophore.

5.1.1.3 Relationship among the species of the genus *Sogatella* Fennah

All the three species of *Sogatella* namely *kolophon* (Kirkaldy), *vibix* (Haupt) and *furcifera* (Horváth) recorded from India were found in the study area. *Sogatella vibix* (Haupt) has dark fuscous genae, pale frons and clypeus. *S. kolophon* (Kirkaldy) has paramere deeply curved apically, whereas in *S. vibix* (Haupt) the paramere apically bifid with unequal lobes. In the case of *S. furcifera* (Horváth) parameres are almost equally bifurcated apically (Asche, 1990).

The genus *Toya* Distant comprises small planthoppers with very short vertex that distinguishes them from other genera of Delphacinae (Wilson and Claridge, 1991). *Toya propinqua* (Fieber), *Toya bridwelli* (Muir) are the two species reported from India. *T. propinqua* and *Toya.* sp. were recorded during this study. The genera *Toya* and *Latristria* share the characters of broad plate-like protrusion with rounded lobe-like lateral edges of the diaphragm and elongate paramere differ in the coloration and body proportions. The species of *Toya* present lack the white dorsal stripe in *Ltristria.* (Asche, 1990).

5.1.1.4 Relationship among the species of the genus Toya Distant

Intercarinal areas of frons are light fuscous in *T. propinqua* where as it is dark fuscous in *Toya*. sp. The process on the medio-dorsal margin of the diaphragm, shape of paramere and adeagus vary across the species. Medio-dorsal margin of the diaphragm is Y-shaped in *T. propinqua* (Wilson and Claridge, 1991), three lobed medially with well developed outer lobe in *Toya sp* and slightly concave without any process in *T. bridwelli* (Yang, 1989). Paramere more or less quandrangular with a tooth-like process meso apically in *T. bridwelli*, short, broad basally and constricted medially with two short forks apically in *T. propinqua* and short, broad base and converging distally with a blunt apex in *Toya. sp*. Adeagus tubular toothed apically on dorsal and ventral side in *T. propinqua*, short and stout elongate oval, slightly narrowed at both ends with two rows of teeth in *T. bridwelli* and twisted with series of tooth dorsoventrally in *Toya. sp* (Yang and Yang, 1986).

5.1.2 Tribe Tropidocephalini and its generic and species affinities

30 genera are known from the tribe Tropidocephalini but India has only species diversity from the genus Tropidocephala and a single species each from genera *Columbisoga* and *Purohita*. Among the three, *Tropidocephala* and *Purohita* have been reported from Karnataka. Present study added one more genus *Arcofaciella* Fennah apart from the above mentioned genera. Genus *Arcofaciella* Fennah differs from all other genera in having trapezoidal basal compartment of vertex and forewings with shallowly undulating wing margin. The species of genus are commonly found on bamboo. The specimens of the *Arcofaciella* studied here agree with the description given by Liang and Jiang (2004) for the genus but the clypeus is having median carina. Liang and Jiang (2004) referred to the similarity between the *Arcofaciella* Fennah and *Arcofacies* Muir. Yang and Yang (1986) also described both the genera and judging from their description the genea are quite different. The species found during the present study differs from *Arcofaciella verrucosa* Fennah in the shape of the paramere. The paramere differs from straighten with bifid apex in the species under study compared that in *Arcofaciella verrucosa.*

Genus *Purohita* Distant can be readily distinguished by the elongated foliaceous antennae with the short pedicel and elongated scape. Other characters that distinguish this genus are head including compound eyes being distinctly narrower than pronotum, the lateral carinae of the vertex raised with obsolete median carina and granulated veins of forewings. *Purohita* sp. collected during this study differs from *P. arundinaceae* Distant and *P. cervina* Distant in the body coloration (Distant, 1906, 1916) and male genitalia (Mammen, 1971) especially in the shape of the lobes on posterio-ventral margin of pygophore and the shape of the parameres. The species under reference resembles *P. taiwanensis* Muir in the male genitalia, however they differ in having the pedicel of the antenna more elongate, the pramere having a basal tooth and the adeagus with a tubercle on basal half of the adeagal process (Yang and Yang, 1986). Yang and Yang (1986) in their paper have misidentified the aedeagal shaft as the aedeagus guide.

Genus *Tropidocephala* Stål is distinguished from other genera by the narrow head and raised lateral carina of vertex. The antennal segments are short and have oblique dark brown lines (Distant, 1916).

