TAXONOMIC STUDIES ON PENTHIMIINAE AND TRIBE STENOMETOPIINI OF DELTOCEPHALINAE (HEMIPTERA: CICADELLIDAE) OF THE INDIAN SUBCONTINENT

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BANGALORE **August, 2008**

Affectionately Dedicated
To
My beloved husband
Sidramappa

And
Beloved Teacher
Dr. C. A. Viraktamath

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
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CERTIFICATE

This is to certify that the thesis entitled, "**Taxonomic studies on Penthimiinae ınd tribe Stenometopiini of Deltocephalinae (Hemiptera: Cicadellidae) of the Indian Subcontinent**" submitted by **Mrs. SHOBHARANI, M., ID No. PAK 4009,** in partial ulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY** 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, ellowship and other similar titles.

Bangalore
August, 2008

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INTRODUCTION

I. INTRODUCTION

The leafhoppers belong to the family Cicadellidae (Auchenorrhyncha) that constitutes the largest family in the order Hemiptera. They range from minute brilliantly coloured Typhlocybinae to large robust Eurymelinae and Cicadellinae. Leafhoppers are considered closest to treehoppers (Membracidae) from which they differ in having two or more rows of spines on the hind tibiae and by not having the pronotum extending back over abdomen.

The current conservative estimate for total number of leafhoppers is between 30,000 and 45,000 species of which a little over 22,600 species are known (Dietrich, 2004). In recent years, leafhoppers are gaining importance as pests of economically important crops often causing direct damage by sucking plant sap and reducing their vigour and a few of them are also known to inject toxins and cause local destruction of tissue of the leaves and stems. The most important damage caused by leafhoppers in general to various crops is however in an indirect way by their ability to act as vectors of several plant pathogens. Nielson (1979) listed 151 species and subspecies as vectors of plant pathogens such as plant viruses, phytoplasmas, spiroplasmas and bacteria.

Of the 40 subfamilies recognized in the family Cicadellidae (Oman *et al.*, 1990), 25 occur on the Indian subcontinent (Viraktamath, 2007). Penthimiinae are one among the 40 subfamilies of the family Cicadellidae. These are medium sized, depressed rather ovoid leafhoppers. Head is produced with transverse carinae on the anterior margin. The ocelli are either on the anterior margin (*Neodartus* Melichar) or on the crown near anterior margin of head. The lateral frontal sutures are either extending to ocelli or not. Face is usually concave in profile. The forewing venation is complete with large appendix that goes round the apex. The claval cross veins are present. The male valve and the subgenital plates are triangular. *Neodartus acocephaloides* Melichar and *Penthimia compacta* (Distant) are the common and polyphagous leafhoppers of this subfamily and show considerable variation in colour. Sharma (1986) reported *Uzelina thaloriensis* Sharma on *Citrus* sp. from Jammu. Viraktamath and Viraktamath (1995) reported *N. acocephaloides* feeding on *Clerodendron inerme* (L.) and *Penthimia* spp. on *Mangifera indica* L., *Bauhinia* spp., *Lycopersicon esculentum* Mill. and *Santalum album* L. Pruthi (1934) reported *P. melanocephala* Motschulsky, *P. compacta* Walker, *P. subnigra* Distant, *P. scutellata* (Distant) and *N. acocephaloides* on both healthy and

spike disease affected sandal. He also reported *N. acocephaloides* on *Dodonea viscosa* (L.). *Penthimia testacea* Kuoh was found injurious to tea in Anhui and Zhejiang Provinces of China (Kuoh, 1991).

The Penthimiinae of the Indian subcontinent constitute 39 species grouped in seven genera (Distant, 1908, 1918; Metcalf, 1962). Evans (1972) studied the genera of Oriental and Australian Penthimiinae. Linnavuori (1977) and Hayashi and Machida (1996) revised the Penthimiinae of the Afrotropical region and Japan, respectively. Similar revisionary studies are lacking for the Indian subcontinent.

The Deltocephalinae are currently the largest subfamily of leafhoppers, with approximately 6500 described species, grouped in 800 genera (Oman *et al.,* 1990). Deltocephalinae is also among the most economically important leafhopper subfamilies, as it contains 95 of the 151 reported leafhopper vectors of phytopathogenic diseases of economically important crops (Nielson, 1985).

Deltocephalinae are usually grouped in 23 tribes (Oman *et al.*, 1990). Of these 16 tribes *viz.,* Athysanini, Chiasmusini, Cicadulini, Deltocephalini, Fieberiellini, Goniagnathini, Grypotini, Paraboloponini, Hecalini, Macrostelini, Occinirvanini, Opsiini, Paralimnini, Platymetopiini, Scaphytopiini and Stenometopiini occur in the Indian subcontinent (Viraktamath, 2007).

Stenometopiini are one among the 16 tribes of Deltocephalinae. These are exclusively grass feeders. Many species of this group are iridescent green or blue in life and lose that color once they are killed. They have very uniform male and female genitalia but the shape of the head is very variable from short head in *Doratulina rotundus* (Pruthi) to greatly elongated head in *Cymbopogonella* Viraktamath. Vilbaste (1965) and Emeljanov (1962)) synonymised several of the Oriental genera with *Doratulina* Melichar as these genera have rather uniform male and female genitalia.

Since there is a considerable confusion regarding the taxonomic position of these genera and also no comprehensive revisionary works regarding this group from the subcontinent are available, the present study was undertaken with the following objectives.

1. To study the leafhopper fauna of the subfamily Penthimiinae and the tribe Stenometopiini of Deltocephalinae of Indian Subcontinent.
2. To revise the known taxa and to describe new taxa, if any discovered.
3. To prepare an illustrated key to species and genera.

4. To analyze the relationship of Penthimiinae and the tribe Stenometopiini with other groups of leafhoppers.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

There are more than 1350 species of leafhoppers described from the Indian subcontinent grouped under 25 subfamilies of 40 major subfamilies recognized (Viraktamath, 2005). The subfamily Deltocephalinae forms one of the major subfamilies comprising 389 species in the Indian subcontinent, whereas Penthimiinae is one of the smaller subfamilies comprising 38 species from Indian subcontinent. The literature available on the two groups under study namely Penthimiinae and the tribe Stenometopiini of Deltocephalinae are briefly reviewed in this chapter.

2.1. Subfamily Penthimiinae

Opinion differ on the taxonomic position of Penthimiinae among the leafhopper workers. Distant (1908) recognized the division Penthimiaria under the subfamily Gyponinae of the family Jassidae. Evans (1947) considered Penthimiinae as a tribe within Jassinae along with Krisnini, Gyponini, Selenocephalini, Jassini, Reuterellini (now Reuplemmelini) and Trocnadini. Oman (1949) treated the Penthimiinae as a separate subfamily and characterized this subfamily as follows; broad, short, depressed leafhoppers. Head broad; face in a horizontal plane or nearly so; clypeus concave in profile; lateral frontal suture either terminating at antennal pit or extending over anterior margin of head; crown declivous. Macropterous, forewing broad and appendix very large. Valve of male not concealed; male plates broad basally. Wagner (1951) regarded Penthimiinae as a tribe of Deltocephalinae and Ribaut (1952) placed it as a separate subfamily next to Aphrodinae, Cicadellinae and Evacanthinae. Metcalf (1964) included this subfamily under the family Gyponidae in his monumental work "General Catalogue of the Homoptera Fascicle VI Cicadelloidea".

Penthimiinae have been studied by Baker (1924), Distant (1908, 1912, and 1918), Kirkaldy (1906), Melichar (1903), Motschulsky (1863), Walker (1851 and 1857) and Germar (1821).

The Penthimiinae of the Indian subcontinent constitute 38 species grouped in seven genera (Distant, 1908, 1918; Metcalf, 1962).

Evans (1972) described 36 new species from Australia, New Guinea and from Amboina. The characteristics and discussed possible relationships of the Penthimiinae with Deltocephalinae. He also reviewed Oriental and Australian genera of Penthimiinae

and provided a key to the genera present in Australia and New Guinea.

Linnavuori (1977) revised the Penthimiinae of the Afrotropical region. He recognized fourteen genera including three new genera (*Irenaella* Linnavuori, *Nielsoniella* Linnavuori and *Musosa* Linnavuori) and 59 species of Penthimiinae (35 new species).