5.1.2.1 Relationship among the species of the genus *Tropidocephala* Stål

Among the eight species reported from India, two were found during the study, *Tropidocephala saccharivorella* Matsumura and *Tropidocephala serendiba* (Melichar). In addition an unidentified species of the genus was also collected. These three species can be identified both based on external appearance and male genitalia. The three species also differ from *Tropidocephala indica* Muir reported from south India in lacking five carinations on pronotum. *Tropidocephala butleri* Muir has a tumid rounded clypeus without carinae whereas it is carinate and not tumid in the species studied. All the three species studied differ from *Tropidocephala festiva* (Distant) in the body coloration and lack paired median carinae on thorax with two lateral carinae on each side of the median carinae (Distant, 1906). *Tropidpocephala serendiba* (Melichar) resembles *Tropidpocephala signata* (Distant) in general appearance (Distant, 1916) and differs in the male genitalia. The paramere in *T. serendiba* has a deep narrow curve apically at the mesal margin with a tooth-like process apically whereas in *T. signata* has deep incision mesally at basal one third (Mammen, 1971). *Tropidocephala serendiba* (Melichar) is bright ochraceous with oval shaped frons with highly convex lateral carinae and distinct paramere with a sclerotized area in mesal and apical area. *Tropidocephala saccharivorella* Matsumura is green in colour, the paramere with a horn-like process at base makes it unique species. They are associated with sugarcane ecosystem. The third species *Tropidocephala*. sp are brown to black species feeding on bamboo. The aedeagus of this species S-shaped with lateral flanges and apophysis of the style is narrowed and finger-like.

5.2 Subfamily Stenocraninae

Stenocraninae comprise five genera and 75 species from the world. The genus *Stenocranus* is the largest (Bartlett, 2005). They are characterized by the aedeagus with atleast one curved, horn-shaped process arising from base or middle of theca and the

theca membraneous distally (Asche, 1990). Two species of the genus studied are likely to be new to science as they do not agree with the characters of the known species of the genus.

The two species differ from *Stenocranus ajmerensis* Joseph, the only species of the genus known from India in the structure of male genetilia and externally in having unpaired median carina (paired in *S. ajmerensis*).

5.3 Subfamily Vizcayinae

Seven species of the genus *Vizcaya* Muir and a single species of *Neovizcaya* Liang are the representatives of the subfamily in the world (Asche, 1990; Liang, 2002). The genus *Vizcaya* Muir is very distinctive compared to the other genera of Delphacidae and can be readily identified by the slender, elongate body with elongated rod-like antennal segments with second segment almost twice the length of the first segment. The teeth on the post tibial spurs are prominent (Asche, 1990). Among the two reported species of the genus *Vizcaya* from south India namely, *Vizcaya aschei* Liang and *V. vindaloa* Asche from Tamil Nadu (Madras) and Kerala (Travancore) respectively, only a female specimen of *V. vindaloa* was recorded during the study. This is the first of the genus record for Karnataka. It can be readily recognized from *Vizcaya aschei* Liang by the extended brown area at the distal part of the forewing with hyaline apical margin instead of the narrow apical C- shaped fuscous patch found in V. *aschei* (Asche, 1990, Liang, 2002).

SUMMARY

VI. SUMMARY

The study of Delphacidae in different agroecosystems of Karnataka was undertaken based on the specimens collected from districts of Bangalore Rural, Bangalore Urban, Chikmagalur, Dharwad, Kodagu, Kolar, Mandya and Mysore. A total of 818 specimens were examined and the study was mainly based on the male genitalia characters apart from the external morphology of both male and female specimens. Study revealed presence of three subfamilies, Delphacinae, Stenocraninae and Vizcayinae. Twenty eight species across 20 genera were studied. Diagnostic characters of the taxa along with the keys for their identification were prepared. Taxa described were provided with illustrations of male genitalia except for a single species of the subfamily Vizcayinae where only females were available for study.