Linnavuori (1977) characterized penthimiines as medium sized or large leafhoppers. Black or brown, rarely red or yellow, dark species often with reticulate pale pattern in forewing. Body robust, short and broad, convex or flattened. Primitive forms with distinct hair covering and strong rugose and tuberculate micro sculpturing on head, thorax and even forewings. In advanced genera at least anterior margin of head transversely rugose. Head broad, rarely *(Haranga, Penthimidia)* much narrower than pronotum, shape otherwise very variable: anterior margin either rounded to face, subacute to foliaceous, or provided with a marginal groove between two ridges as in the subfamily Selenocephalinae. Face very short and broad, convex or flattened; anteclypeus broadening apicad, with a blunt median keel; frontoclypeus strongly broadening upwardly, extending distinctly on to the crown, epistomal suture sometimes visible; genae broad, usually only shallowly insinuated near eyes; ocellocular area broad; antennal ledges sharp, facial, obliquely directed dorso-laterad or transverse, forming in the latter case the anterior margin of crown laterally. Antennae short, arising usually near upper margin of face. Crown nearly of uniform length or prolonged, even spatulate, often strongly sloping apicad. Ocelli usually on crown, rarely marginal, far from eyes. Anterior tentorium branches falcate. Pronotum broad, lateral margin often long, carinated; disk usually at least faintly transversely sulcate. Forewings broad, tectiform, broadly overlapping apically; coriaceous, setose, tuberculate or punctate in primitive forms, hyaline and smooth in advanced ones; appendix and first apical cell often very wide; venation complete, claval veins linked by a cross vein, corium often with extra cross veins. Venation of hind wings of the common Deltocephalinae type. Abdomen broad and depressed. Legs strong. Dorsal surface of fore and middle tibiae scored or broadly flattened even in the most advanced genera, spinulation often rather weak. Spinulation of hind femora usually 2+2+1. Hind tibiae flattened and reflexed, with strong marginal spines, apical pecten with strong spines arising from triangular plates. Undersurface of first joint of hind tarsi with two longitudinal rows of spines, apical margin with a transverse row of stout spines arising from triangular plates. Male genitalia of the deltocephaline type. Genital segment small, broadly conical. Side lobes

of pygophore usually setose, rarely provided with sclerified processes. Valve triangular, articulated to pygophore. Genital plates often with developed spinulation. Basal part of stylus usually relatively narrow, apophysis digitate. Connective robust, Y-shaped. Aedeagus often relatively small, digitate, sometimes with basal or apical appendages. Genital segment of female short and broad.

Mac Gillivray (1986) studied the South African species of the genus *Citorus* Stål and reported two new species, *Citorus brevistilus* and *Citorus citri.* Hayashi and Machida (1996) revised the Japanese species of Penthimiinae that included five species under two genera including one new genus *Chanohirata* Hayashi and Machida (type species: *Penthimia theae* Matsumura) and two new species. Zhang *et al.* (2004) gave information on Penthimiinae described by Jacobi (1944) from 'Fukien' (China). The types of *Penthimia castanaica* Jacobi and *P. nigerrima* Jacobi were also studied.

Zahniser (2007) evaluated 119 morphological characters for 85 taxa which included representatives from all the tribes of Deltocephalinae, related subfamilies like Penthimiinae, Selenocephalinae, Eupelicinae, Drakensbergeninae, Koebeliinae and six out group taxa, *Errhomus* Oman, *Calliscarta* Stål, *Portanus* Ball, *Xestocephalus* Van Duzee, *Chinaia* Bruner and Metcalf and *Aphrodes* Curtis to work out the phylogenetic relationship among them. The resulting phylogeny corroborated previous phylogenetic analysis of Cicadellidae and showed that members of some groups currently classified in separate subfamilies are nested well within the deltocephaline lineage. The outgroups used here rooted the tree such that Acinopterini, Fieberiellini and Goniagnathini, *Pachymetopius* Matsumura (Stegelytrinae) and Acostemminae, all of which do not possess the typical deltocephaline male genitalia were near the base of the tree. The remainder of the ingroup possessed the typical deltocephaline male genitalia. He also mentioned that along with male genitalia characters, leg chaetotaxy and female genitalia characters proved to be useful in inferring relationships among the tribes.

Previous phylogenetic analysis of the leafhopper family Cicadellidae based on morphological and molecular data suggested that Deltocephalinae, as traditionally defined, is polyphyletic. These analyses recovered a large clade comprising Deltocephalinae and several other subfamilies. To further elucidate relationships within this large clade of Deltocephalinae-like leafhoppers, an expanded data set of 119 morphological characters and 68 taxa was compiled and analysed using cladistic methods. The taxon sample included one or more representatives of nearly all previously recognized tribes of Deltocephalinae, representatives of non-deltocephaline

family-group taxa which grouped with Deltocephalinae in previous analyses, and six putative outgroup taxa drawn from other cicadellid subfamilies. The resulting most parsimonious trees consistently recovered the putative ingroup as monophyletic. Based on these results, subfamilies derived from within the deltocephaline lineage include Acostemminae, Arrugadinae, Drakensbergeninae, Eupelicinae, Koebeliinae, Mukariinae, Paraboloponinae, Penthimiinae, Selenocephalinae and Stegelytrinae. The phylogeny indicates that grass specialization is much more phylogenetically conservative than implied by the current higher classification of leafhoppers (Zahniser and Dietrich, 2008).

Kamitani (1999) studied the phylogenetic relationship among the genera of the subfamily Deltocephalinae and its allies occurring in Japan and redefined the tribes Deltocephalini and Paralimnini. The phylogenetic analysis was based on the maximum-parsimony method by manual and computer-aided reconstruction with the Fitch characters and Wagner characters (non-weighted or weighted). Sixty-four characters were used for the phylogenetic analysis. Deltocephalini *s. str.* was concluded to be paraphyletic and included 2 lineages. The *Deltocephalus* clade consists of *Alobaldia* Emeljanov, *Deltocephalus* Burmeister, *Endria* Oman, *Recilia* Edwards and *Paramesodes* Ishihara. Contrary to this *Futasujinus* Ishihara, *Hengchunia* Vilbaste, *Takagiella* Vilbaste, and Ishihara belonged to the *Paralimnus* Matsumura lineage with *Paralimnus* Matsumura, *Paralaevicephalus* Ishihara, *Psammotettix* Haupt, *Metalimnus* Ribaut, *Diplocolenus* Ribaut, *Jassus* Fabricius, *Sorhoanus* Ribaut, *Doratura* Sahlberg, and *Aconurella* Ribaut. The *Deltocephalus* Burmeister clade was referred to the tribe Deltocephalini and the *Paralimnus* Matsumura clade to the tribe Paralimnini.

The centre of origin of Penthimiinae is considered to be in the Oriental region (Evans, 1972).

2.2. Taxonomy of the genera of the Indian subcontinent

Genus *Haranga* Distant

Distant (1908) described the genus *Haranga* for the type species *Haranga orientalis* Walker. Three species of *Haranga* are known from the Indian subcontinent. Their distribution ranges from India, Nepal and Sri Lanka in the Indian subcontinent and Africa, China. It has very long scutellum almost reaching apex of the clavus, very broad at base and narrowed from about middle to apex. Linnavuori (1977) described

one new species under the genus *Haranga* from Africa. Zhonglin (1992) described one new species, *Haranga maculata* Kuoh from China. Sun and Zhang (2001) described a new species *H. aridgina* Sun and Zhang from Hainan and Yunnan (China).

Genus *Malichus* Distant

Distant (1918) described the genus *Malichus* Distant for the type species *Malichus capitatus* Distant. This genus is known only by its type species from Sri Lanka. It has vertex of head large and spatulate. This genus is allied to *Tambila,* from which it differs by the large foliaceous vertex and pronotum being shorter than vertex.

Genus *Neodartus* Melichar

Melichar (1903) established the genus *Neodartus* with *N. acocephaloides* Melichar as the type species. Three species are reported under this genus from the Indian subcontinent and they are distributed in Sri Lanka and India. The head is broadly parabolic and rimmed with three carinae, the ocelli are located on the marginal rim of the vertex and placed at a distance greater than twice own diameter away from adjacent eye. Linnavuori (1977) and Evans (1972) redescribed the genus. Viraktamath and Viraktamath (1995) reported *N. acocephaloides* feeding on *Clerodendron inerme*. Pruthi (1934) reported *N. acocephaloides* on both healthy and spike diseased sandals and on *Dodonea viscosa.*

Genus *Penthimia* Germar

This is a genus recorded in all the zoogeographical regions of the World. Germar (1821) described the genus *Penthimia* with *Penthimia atra* Fabricius as the type species. In this genus head is convexly rounded to face with the anterior margin transversely striated. Ocelli placed on the disk of the vertex, remote from each other than from the eyes. Lateral frontal suture not reaching the ocelli or ocellar vestiges. Of the twenty three species known from the subcontinent, two species were described by Walker (1851 and 1857), two species by de Motschulsky (1863), 18 species were described by Distant (1908, 1918, and 1912), and one species by Baker (1924).

Datta (1973e) redescribed three species of *Penthimia* (*P. compacta* Walker, *P. juno* Distant, and *P. maculosa* Distant) from Indian subcontinent and illustrated male and female genitalia.

Linnavuori (1977) dealt with species of *Penthimia* from Africa and reported 20

species under this genus. Of the 20 species, 16 were new and he also gave illustrations of male genitalia for most of the species. Hayashi and Machida (1996) revised the species of Penthimiinae from Japan and reported four species of *Penthimia,* including two new species.

Viraktamath and Viraktamath (1995) reported *Penthimia* spp. on mango, *Bauhinia* spp., tomato and sandal. Pruthi (1934) reported *P. melanocephala, P. compacta, P. subnigra* Distant, *P. scutellata* (Distant) on both healthy and spike diseased sandals. *Penthimia testacea* Kuoh was found injurious to tea in Anhui and Zhejiang Provinces, China (Kuoh, 1991).

Zhonglin (1992) described six new species of the genus *Penthimia viz., P. alboguttata* Zhonglin, *P. densa* Zhonglin, *P. fumosa* Zhonglin *P. rubramaculata* Zhonglin *P. rubrostriata* Zhonglin and *P. yunnana* Zhonglin from China. Kwon and Lee (1978) studied the Penthimiinae of Korea and reported two new species *viz., P. dorsimaculata* Kwon and Lee and *P. fuscomaculosa* Kwon and Lee. Cheng and Li (2003) reported two new species of *Penthimia, P. fulviguttata* Cheng and Li and *P. maolanensis* Cheng and Li from China. Cai and Shen (1998) reported three new species of *Penthimia* from Mt. Funiu in Henan. Wang and Ma (1995) reported a new species of the genus *Penthimia* Germar - *Penthimia citrina* R.Z. Wang from China. Logvinenko (1983) reported new species *Penthimia proxima* Logvinenko from Transcaucasia.

Genus *Tambila* Distant

Distant (1908) described the genus *Tambila* with *Tambila greeni* Distant as the type species. Five species are reported under this genus from Indian subcontinent. *Tambila gravelyi* Distant was the only species reported from India, whereas all other species were reported from Sri Lanka. In this genus the head in profile is spatulate, rimmed with five to six transverse carinae. The lateral frontal suture reaches ocelli.

Genus *Uzelina* Melichar

Melichar (1903) described the genus *Uzelina* Melichar with *Uzelina laticeps* Melichar as the type species from Sri Lanka. The vertex is as broad as pronotum, in front broadly rounded, above arched, surface curved downward with the ocelli on the disc. The lateral frontal suture does not reach ocelli or ocellar vestiges. Sharma (1986) added one more species, *Uzelina thaloriensis* Sharma from Jammu and Kashmir (India). Linnavouri (1977) redefined the genus and described four species of the genus

from Africa.

Genus *Vulturnus* Kirkaldy

Kirkaldy (1906) described the genus *Vulturnus* Kirkaldy with *Vulturnus vulturnus* Kirkaldy as the type species. Two species have been reported under this genus by Distant (1912) from Sri Lanka. The vertex, the pronotum and the scutellum have thick black reticulations. Evans (1972) described five species of the genus from New Guinea and Amboina.

Genera and species of the subfamily Penthimiinae recorded from the Indian subcontinent

Genus *Haranga* Distant

Haranga Distant 1908: 248. Type species: *Haranga orientalis* Distant, by original designation.

Haranga decurtata Distant 1908: 250.
Distribution: India: Tamil Nadu.

Haranga orientalis Walker 1851: 841, Distant 1908: 249.
Distribution: North India. Nepal.

Haranga scutellaris Distant 1908: 249.
Distribution: India: Assam, West Bengal. Sri Lanka.

Genus *Malichus* Distant

Malichus Distant 1918: 24. Type species: *Malichus capitatus* Distant, by original designation.

Malichus capitatus Distant 1918: 25.
Distribution: Sri Lanka.

Genus *Neodartus* Melichar

Neodartus Melichar 1903: 266. Type species: *Neodartus acocephaloides* Melichar, by original designation.

Neodartus acocephaloides Melichar 1903: 163.
Distribution: India: Karnataka, Punjab, Tamil Nadu, West Bengal. Sri Lanka.

Neodartus rufopunctatus de Motschulsky 1863: 94.
Distribution: Sri Lanka.

Neodartus scutellatus Distant 1908: 246.
Distribution: India: Madras,Karnataka. Sri Lanka. Myanmar.

Genus *Penthimia* Germar

Penthimia Germar 1821: 46. Type species: *Cercopis atra* Germar, by monotypy.

Ectopiocephalus Kirkaldy 1906: 463. Type species: *Ectopiocephalus vanduzeei* Kirkaldy, by monotypy.

Penthimia attenuata Distant 1918: 22.
Distribution: India: Karnataka.

Penthimia badia Distant 1918: 17.
Distribution: India: Karnataka.

Penthimia castanea Walker 1857: 98; Distant 1908: 243.
Distribution: Myanmar.

Penthimia compacta Walker 1851: 842; Distant 1908: 242.
Distribution: India: Bihar, Karnataka, Maharashtra, Punjab, Tamil Nadu, West Bengal.

Penthimia distanti Baker 1924: 367, nom. nov. pro. *nitida* Distant 1912 not Lethierry 1876.

Penthimia nitida Distant 1912: 444; 1918:21.
Distribution: Myanmar.

Penthimia erebus Distant 1908: 245.
Distribution: India: Karnataka, Tamil Nadu. Sri Lanka.

Penthimia flavocapitata Distant 1918: 20.
Distribution:Indla: Tamil Nadu.

Penthimia fraterna Distant 1918: 21.
Distribution:India: Tamil Nadu.

Penthimia funebris Distant 1918: 19.
Distribution:Indla: Tamil Nadu.

Penthimia juno Distant 1908: 245.
Distribution: Sri Lanka.

Penthimia majuscula Distant 1918: 18.
Distribution:India: Karnataka.

Penthimia melanocephala de Motschulsky 1863: 95; Distant 1908: 241.
Distribution: India: Karnataka. Sri Lanka. Myanmar.

Penthimia montana Distant 1918: 17.
Distribution: India: Tamil Nadu.

Penthimia mudonensis Distant 1912: 444; 1918: 20.
Distribution: Myanmar: Tenasserim.

Penthimia nilgiriensis Distant 1918: 16.
Distribution:India: Tamil Nadu.

Penthimia nitida Lethierry 1876: 11.
Distribution: India: West Bengal.

Penthimia noctua Distant 1918: 22.
Distribution: India: West Bengal.

Penthimia quadrinotata Distant 1918: 21.
Distribution:India: Tamil Nadu.

Penthimia scapularis Distant 1908: 244;1918: 21.
Penthimia maculosa Distant 1908: 244.
Distribution: India: Assam, Maharashtra, Tamil Nadu, Uttaranchal, West Bengal. Myanmar.

Penthimia subnigra Distant 1908: 243.
Distribution:India: Assam, Bihar, Tamil Nadu, West Bengal.

Penthimia thoracica Distant 1918: 19.
Distribution: India: Tamil Nadu.

Penthimia variabilis Distant 1918: 18.
Distribution: India: Tamil Nadu.

Penthimia vittatifrons Distant 1918: 17.
Distribution: Sri Lanka.

Genus *Tambila* Distant
Tambila Distant 1908: 247. Type species: *Tambila greeni* Distant, by original designation.

Tambila conspersa Distant 1918: 24.
Distribution: Sri Lanka.

Tambila fletcheri Distant 1918:23.
Distribution: Sri Lanka.

Tambila gravelyi Distant 1918: 23-24.
Distribution: India: Maharashtra.

Tambila greeni Distant 1908: 247-248; 1918: 23.
Distribution: Sri Lanka.

Tambila opulenta Distant 1918: 23.
Distribution: Sri Lanka.

Genus *Uzelina* Melichar
Uzelina Melichar1903: 181. Type species *Uzelina laticeps* Melichar, by original

designation.

Uzelina laticeps Melichar 1903: 182; Distant 1908: 267.
Distribution: Sri Lanka.

Uzelina thaloriensis Sharma 1986: 39-42.
Distribution: India: Jammu and Kashmir.

Genus *Vulturnus* Kirkaldy
Vulturnus Kirkaldy 1906: 463. Type species *Vulturnus vulturnus* Kirkaldy, by original designation.

Vulturnus ornatus Distant 1912: 445; 1918: 26.
Distribution: Sri Lanka.

Vulturnus speciosus Distant 1912: 445; 1918: 27.
Distribution: Sri Lanka.

2.3. Subfamily: Deltocephalinae

The subfamily Deltocephalinae is one among the 40 subfamilies of the family Cicadellidae and forms the largest and phylogenetically the most advanced group of leafhoppers (Knight, 1983; Nielson, 1979). Metcalf (1968) treated this subfamily as the family Euscelidae in his monumental work "General catalogue of the Homoptera, Fasicle VI - Cicadelloidea". All the families of Cicadelloidea of Metcalf however, are being treated as subfamilies in recent years (Oman, 1971; Knight, 1983 and Young, 1968). The Deltocephalinae are usually divided into 23 tribes (Oman *et al.*, 1990) on a world wide basis. Of these 16 tribes occur in India (Viraktamath, 2007).

Deltocephalinae are small to medium sized (2-8 mm long) leafhoppers with ocelli on front margin of head often close to eyes than to each other. Lateral frontal sutures reach ocelli. Antennal ledges are reduced or absent. Forewing venation is complete and the claval region is with at least one cross-vein connecting outer claval vein with claval suture. Male valve is triangular and not fused with lateral margins of pygophore. This subfamily occurs in all zoogeographical regions and is the largest as far as the number of species is concerned. It also includes species of great economic importance. Of the 151 species of leafhopper vectors reported, 95 species belong to this subfamily (Nielson, 1985). In India, species of *Nephotettix* Matsumura, *Deltocephalus (Recilia), Orosius* Distant and *Hishimonus* Ishihara are of importance as they serve as vectors of plant pathogens of agriculturally important crops (Viraktamath, 2007).