Subfamily Delphacinae is the largest of the group Fulgoroidea among the subfamilies studied and is represented by 20 genera and 25 species. They exhibited wide variation in the male genitalia and external morphology across the tribes and genera. The two tribes represented are Delphacini and Tropidocephalini. The genera represented in Delphacini are *Cemus* Fennah, *Coronacella* Metcalf, *Euidella* Puton, *Harmalia* Fennah, *Neycheuma* Fennah, *Nilaparvata* Distant, *Nothokalpa* Fennah, *Opiconsiva* Distant, *Peregrinus* Kirkaldy, *Perkinsiella* Kirkaldy, *Sardia* Melichar, *Sogatella* Fennah, *Syndelphax* Fennah, *Tagosodes* Acshe & Wilson, *Toya* Distant. The three species *Neycheuma coctum* Yang, *Nilaparvata bakeri* (Muir) and *Syndelphax euroclydon* Fennah are reported for the first time from Karnataka. Genera that belong to Tropidocephalini are *Arcofasciella* Fennah, *Purohita* Distant and *Tropidocephala* Stål. Species of the tribe Tropidocephalini were collected exclusively on bamboo and sugarcane. Three species from *Tropidocephala* and one species each from *Arcofasciella* and *Purohita* were studied. Genera of Delphacini were collected from different annual monocotyledonous plants.

Subfamily Stenocraninae are distinct in the male genitalia in having well developed phallobase and slender phallus passing through phallobase. Single

representative genus *Stenocranus* Fieber with two species were studied. They were reported from sugaracane and lemon grass.

The subfamily Vizcayinae are very distinct with the slender elongate body and long rod like antennae, was available for the study. The only representative genus *Vizcaya* with the species *Vizcaya vindaloa* Asche forms a new report for Karnataka. Specimens were collected from grass.

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APPENDIX

APPENDIX

Check List of Delphacidae of Indian sub-continent

Subfamily: Asiracinae motschulsky, 1863

Tribe: Ugyopini Fennah, 1979

Genus: *Punana* Muir

Type species: *Punana brunnea* Muir

***Punana annulata* (Distant)**

Onkelos annulatus Distant 1916: 137

Distribution: India (Tamil Nadu: Kodaikanal)

Genus *Paranda* Melichar 1903

Type species: *Paranda globiceps* Melichar

***Paranda globiceps* Melichar 1903**: 93

Distribution: Sri Lanka

Genus *Eodelphax* Kirkaldy 1901

Type species: *Eodelphax serendiba* Kirkaldy

***Eodelphax serendiba* Kirkaldy 1901**: 40

Distribution: Sri Lanka

Subfamily: Vizcayinae Asche, 1990

Genus: *Vizcaya* Muir, 1917

Type species: *Vizcaya bakeri* Muir

***Vizcaya aschei* Liang 2002**: 612

Distribution: India (Tamil Nadu: Cinchona, Nilgiri Hills)

* ***Vizcaya vindaloa* Asche 1990**: 174

Distribution: India (Karnataka: Balehunnur, Kerala: Travancore)

Subfamily: Stenocraninae Wagner, 1963

Genus: *Stenocranus* Fieber, 1866

Type species: *Stenocranus minutus* Oshanin

***Stenocranus ajmerensis* Joseph 1963**: 460

Distribution: India (Rajasthan: Ajmer)

***Stenocranus oroba* Fennah 1975**: 98

Distribution: Sri Lanka

***Stenocranus polenor* Fennah 1975**: 98

Distribution: Sri Lanka

Subfamily: Delphacinae Leach, 1815

Tribe: Tropidocephalini Muir, 1915

Genus Arcofacies Muir 1915

Type species: *Arcofacies fullawayi* Muir

***Arcofacies truncatipennis* Fennah 1975**: 86

Distribution: Sri Lanka

Genus *Columbisoga* Muir, 1921

Type species: *Columbisoga campbelli* Muir

***Columbisoga campbelli* Muir 1921**: 483

Distribution: India (Tamil Nadu: Nilgiri Hills)

Genus *Epeurysa* Matsumura 1900

Type species: *Epeurysa nawaii* Matsumura

***Epeurysa nawaii* Matsumura 1900** : 261

Distribution: Sri Lanka

***Epeuriysa remanei* Asche 1983** : 213

Distribution: Nepal

***Epeurysa stigma* (Distant)**

Upachara stigma Distant 1906 : 469

Distribution: Sri Lanka

Genus *Tropidocephala* stål 1853

Type species: *Tropidocephala flaviceps* 1855

***Tropidocephala atrata* (Distant)**

Smara atrata Distant 1906: 479

Distribution: Myanmar, Sri Lanka

***Tropidocephala brunnipennis* Signoret 1860**

Distribution: Sri Lanka

***Tropidocephala butleri* Muir 1921**: 481

Distribution: India (Tamil Nadu: Kodaikanal), Sri Lanka

***Tropidocephala festiva* (Distant)**

Smara festiva Distant 1906 : 478

Distribution: Sri Lanka

*** *Tropidocephala saccharivorella* Matsumura 1907**: 65

Distribution: India (Karnataka:Bangalore, Mandya), Sri Lanka

*** *Tropidocephala serendiba* (Melichar)**

Orchesma serendiba Melichar 1903: 95

Distribution:India (Bangalore, Dharwad and Mandya) , Sri Lanka

***Tropidocephala marginepunctata* (Melichar)**

Orchesma marginepunctata Melichar 1903: 95

Distribution: Sri Lanka

***Tropidocephala indica* Muir 1921**: 482

Distribution: India (Karnataka: Devarayan durga, Tamil Nadu: Kodaikanal)

***Tropidocephala luteola* Distant 1912**: 193

Distribution: India (Bihar: Pusa, West Bengal: Culcutta)

Genus *Purohita* Distant, 1906

Type species: *Purohita cervina* Distant

***Purohita arundinacea* Distant**, 1907: 10

Distribution: India (West Bengal: Darjiling)

***Purohita cervina* Distant 1906**: 257

Distribution: India, Sri Lanka

***Purohita punjabensis* Sharma and Singh 1982**: 23

Distribution: India (Punjab)

***Purohita qadrii* Khan and Khan 1985**: 401

Distribution: Pakistan

Tribe: Delphacini Leach, 1815

Genus: *Akilas* Distant, 1916

Type species: *Akilas fasciatus* Distant

***Akilas fasciatus* Distant 1916**: 138

Distribution: India (Tamil Nadu: Kodaikanal)

Genus *Altekon* Fennah ,1975

Type species: *Delphacodes marpessa* Fennah

***Altekon charcamis* Fennah 1975** : 125

Distribution: Sri Lanka

Genus *Anectopia* Kirkaldy, 1907

Type species: *Anectopia mandane* Kirkaldy,

***Anectopia mandane* Kirkaldy 1907** : 144

Distribution: Sri Lanka

Genus *Cemus* Fennah, 1964

Type species: *Cemus leviculus* Fennah

***Cemus pulchellus* (Distant)**

Pundaluoya pulchella Distant 1912 : 190

Distribution: India (Bihar : Pusa, Kerala : Travancore, Maharashtra : Bombay), Sri Lanka

***Cemus sauteri* (Muir)**

Phyllodinus sauteri Muir 1917 : 319

Distribution: Sri Lanka

Genus *Coronacella* Metcalf, 1950

Type species: *Kelisia kirkaldyi* Muir

***Coronacella sinhalana* (Kirkaldy)**

Delphacodes sinhalanus Kirkaldy 1906: 156

Liburnia frontalis Melichar 1903:100

Kelisia kirkaldyi Muir 1917: 329

Distribution: Sri Lanka, India (Karnataka)

Genus *Dicranotropis* Fieber, 1866

Type species: *Dicranotropis hamata* Boheman

***Dicranotropis nigropunctatus* Motschulsky 1863**

Distribution: Sri Lanka

Genus *Eoeurysa* Muir, 1913

Type species: *Eoeurysa flavocapitata* Muir

***Eoeurysa flavocapitata* Muir 1913**: 249

Distribution: India (Bengal, Assam), Pakistan

Genus *Euconon* Fennah, 1975

Type species: *Euconon astarte* Fennah

***Euconon astarte* Fennah 1975** : 92

Distribution: Sri Lanka

Genus *Euidellana*, Metcalf 1950

Type species: *Euidellana carolinensis* Metcalf

***Euidellana celadon* Fennah 1975** : 89

Distribution: Sri Lanka

Genus Euidella, puton

Type species: *Euidella basiliniea* Oshanin

***Euidella kashmirensis* Muir 1922** : 351

Distribution: India (West Bengal: Darjeeling)