2.3.1. Tribes of Deltocephalinae

Sixteen tribes of the subfamily are reported from the Indian subcontinent. They are Athysanini, Chiasmini, Cicadulini, Deltocephalini, Fieberiellini, Goniagnathini, Grypotini, Paraboloponini, Hecalini, Macrostelini, Occinirvanini, Opsiini, Paralimnini, Platymetopiini, Scaphytopiini and Stenometopiini (Viraktamath, 2007).

Stenometopiini are exclusively grass feeding leafhoppers. Many species of this group are iridescent green or blue in life and lose that color when they are killed. They have a very uniform male and female genitalia but the shape of the head is very variable from short to greatly produced (Viraktamath, 1976).

There is considerable confusion regarding the taxonomic position of the tribe Stenometopiini among the earlier workers. Metcalf (1963) considered Stirellini and Stenometopiini as separate tribes under his family Nirvanidae. Evans (1966) treated it as a tribe of the subfamily Coelidiinae.

Hamilton (1975) considered Stenometopiini (=Stirellini) as a tribe of Aphrodinae. He also characterized the tribe as follows; crown bluntly to acutely produced; coronal margin rounded to angulate; eyes separated by only their own width; ocelli on margin of crown very close to eyes, but well removed from insertion of antennae below eyes; antennal ledges absent; frons normal to elongate, distinctly wider than genae; clypellus truncate apically, parallel sided or tapering apically; genae almost completely concealing tiny prothoracic episterna, adhering to sides of clypellus apically. Pronotum bowed between eyes, lateral margins situated below midline of eyes. Forewing normal. Two femoral macro setae of hind leg apical, a third seta lateral and sometimes also dorsolateral, close to third seta, and a fifth macroseta further basad of third seta; apical pecten of hind tibia regular in length, oblique; hind tibia strongly flattened, thin, armed with 9-11 macro setae in outer row.

Oman *et al.* (1990) synonymised Stirellini Emeljanov (1966) and Stenometopiini Baker (1923) and used the oldest available name Stenometopiini as the valid name for the tribe and treated Stirellini as a junior synonym.

2.3.2. Stenometopiini from the Indian subcontinent

Eighteen genera and 28 species of the tribe are known from the Indian subcontinent. The first comprehensive study on the Indian Stenometopiini was done by Distant (1908, 1918) wherein he dealt with 13 genera and 16 species. Further Pruthi (1930, 1936) added two more new genera, *Sunda* Pruthi and *Bella* Pruthi along with eight new species. Ishihara (1961) described the genus *Umesaona* Ishihara for

Umesaona asiatica Ishihara from Thailand. Mahmood *et al.* (1972) described two new species of *Stirellus* from Pakistan and Ahmad and Aziz (1988) also added one more species *Paternus jhokensis* Ahmad and Aziz from Pakistan.

Emeljanov (1962) synonymised *Anemochrea* Kirkaldy, *Anemolua* Kirkaldy, *Arya* Distant, *Bella* Pruthi, *Bituitus* Distant, *Campbellinella* Distant, *Gilettiella* (Sic) Osborn, *Kinonia* Ball, *Nandidrug* Distant. *Paivanana* Distant, *Paternus* Distant, *Penestirellus* Beamer and Tuthill, *Phrynophyes* Kirkaldy, *Pseudaconura* Linnavuori, *Sunda* Pruthi, *Trebellius* Distant, *Umesaona* Ishihara and *Volusenus* Distant and *Aconura* of authors (not Lethierry) as new synonyms of *Stirellus.* Further during 1966, he erected a separate tribe Stirellini to receive *Stirellus* and related genera.

Vilbaste (1965) also considered *Anemochrea* Kirkaldy, *Arya* Distant, *Bella* Pruthi, *Bituitus* Distant, *Campbellinella* Distant, *Nandidrug* Distant, *Paivanana* Distant, *Paternus* Distant, *Phrynophyes* Kirkaldy, *Sunda* Pruthi, *Trebellius* Distant, *Umesaona* Ishihara, *Volusenus* Distant and *Aconura* of authors (not Lethierry) as synonyms of *Doratulina* Melichar

2.3.3. Genera of Stenometopiini

Genus *Doratulina* Melichar

Melichar (1903) described the genus *Doratulina* with the type species *Doratulina*

jacosa Melichar. The species of this genus are widely distributed in the Oriental Region. They are distributed in India (Andhra Pradesh, Assam, Bihar, Karnataka, Jammu and Kashmir, Kerala, Madhya Pradesh, Punjab, Tamil Nadu, Uttar Pradesh, and West Bengal), Sri Lanka, and Pakistan. There are a total of twenty eight species reported from Indian subcontinent. Species of *Doratulina* have a very uniform male and female genitalia but the shape of the head is very variable from short to greatly elongated. Species of this genus can be readily recognized based on external morphology and male genitalia (Pruthi, 1930, 1936; Datta, 1973a, 1973b, 1973c, 1973d, 1973f). Pruthi (1930, 1936) added eight new species under this genus from India.

Viraktamath (1976) described the subgenus, *Cymbopogonella* under the genus *Doratulina* for the type species *Doratulina (Cymbopogonella) longivertex* Viraktamath form Karnataka.

Datta (1973a, 1973b, 1973c, 1973d, 1973f) redescribed five species of *Doratulina (D. speciosum* (Distant), *D. viridicans* (Distant), *D. rotundus* (Pruthi), *D.*

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Bangalore
August, 2008

Rani
(Shobharani, M.)

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INTRODUCTION

indra (Distant), *D. verticus* (Pruthi) with illustrations of male genitalia from India.

Oman (1938) pointed out the external similarity between *Stirellus* Osborn and Ball and *Aconura* Lethierry, *Anemochrea* Kirkaldy, *Phrynophyes* Kirkaldy, *Nandidrug* Distant and *Paivanana* Distant. To this group he also added *Campbellinella* Distant, *Trebellius* Distant, *Volusenus* Distant, *Arya* Pruthi, *Sunda* Pruthi and possibly *Bituitus* Distant. He also mentioned that, it is probable that this group will be found to warrant recognition as a distinct tribe. Oman (1949) mentioned that in the Nearctic fauna the genera *Stirellus* Osborn and Ball, *Penestirellus* Beamer and Tuthill, *Gilettiella* Osborn, and *Kinonia* Ball, forms a reasonably homogenous group on the basis of head structure and this association was supported by the structure of the male genitalia.

Emeljanov (1962) stated that the genus *Aconura* Lethierry 1876 included in the tribe Doraturini has been described from two closely related species from Astrakhan. The type species *Aconura jakovlevi* Lethierry was described only from females. It has since become apparent that the species from two completely unrelated groups have been described under the generic name *Aconura* (Ribaut, 1948). Ribaut (1948) not being acquainted with type of the genus, erroneously retained the name *Aconura* for a genus that should have been named *Stirellus* and gave the genus *Aconura* the new name of *Aconurella* (Ribaut, 1948) with the generic type *Thamnotettix prolixus* Lithierry. All later authors have accepted this incorrect treatment by Ribaut. Emeljanov (1962) included the genus *Stirellus* under the tribe Doraturini of the subfamily Euscelinae. Further, he also mentioned that, owing to the great variability in the shape of the head, proportions of the body, length of forewing and its patterning, almost every species of the genus *Stirellus* may be described under another generic name. It may be necessary to divide the genus into several genera, but this can only be done after a critical reevaluation of the attributes of the whole group based on extensive material. He further considered the genera, *Anemochrea* Kirkaldy, *Anemolua* Kirkaldy, *Arya* Distant, *Bella* Pruthi, *Bituitus* Distant, *Campbellinella* Distant, *Gilettiella* Osborn, *Kinonia* Ball, *Nandidrug* Distant, *Paivanana* Distant, *Paternus* Distant, *Penestirellus* Beamer and Tuthill, *Phrynophyes* Kirkaldy, *Pseudaconura* Linnavuori, *Sunda* Pruthi, *Trebellius* Distant, *Umesaona* Ishihara and *Volusenus* Distant and *Aconura* of authors (not Lethierry) as synonyms of *Stirellus*. Further, during 1966, he erected a separate tribe Stirellini to receive *Stirellus* and related genera. Vilbaste (1965) examined some species of the genus *Stirellus* and concluded that although above mentioned genera are very near to one another, they are distinct. He mentioned that the pygophore lobes of

Aconura of authors (not Lethierry) are relatively longer, and have a minute strongly pigmented tooth near the lower margin which is always absent in *Stirellus*. The aedeagus is also different. The genus *Aconura* has a very characteristic form with a well developed preatrium into which a long stem, almost parallel to the preatrium, is inserted. The latter is almost round in section. At the tip of the aedeagal shaft around the gonopore a membranous formation exists. In *Stirellus,* the aedeagus is shorter, its stem is inserted into the preatrium at a distinct angle and the stem, especially in the lower part, is semicircular in section and some minor differences also exist in the structure of the style and connective. Looking into these characters he treated *Stirellus* and *Aconura* as distinct genera.