Genus *Falcotoya* Fennah, 1975

Type species: *Falcotoya aurinia* Fennah

***Falcotoya citipes* Fennah 1969** : 41

Distribution: Sri Lanka

Genus *Hagamiodes* Fennah 1975

Type species: *Dicranotropis fuscicaudata* Muir 1917

***Hagamiodes meator* Fennah 1975** : 90

Distribution: Sri Lanka

Genus *Harmalia* Fennah, 1969

Type species: *Sogata thoracica* Distant

***Harmalia anacharsis* Fennah 1969** : 38

Distribution: Sri Lanka

***Harmalia heitensis* otho Fennah 1975** : 105

Distribution: Sri Lanka

***Harmalia tarasco* Fennah 1975**: 107

Distribution: Sri Lanka

***Harmalia thoracica* (Distant)**

Sogata thoracica Distant 1916 :140

Distribution: Sri Lanka

***Harmalia tiphys* Fennah 1971** : 582

Distribution: Sri Lanka

Genus *Horcoma* Fennah, 1969

Type species: *Delphacodes lacteipennis* Muir

***Horcoma colorata* (Motschusky)**

Horcoma coloratus Motschusky 1863: 110

Distribution: Sri Lanka

Genus *Indozuriel* Fennah, 1975

Type species: *Indozuriel samiator* Fennah

***Indozuriel samiator* Fennah 1975**: 133

Distribution: Sri Lanka

Genus *Jassidaeus* Fieber, 1886

Type species: *Jassidaeus morio* Fieber

***Jassidaeus lugubris* Signoret 1865**: 130

Distribution: Sri Lanka

Genus *Kartalia* Kocak, 1981

Type species: *Zuleika bengalensis* Distant

***Kartalia bengalensis* (Distant)**

Kartalia bengalensis Distant 1912 : 194

Distribution: India (West Bengal : Culcutta)

Genus *Liburnia* Stål, 1866

Type species: *Liburnia* (*Embolophora*) *monoceros* Stål

***Liburnia albovittata* Matsumura 1931**: 1261

Distribution: India

***Liburnia atromaculata* Distant 1916**: 45

Distribution**:** India (Tamil Nadu : Kodaikanal)

***Liburnia paludum* Kirkaldy 1910**: 579

Distribution**:** Sri Lanka

***Liburnia sternalis* (Distant)**

Sogata sternalis Distant 1916: 139

Distribution**:** Sri Lanka

***Liburnia tuberculosa* Distant 1916**: 145

Distribution**:** Sri Lanka

Genus *Matutinus* Distant, 1917

Type species: *Matutinus opulentus* Distant

***Matutinus melichari* (Kirkaldy)**

***Delphacodes melichari* Kirkaldy 1906** : 156

Distribution: Sri Lanka

Genus Mestus Motschulsky, 1863

Type species: *Mestus morio* Motschulsky

***Mestus morio* Motschulsky 1863**: 111

Distribution: Sri Lanka

Genus *Nanotoya* Fennah, 1975

Type species: Liburnia alboguttata Melichar

***Nanotoya alboguttata* (Melichar)**

Liburnia alboguttata Melichar 1903: 99

Distribution: Sri Lanka

Genus *Necodan* Fennah, 1975

Type species: *Necodan zimara* Fennah 1975

***Necodan zimara* Fennah 1975**: 132

Distribution: Sri Lanka

Genus *Nilaparvata* Distant, 1906

Type species:*Delphax lugens* stål

**** Nilaparvata lugens* (Stål)**

Delphax lugens Stål 1854: 246

Distribution: India (In all the states), Sri Lanka

**** Nilaparvata bakeri* (Muir)**

Delphacodes bakeri Muir 1917: 336

Distribution: India (Bangalore, Mudigere), Sri Lanka

***Nilaparvata chaeremon Fennah* 1975**

Distribution: Sri Lanka

Genus *Nothokalpa* Fennah, 1975

Type species: *Nothokalpa salome* Fennah

***Nothokalpa salome* Fennah 1975**: 102

Distribution: India (Karnataka: Bangalore); Sri Lanka

Genus *Nycheuma* Fennah, 1964

Type species: *Dicranotropis capensis*

***Nycheuma cognatum* (Muir)**

Dicranotropis cognata Muir 1917: 317

Distribution: Sri Lanka

***Neycheuma coctum* Yang**

Distribution: India (Karnataka : Bangalore)