Vilbaste (1965) also examined some species of the genera *Arya, Paternus, Bella* indicated by Pruthi (1930) to be very near to *Aconura*, *Phrynophyes* Kirkaldy and *Doratulina* Melichar. The characters of the male genitalia of these taxa suggest that these are congeneric, having the characteristic features of *Aconura* (of authors, not Lethierry). Therefore, he concluded that all these genera, which agree well with the generic concept of *Aconura* to be treated as junior synonyms of the genus *Doratulina* Melichar.

Mahmood *et al.* (1972) stated that Vilbaste in a personal communication mentioned that he was not right in treating *Stirellus* and *Doratulina* as separate genera, and that *Stirellus* Osborn and Ball being the older name, is the right name for this group. Therefore, the correct name of the genus would be *Stirellus* Osborn and Ball and all other genera referred to by Vilbaste (1965) including *Doratulina* Melichar should be treated as junior synonyms. However, these two genera have not been formally synonymised.

Dai *et al.* (2003) reported a new species, *Paivanana centristriata* Dai, Chen and Li from China.

Genus *Stirellus* Osborn and Ball

Osborn and Ball (1902) described the genus *Stirellus* as a subgenus of *Athysanus* Burmeister with *Athysanus bicolor* Van Duzee as the type species.

Oman (1949) characterized the genus *Stirellus* Osborn and Ball as follows: Small leafhoppers. Head about as wide as pronotum, apex bluntly subconical; clypellus long, parallel-sided and extending beyond the normal curve of the genae; genae expanded, lateral margins sinuate; crown distinctly longer medially than next to eye,

longer than pronotum. Pronotum short, surface faintly transversely striated. Forewing rather short, barely exceeding tip of ovipositor sheath in female, appendix small, outer anteapical cell small, inner anteapical cell open basally. Male genital capsule small, valve comparatively large and triangular; plates small, spine-like setae uniseriate, but not marginal. Tenth segment small, sclerotized dorsally as a narrow band. Connective very narrowly forked, arms nearly parallel, apex of shaft extending caudad of tips of styles. Aedeagus simple, broad basally, acuminate distally, roughly V -shaped in lateral view with posterior arm of V about twice as long as anterior arm; gonopore terminal or subterminal on the anterior surface of shaft. Style with a long basal arm. Ovipositor sheath extending well beyond pygofer; pygofer of female with a few short setae.

From the Oriental region only two species, *S. peshawarensis* and *S. thattaensis* are reported under this genus from Pakistan (Mahmood *et al.*, 1972).

Genus *Viridomarus* Distant

Distant (1918) described the genus *Viridomarus* Distant with *Viridomarus capitatus* Distant as the type species from Karnataka. The vertex is twice as long as breadth between eyes, elongate, subtriangular, narrowed, broadly sub-acute at apex. The forewings are about two and half times as long as broad. In the females, the forewing cover only three fourth of the abdomen. This genus is represented by the type species only.

Genera and species of the tribe Stenometopiini recorded from the Indian subcontinent

Genus *Doratulina* Melichar 1903: 198-199 Type species: *Doratulina jacosa* Melichar, by original designation

Allectus Distant 1918: 75. Type species *Allectus notatus* Distant, by original designation.

Anemochrea Kirkaldy 1906: 329. Type species: *Anemochrea mitis* Kirkaldy by original designation.

Anemolua Kirkaldy 1906:329. Type species: *Anemolua hanuala* Kirkaldy by original designation.

Arya Distant 1908: 338. Type species: *Arya rubrolineata* Distant, by original designation.

Bella Pruthi 1930: 44. Type species: *Bella apicalis* Pruthi, by original designation.

Bituitus Distant 1918: 70. Type species: *Bituitus projectus* Distant, by original designation.

Campbellinella Distant 1918: 69. Type species: *Campbellinella illustrata* Distant, by original designation.

Giletiella (Sic) Osborn 1930: 23: 689. Type species: *Deltocephalus labiata* Gillette, by original designation.

Kinonia Ball 1933: 28: 224. Type species: *Kinonia elongata* Ball, by original designation.

Nandidrug Distant 1918: 74. Type species: *Nandidrug speciosum* Distant, by original designation.

Paivanana Distant 1918: 95. Type species: *Paivanana indra* Distant, by original designation.

Paternus Distant 1918: 71. Type species: *Paternus pusanus* Distant, by original designation.

Penestirellus Beamer and Tuthill 1934: 21. Type species: *Penestirellus catalinus* Beamer and Tuthill, by original designation.

Phrynophyes Kirkaldy 1906: 237. Type species: *Phrynophyes phrynophyes* Evans.

Pseudoconura Linnavuori 1952: 182. Type species: *Pseudaconura luxorensis* Linnavuori .

Sunda Pruthi 1936: 112. Type species: *Sunda ribeiroi* Pruthi, by original designation.

Umesaona Ishihara 1961: 246. Type species *Umesaona asiatica* Ishihara, by original designation.

Volusenus Distant 1918: 72. Type species: *Volusenus lahorensis* Distant, by original designation.

Aconura of authors

Doratulina apicalis Pruthi 1930: 45
Distribution: India: Andhra Pradesh.

Doratulina asiatica Ishihara1961
Distribution: India: Kompong Cham, Cambodia.

Doratulina atrata Distant 1918: 77
Distribution: India: Tamil Nadu.

Doratulina columbensis Melichar 1903: 187: 1908: 379
Distribution: Sri Lanka.

Doratulina dindorensis Pruthi 1930: 38
Distribution: India: Madhya Pradesh.

Doratulina illustrata Distant 1918: 69
Distribution: India: Karnataka, Tamil Nadu.

Doratulina indra (Distant)1908: 415 : Pruthi 1934: 98
Distribution: India: West Bengal.

Doratulina jacosa Melichar 1903: 199
Distribution: India: Karnataka, Kerala. Tamil Nadu. Sri Lanka.

Doratulina jhokensis Ahmad and Aziz 1988: 808
Distribution: Pakistan: Sind.

Doratulina khewrensis Pruthi 1936: 111
Distribution: India: Punjab.

Doratulina laetus (Melichar) Comb. nov. (1908): 483 : Rao 1986 : 55-56
Distribution: India: Kerala, Karnataka. Sri Lanka .

Doratulina lahorensis Distant 1918: 72
Distribution: India: Punjab.

Doratulina notatus Distant 1918: 76
Distribution: India: Tamil Nadu.

Doratulina projectus Distant 1918: 71
Distribution: India: Karnataka

Doratulina pusanus Distant 1918: 71
Distribution: India: Bihar

Doratulina ribeiroi Pruthi 1936: 112
Distribution: India: West Bengal.

Doratulina rotundus Pruthi 1930: 40
Distribution: India: Madhya Pradesh.

Doratulina rubrolineata Distant 1908: 338
Distribution: India: Andhra Pradesh, West Bengal.

Doratulina speciosum Distant 1918: 74
Distribution: India: Karnataka, Jammu and Kashmir, Tamil Nadu.
Doratulina solitaris Melichar 1903: 188
Distribution: Sri Lanka.

Doratulina tolla (Pruthi) 1930: 39
Distribution: India: Assam. West Bengal. Pakistan.

Doratulina verticus Pruthi 1930: 44
Distribution: India: Andhra Pradesh. Sri Lanka.

Doratulina viridcans (Distant) 1918: 75
Distribution: India: Tamil Nadu.

Doratulina viridulus Pruthi 1930: 42
Distribution: India: Andhra Pradesh, Karnataka, Tamil Nadu.

Subgenus *Cymbopogonella* Viraktamath 1976: 79. Type species: *Doratulina (Cymbopogonella) longivertex* Viraktamath, type by original designation
Distribution: India: Karnataka.

Genus *Stirellus* Osborn and Ball
Genus *Stirellus* Osborn and Ball 1902: 250 as a subgenus of *Athysanus* Burmeister 1838: 14. Type species: *Athysanus bicolor* Van Duzee.

Stirellus peshawarensis Mahmood, Sultana and Waheed 1972: 80-82
Distribution: Pakistan: Peshawar.

Stirellus thattaensis Mahmood, Sultana and Waheed 1972:82-83
Distribution: Pakistan: Thatta.

Genus *Trebellius* Distant
Genus *Trebellius* Distant 1918: 52. Type species *Trebellius albifrons* Distant by original designation; Nast 1972: 354.

Trebellius albifrons (Distant) 1918: 53
Distribution: India: UP (Allahabad).

Genus *Viridomarus* Distant 1918: 69. Type species: *Viridomarus capitatus* Distant, by original designation.

Viridomarus capitatus Distant 1918: 70
Distribution: India: Karnataka.