Genus *Opiconsiva* Distant, 1917

Type species: *Opiconsiva fuscovaria* Distant

***Opiconsiva dodona* (Fennah)**

Corbulo dodona Fennah 1965: 48

Distribution: Sri Lanka

***Opiconsiva albicollis* (Motschulsky)**

Delphax albicollis Motschulsky 1863: 110

Distribution: Sri Lanka

Genus *Peregrinus* Kirkaldy, 1904

Type species: *Delphax maidis* Ashmead

***Peregrinus maidis* (Ashmead)**

Delphax maidis Ashmead 1890: 323

Distribution: India (In all the states), Sri Lanka

Genus *Perkinsiella* Kirkaldy,1903

Type species: *Perkinsiella saccharicida* Kirkaldy

***Perkinsiella facialis* (Distant)**

Pundaluoya facialis Distant 1912 : 191

Distribution: India (Karnataka: Bangalore, West Bengal: Chapra)

***Perkinsiella insignis* (Distant)**

Pundaluoya insignis Distant 1912: 190

Distribution: India (Bihar: Pusa, Maharashtra: Bombay, Karnataka: Bangalore, West Bengal)

***Perkinsiella sinensis* Muir 1913**: 241

Distribution: India (In all the states)

Genus *Phacalastor* Kirkaldy 1906

Type species: *Phacalastor anaxarete* Fennah

***Phacalastor anaxarete* Fennah 1975**:91

Distribution: Sri Lanka

Genus *Platypareia* Muir, 1934

Type species: *Platypareia albipes* Muir

***Platypareia albipes* Muir 1934**: 579

Distribution: India

Genus *Smicrotatodelphax* Kirkaldy 1906

Type species: *Smicrotatodelphax perkinsi* Kirkaldy

***Smicrotatodelphax iota* Fennah 1975**: 130

Distribution: Sri Lanka

***Smicrotatodelphax maenobora* Fennah 1975**: 129

Distribution: Sri Lanka

***Smicrotatodelphax stasander* Fennah 1975**: 127

Distribution: Sri Lanka

Genus Rhombotoya Fennah 1975

Type species: *Delphacodes pseudonigripennis* Muir

***Rhombotoya pseudonigripennis* (Muir)**

Delphacodes nigripennis Muir 1917: 338

Distribution: Sri Lanka

***Rhombotoya pseudonigripennis calitas* Fennah 1975**: 130

Distribution: Sri Lanka

Genus *sardia* Melichar, 1903

Type species: *Sardia rostrata* Melichar

***Sardia campbelli* Muir 1921**:485

Distribution: India (Tamil Nadu: Nilgiri Hills)

***Sardia pluto*(Kirkaldy)**

Hadeodelphax pluto Kirkaldy 1907: 140

Distribution: Sri Lanka

***Sardia pronotalis* Distant 1916**: 141

Distribution: Sri Lanka

***Sardia rostrata* Melichar 1903**: 96

Distribution: India (Bombay, Kerala, West Bengal), Sri Lanka

Genus *Sogatella* Fennah 1956

Type species: *Delphax furcifera* Horváth

***Sogatella furcifera* (Horváth)**

Delphax furcifera Horváth 1899: 372

Sogata distincta Distant 1912: 191

Sogata pallescens Distant 1912: 192

Sogata kyusyuensis Matsumura and Ishihara 1945: 65

Sogata tandojamensis Qadri and Mirza 1960 : 115

Distribution: India (In all the states) Pakistan, Nepal, Sri Lanka

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

Delphax kolophon Kirkaldy 1907 : 157

Delphacodes elegantissima Ishihara 1952: 45

Opiconsiva insularis Distant 1917: 303

Opiconsiva balteata Distant 1917: 302

Opiconsiva derelicta Distant 1917: 303

Sogatella balteata Fennah 1963a : 64

Sogatella chenhea Kuoh 1977: 440

Sogatella derelicta Fennah 1963a : 62

Sogatella elegantissima Fennah 1963a : 76

Sogatella kolophon atlantica Fennah 1963a : 58

Sogatella kolophon insularis Fennah 1963a : 59

Sogatella kolophon meridiana Fennah 1963a : 59

Sogata meridiana Beamer 1952: 111

Sogatella nebris Fennah 1963a : 67

Distribution: India(Andhra Pradesh, Karnataka : Bangalore ,Chinthamani, Dodballapura, Devanahalli, Mandya ; Maharashtra; Tamil Nadu) Pakistan, Sri Lanka

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

Delphacodes dogensis Ishihara 1952: 47

Delphacodes longifurcifera Eskai and Ishihara 1947: 41

Delphacodes panicola Ishihara 1949: 51

Liburnia matsumurana Metcalf 1943: 364

Liburnia vibix Haupt 1927 : 13

Sogatella catoptron Fennah 1963a : 54

Sogatella diachenhea Kuoh 1977 : 441

Sogatella longifurcifera Fennah 1963a : 53

Sogatella matsumurana Nast 1975:2

Sogatella panicola Fennah 1963a : 76

Sogatella parakolophon Linnavuori 1973 : 108

Sogatella suezensis Linnavuori 1964: 341

Distribution: India (Andhra Pradesh, Karnataka : Chinthamani, Dodballapura, Mudigere ; Maharashtra, Tamil Nadu ; Pakistan

Genus *Syndelphax* Fennah 1963

Type species: *Delphax matanitu* Kirkaldy

***Syndelphax agametor* Fennah 1975** :110

Distribution: Sri Lanka

***Syndelphax disonymos* (Kirkaldy)**

Delphax disonymos Kirkaldy 1907 : 151, 156

Distribution: Sri Lanka

***Syndelphax euonymus* (Fennah)**

Toya euonymus Fennah 1965 : 57

Distribution: Sri Lanka

***Syndelphax euroclydon* Fennah 1975** : 111

Distribution:India (Karnataka : Bangalore), Sri Lanka

Genus *Tagosodes* Asche and Wilson

Type species: *Dicranotropis cubanus* Crawford

***Tagosodes candidope* (Fennah)**

Sogatodes candidope Fennah 1975: 97

Distribution: Sri Lanka

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

Himeunka chibana Tian and Kuoh 1981: 193

Sogatodes assimilis Yang 1989: 178

Sogata pusana Distant 1912: 191

Sogata striatus Qadri and Mirza 1960: 117

Unkana formosella Matsumura 1935: 72

Distribution: India (Andhra Pradesh, Karnataka: Bangalore, Makuta, Maharashtra, Tamil Nadu) ; Nepal; Pakistan; Sri Lanka

***Tagosodes sternalis* (Distant)**

Sogata sternalis Distant 1916: 139

Distribution: Sri Lanka

Genus *Terthron* Fennah 1965

Type species: *Delphax anemonias* Kirkaldy

***Terthron albomarginatum* (Melichar)**

Liburnia albomarginatum Melichar 1903: 103

Distribution: Sri Lanka

Genus *Toya* Distant 1906

Type species: *Toya* attenuata Distant

***Toya attenuata* Distant1906** : 472

Distribution: Sri Lanka

***Toya beninu* Fennah 1975**: 120

Distribution: Sri Lanka

***Toya bridwelli* (Muir)**

Delphacodes bridwelli Muir 1920: 140

Distribution: India

***Toya cularo* Fennah 1975**: 118

Distribution: Sri Lanka

***Toya larymna* Fennah 1975**: 122

Distribution: Sri Lanka

***Toya minutula* (Melichar)**

***Liburnia minutula* Melichar 1903**: 98

Distribution: Sri Lanka

***Toya peruda* Fennah 1975**: 121

Distribution: Sri Lanka

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

Delphax propinqua Fieber 1866: 325

Distribution: India (Andhra Pradesh, Karnataka: (Bangalore, Dharwad, Mandya), Maharashtra, Tamil Nadu); Pakistan and Sri Lanka

***Toya siaka* Fennah, 1975**: 117

Distribution: Sri Lanka

***Toya tuberculosa* (Distant 1916); Fennah, 1975**

Distribution: Sri Lanka

Genus *Ulanar* Fennah 1975

Type species: *Megamelus muiri* Metcalf

***Ulanar muiri* (Metcalf)**

Megamelus albicollis Muir 1917: 327

Megamelus muiri Metcalf 1943: 209

Distribution: Sri Lanka

Genus *Zuleika* Distant, 1912

Type species: *Zuleika bengalensis* Distant

***Zuleika morio(* Motschulsky)**

Mestus morio Motschulsky 1863: 111

Distribution: Sri Lanka

***Zuleika testaceus* (Motschulsky)**

Mestus testaceus Motschulsky 1863: 112

Distribution: Sri Lanka

* Species included in the present study

Reference cited here not found in the thesis are found in the following publication:

Fennah, 1975

Metcalf, 1943