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The present revisionary study was confined to the subfamily Penthimiinae and the tribe Stenometopiini of the subfamily Deltocephalinae of the Indian subcontinent. A total of 511 specimens of the subfamily Penthimiinae and 1161 specimens of the tribe Stenometopiini were examined during the study. The detailed methods adopted during the course of the study are given below.

3.1. Sources of leafhopper material for study

Field collections were made in and around Bangalore, Mudigere, Sirsi, Raichur, Dharwad, Sira and Bapatla. Leafhoppers were collected by sweep netting on herbs, shrubs and trees. Collected leafhoppers were aspirated and transferred to killing tube. The dead specimens were placed in 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 came from the rich collection of leafhoppers by Dr C.A. Viraktamath preserved in the Department of Entomology, University of Agricultural Sciences, Bangalore (UASB) and specimens were also borrowed for the study from IARI, New Delhi (IARI) and Tamil Nadu Agricultural University, Coimbatore. These specimens were collected from different localities in India, Sri Lanka, Nepal and Myanmar. In addition the diagrams and notes made by Dr C.A. Viraktamath on the types in the Natural History Museum, London (BMNH) and the Zoological Survey of India, Kolkatta (ZSI) were also used in resolving the identity of the species.

3.2.1. Processing of the material for study

The field collected specimens of leafhoppers were mounted singly on triangular card points using Fevicol ^{R} such that it permitted 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 leafhopper 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.

3.2.2. Preparation of genitalia

The procedure advocated by Oman (1949) and Knight (1965) for the study of male genitalia 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 heated slowly in a water bath till the convection currents were observed in the solution. The abdomen was transferred to a glass cavity dish containing water and the macerated soft tissues were pressed out with the help of a pair of bent needles mounted on plastic handles. After repeated washings 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 observation, which 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.

For the study of females, only seventh abdominal sternum was used. The female abdomen was detached and cleared as mentioned above for the male. Seventh sternum was separated and placed on a glass slide and drawings were made.

For the study of female genitalia, the procedure advocated by Davis (1975) was followed. The female abdomen was detached and cleared as mentioned above for male. The cleared abdomen was placed in a glass cavity dish filled with glycerin and was oriented on its dorsum. Using a pair of needles the membrane connecting the gonoplac (third vulvulae) and pygofer was severed, so the gonapophyses were free from the pygofer along their length. The articulation between the second gonocoxae (valvifers) and pygofer was broken by gently pressing the point of articulation on each gonocoxae (valvifer) with a needle. After breaking the articulation, the abdomen was held anteriorly with one needle while the other was inserted into the pygopfer through the opening previously made between the gonoplac (valvulae III) and the pygofer, and placed on the second gonocoxae (valvifer II) away from the articulation point and separated the tounge-and-grove system at the anterior extremities of the rami of the first and second gonapophyses (vulvulae I and valvulae II). Then the second gonocoxae (valvifers II) and their attached second gonapophyses (valvulae II) and gonoplac (valvulae III) were moved posteriorly out and away from the first gonapophyses

(valvulae I) and pygofer. After the study the dissected parts were placed in the abdomen of the specimen and preserved as mentioned under male genitalic preparation.

3.3. Photographs and Illustrations

All the species studied were photographed for ease of identification. The genitalic parts were illustrated using a compound microscope (Ortholux II and Leica DM 2000) with built in drawing tube. The parts of male and female genitalia were held in the desired position on a cavity slide by means of a small quantity of bee wax which had been firmly fixed to the bottom of the cavity slide, before placing glycerin to avoid movement while preparing illustrations. However, the illustrations of male plate, valve, connective, style and female seventh sternum were prepared from temporary slide mounts of these parts in glycerin. The illustrations of head, thorax and face were prepared using a stereoscopic microscope (Leica MZl2) with built in drawing tube. The specimens used for illustration were labeled as "Illustrated MSR" which served to identify them.

3.4.1. Descriptions

The generic descriptions were made fairly elaborate. In case of known species, descriptions of additional characters or variations observed, if any, were provided in addition to brief description. In the case of new species, detailed descriptions were given.

3.4.2. Type depositories

The holotype of the new taxa described are deposited in the collections of the University of Agricultural Sciences, GKVK, Bangalore. The paratypes will be deposited in the Natural History Museum, London (BMNH), Indian Agricultural Research Institute, New Delhi (IARI) and Zoological Survey of India, Kolkata (ZSI).

3.4.3. Terminology

Terms used in the description of the morphology are those used by Oman (1949), Young (1952) and Davis (1975) and are explained below. These structures are also illustrated in figs 1 and 2.

Aedeagus: The sclerotized intermittent organ carrying ejaculatory duct in the male.

Apophysis of style: Terminal finger-like process of style.

Atrium: Broad basal opening of the gonoduct on the aedeagus.

Clavus : The triangular anal portion of the forewing.

Clypellus: More or less rectangular sclerite located just before the mouth parts emerging out of the head.

Connective: A sclerite articulating with the proximal part of aedeagus and laterally with style.

Dorsal apodemes: Apodeme formed possibly by the modification of atrial rim of aedeagus and directed distally to which the muscles of the tenth segment are connected.

Face: The entire cephalic aspect of head.

Frontoclypeus: Area of the face dorsad of the clypellus laterally limited by lateral facial sulci.

Genae: Outermost sclerite below the eyes on the face. In some species it is visible dorsally.

Gonopore: Terminal opening of the gonoduct which runs through the aedeagal shaft.

Lorum (mandibular plate): Present on either side of the clypellus usually delimited on the outside by an arc shaped sulcus.

Ocelli: Simple eyes on disc of vertex near anterior margin of the vertex or marginal rim of the vertex.

Preapical lobe: Any lobe like prolongation before the tip of the organ concerned, here used for style.

Pronotum: Dorsal sclerite of the prothorax which is usually large and shield like.

Pygophore: Combined tergum and the pleura of the ninth abdominal segment which houses the genital organs in both sexes.

Shaft: Part of the aedeagus that carries the gonopore and through which the terminal part of the ejaculatory duct traverses.

Style: A pair of sclerites with apophysis and preapical lobe articulating laterally with connective.

Subgenital plate: Pair of lobe like appendages that extend caudad beneath the pygophore and form the floor of the pygophore cavity.

3.4.4. Measurements

Five males and females of each species were used for the measurements. Where the number of specimens collected was less than five, the available numbers of specimens were used. For the measurement of different parts of genitalia, one male and one female

one female for each species were used. 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 (Jenco, U.S.A). Measurements of the genitalia parts were made with the help of a standardized ocular micrometer placed in one of the eyepieces of Ortholux II compound microscope. All measurements are expressed in millimeters. The alphabets used in parenthesis indicate the way the parts are measured as indicated in figs 1, 2 and 3.

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

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

Length of clavus (C): Length along the claval suture.

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

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

Length of scutellum (F): Distance between posterior margin of pronotum and caudal tip of scutellum along the middorsal line.

Length of clypeus (G): Distance between the anterior margin of frons and the posterior margin of the clypellus along the mid ventral line.

Length of clypellus (H): Distance between trans-clypeal suture and tip of clypellus.
mesothorax) and its apical tip.

Width of vertex (I): Distance between the inner margins of eyes where the width is minimum.

Width of pronotum (J): Distance measured across the posterior angles where the pronotum is the broadest.

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

Width of clypeus (L): Distance between the lateral carinae of frons at its maximum width.

Width of clypellus (M): Distance between the lateral margins of clypellus where the width is maximum.

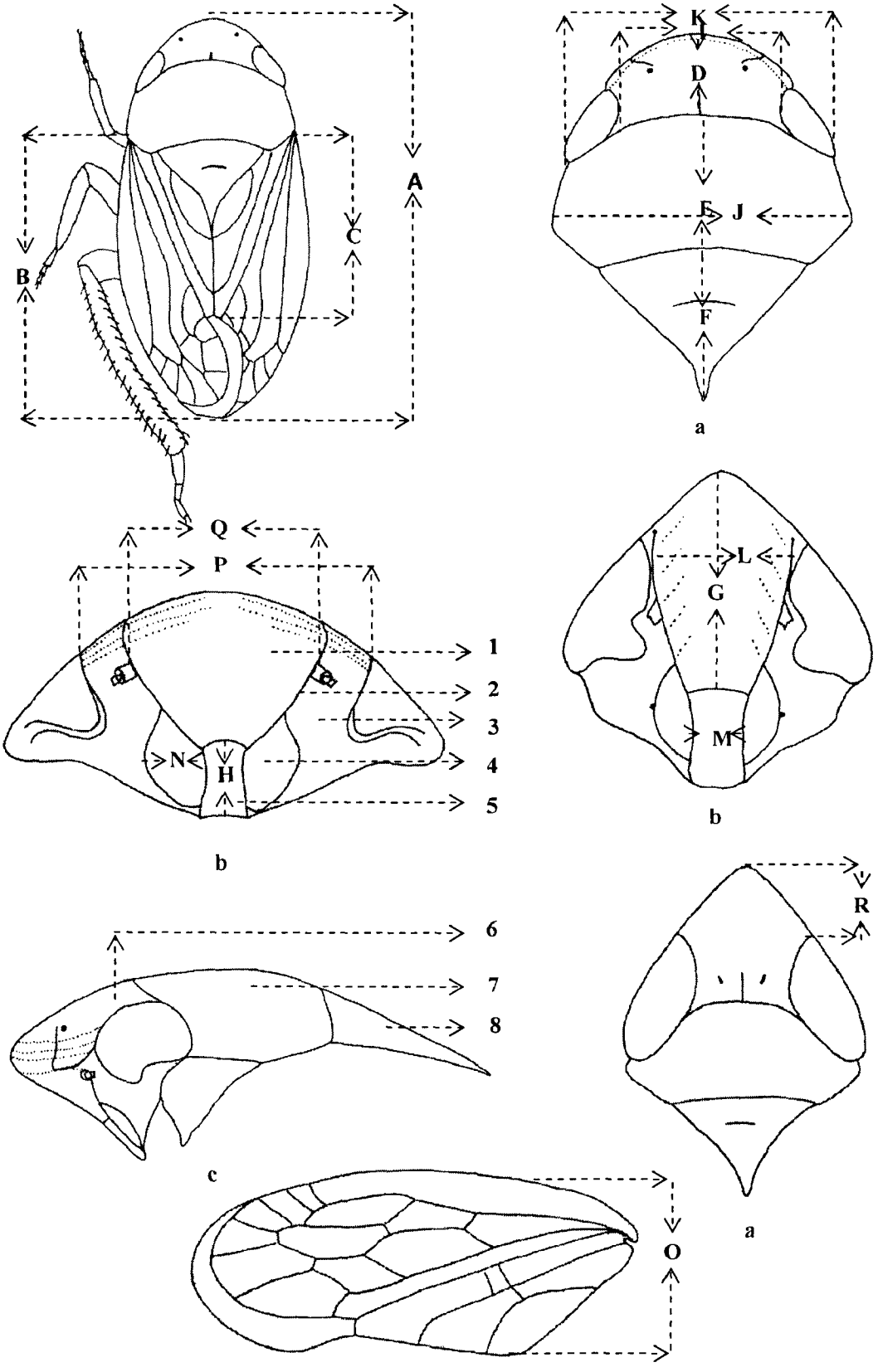


Fig. 1

Width of forewing (O): Distance measured in middle of forewing where it is maximum. **Distance between eyes (P):** Distance between the inner margins of eyes ventrally where the width is maximum.

Distance between antennal pits (Q): Distance between the inner margins of antennal pits.

Eye to anterior margin of vertex (R): Distance from anterior margin of eye to the tip of vertex.

3.4.4. Genitalia characters

Length of valve (S): Distance between anterior and posterior margin of valve where the length is maximum.

Length of subgenital plate (T): Distance between the anterior margin to caudal margin where the length is maximum.

Length of pygophore (U): Distance between the anterior margin to caudal margin where length is maximum.

Length of anal tube (V): Measurement of all three segments of the anal tube separately.

Length of connective (W): Distance between anterior margin and posterior margin

Length of style (X): Distance between anterior margin of style and tip of apophysis.

Length of apophysis (Y): Distance between bases of preapical lobe to tip of apophysis.

Length of aedeagus shaft (Z): Distance between the U-shaped curvature of the aedeagus to tip of the aedeagus.

Width of valve (A1): Distance between lateral margins of valve where the width is maximum.

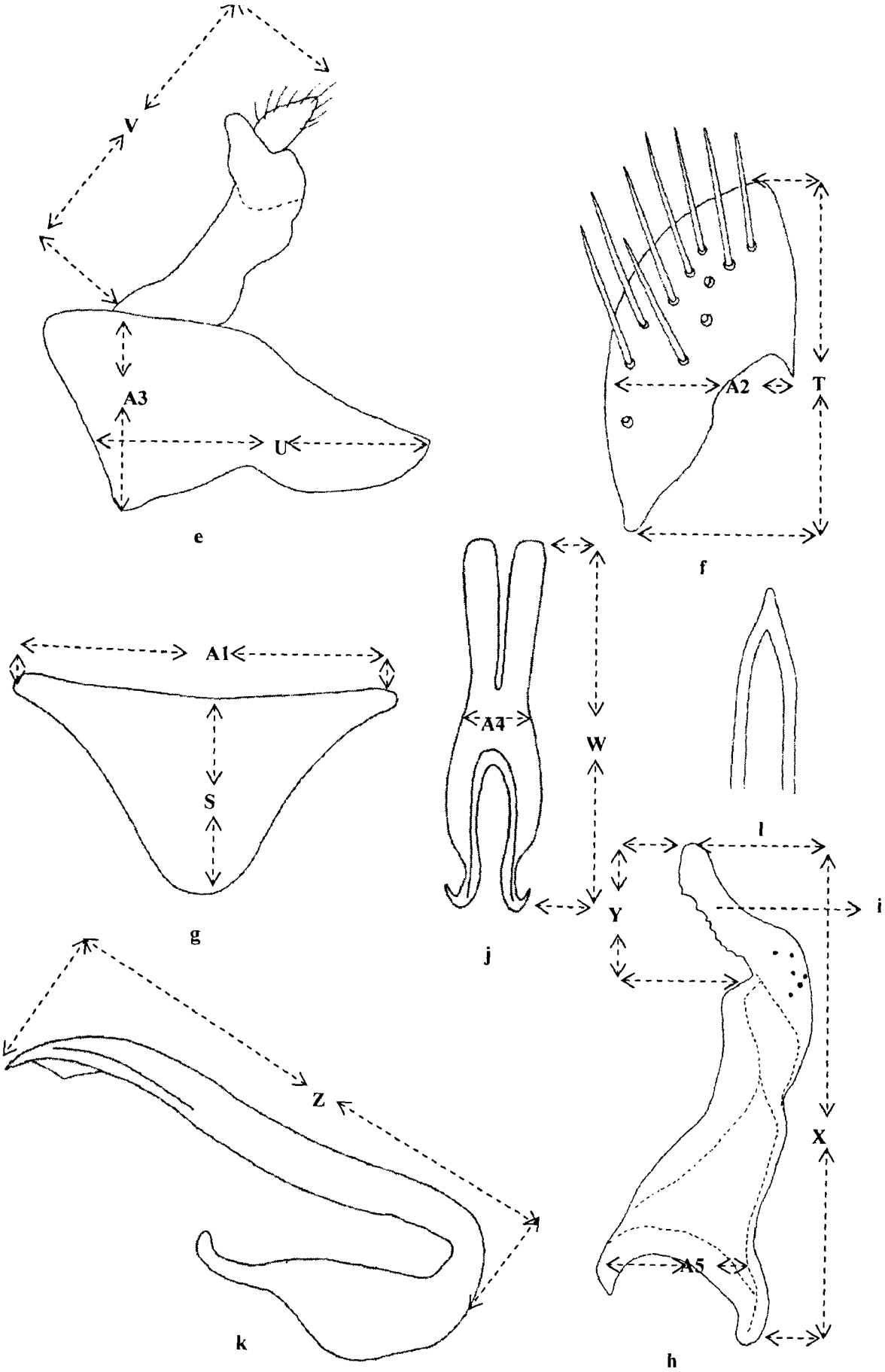
Width of subgenital plate (A2): Distance between lateral margins of the plate where the width is maximum.

Width of pygophore (A3): Distance between dorsal margin to ventral margin where the width is maximum.

Width of connective (A4): Distance between the lateral margins of the connective.

Width of style (A5): Width at anterior margin and width just before apophysis was measured.

Length of seventh sternum (A6): Distance between anterior margin and posterior margin of valve where the length is maximum.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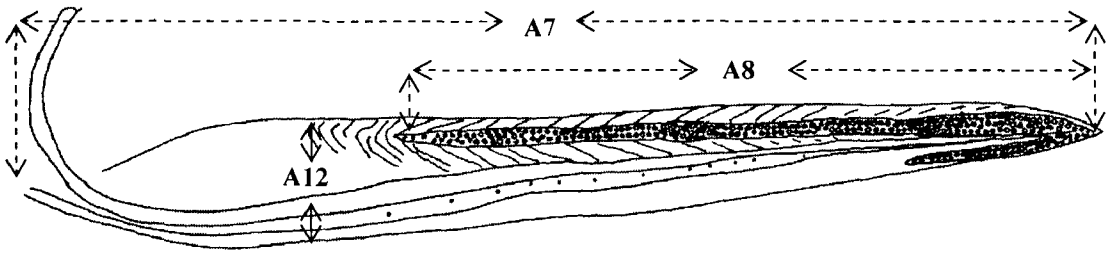

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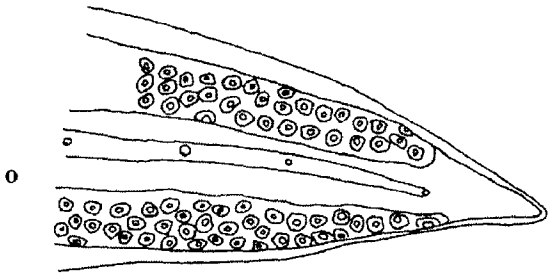

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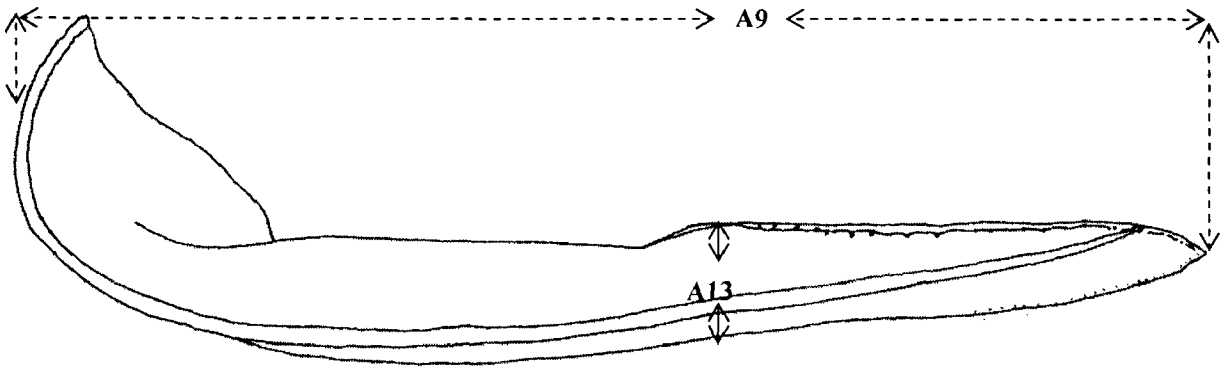

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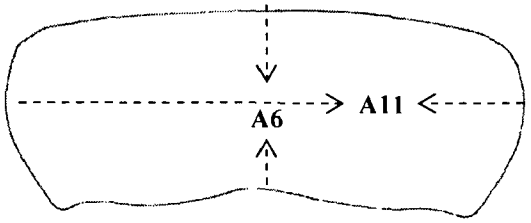

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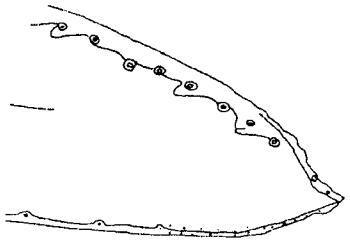

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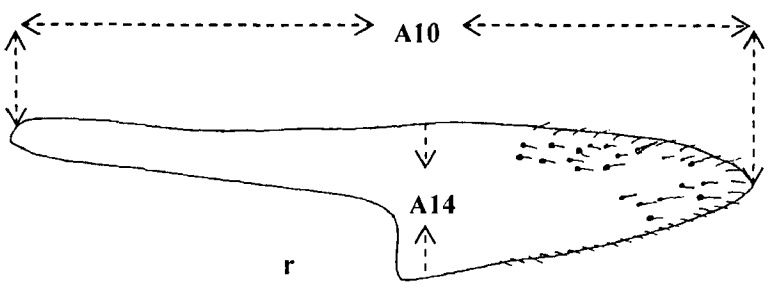

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Fig. 3

Length of first pair of gonapophysis (A7): Distance between the anterior margin to posterior margin of gonapophysis.

Length of dorsal sculpturing of first pair of gonapophysis (A8): Entire distance of the dorsal sculpturing.

Length of second pair of gonapophysis (A9): Distance between the anterior margin to posterior margin of gonapophysis.

Length of gonoplac (A10): Distance between the anterior and posterior tip of the gonoplac.

Width of seventh sternum (A11): Distance between lateral margins of seventh sternum where the width is maximum.

Width of first pair of gonapophysis (A12): Distance between lateral margins of gonapophysis where the width is maximum.

Width of second pair of gonapophysis (A13): Distance between lateral margins of gonapophysis where the width is maximum.

Width of gonoplac (14): Distance between lateral margins of gonoplac where the width is maximum.

3.5. Studying relationship of the subfamily Penthimiinae and tribe Stenometopiini with Deltocephalinae

In this analysis, representative taxa from 15 tribes of Deltocephalinae and the subfamily Penthimiinae as defined by Oman *et al.* (1990) were sampled (Table.1). The tribes Occinirvanini and Platymetopiini were not included as the specimens were not available.

The 96 characters examined during the study are listed below. All the taxa were examined and scored as 0, 1, 2, 3 and 4 (Table 19, 20, 21 and 22). Sixty eight characters with two character states, seventeen characters with three character states, six characters with four character states, four characters with five character states and one character with six character states were included. The clustering was done and dendrograms were drawn by following Unweighted Pair-group Centroid, using the software STATISTICA.

Table 1. List of species of Penthimiinae and Deltocephalinae utilized to study the relationships

SL. NO.	Subfamily/ Tribe	Genus/ Species
	I. Deltocephalinae	
1.	Athysanini	*Acacimenus variabilis* Viraktamath
2.	Balcluthiini	*Balclutha rubrostriata* (Melichar)
3.	Chiasmusini	*Chiasmus uzeli* Melichar
4.	Deltocephalini	*Deltocephalus (R.) trispinosus* Dash & Viraktamath
5.	Doraturini	*Aconurella erebus* (Distant)
6.	Fieberiellini	*Phlogotettix indicus* Rao
7.	Goniagnathini	*Goniagnathus fumosus* Distant
8.	Grypotini	*Pinopona minuta* Viraktamath & Sohi
9.	Hecalini	*Hecalus porrectus* (Walker)
10.	Macrostelini	*Cicadulina bipunctata* (Melichar)
11.	Opsiini	*Hishimonus phycitis* (Distant)
12.	Paralimnini	*Psammotettix* sp.
13.	Scaphoideini	*Scaphoideus morosus* Melichar
14.	Scaphytopiini	*Varta rubrofasciata* Distant
15.	**Stenometopiini**	*S. capitatus*
16.		*S. indra*
17.		*S. jacosa*
18.		*S. laetus*
19.		*S. notatus*
20.		*S. ribeiroi*
21.		*S. rotundus*
22.		*S. rubrolineatus*
23.		*S. speciosum*
24.		*S. solitaris*
25.		*S. tolla*
26.		*Stirellus* sp. 1
27.		*Stirellus* sp. 2
28.		*Stirellus* sp. 3
29.		*Stirellus* sp. 4
30.		*Stirellus* sp. 5
31.		*Stirellus* sp. 6
32.		*Stirellus* sp. 7
33.		*Stirellus* sp. 8
34.		*Stirellus* sp. 9
35.		*C. illustrata*
36.		*C. longivertex*
37.	**II. Penthimiinae**	*Haranga orientalis*
38.		*Neodartus acocephaloides*
39.		*Penthimia compacta*
40.		*Tambila gravelyi*
41.		*Uzelina thaloriensis*
42.		*Vulturnus spatulatus*

3.5.1. List of characters

I. Head

1. Clypellar suture: (0) straight (Fig. 4e, 4b); (1) arcuate (Fig. 4a, 4d).
2. Clypellus shape: (0) tapered or parallel sided (Fig. 4b, 37b); (1) expanded apically (Fig. 4a, 4d).
3. Clypellus apex: (0) not or only slightly produced beyond gena (Fig. 4a, 4c, 4d); (1) greatly produced beyond gena (Fig. 4b); (2) not attaining normal curve of gena (Fig. 4e).
4. Clypellus: (0) not inflated; (1) inflated.
5. Apical margin of clypellus: (0) sinuate/notched; (1) straight or convex.
6. Lorum width: (0) distinctly narrower than clypellus at base; (1) subequal to or wider than clypellus at base.
7. Single fine erect seta on gena near lateral frontal suture: (0) present (close to lateral frontal suture) (Fig. 4d); (1) present (away from lateral frontal suture) (Fig. 4c); (2) absent.
8. Frontoclypeus texture: (0) shagreen; (1) rugose; (2) punctate; (3) striate; (4) glabrous.
9. Longitudinal carina on frontoclypeus: (0) absent; (1) present (Fig. 40b, Plate 14).
10. Frontoclypeus: (0) not inflated posteroventrally; (1) inflated posteroventrally
11. Anterior region of head: (0) not inflated; (1) inflated (Fig. 9c, 15c).
12. Frontoclypeus length: (0) longer than wide; (1) shorter than or subequal to width.
13. Lateral frontal suture extent: (0) reaching ocellus (Fig. 31c); (1) absent or reaching only part way to ocellus (Fig. 15c).
14. Lateral frontal suture (from apex of suture to antennal pit): (0) distinctly shorter than clypeogenal suture (from antennal pit to clypellar suture); (1) subequal to or longer than clypeogenal suture.
15. Lateral frontal sutures: (0) directed mesad of ocelli (Fig. 31c); (1) directed toward middle of ocelli (Fig. 46c); (2) directed laterad of ocelli; (3) strongly divergent (about 90° angle).
16. Ratio of length of frontclypeal-loral suture to clypellar-loral suture: (0) one third or less; (1) more than one third; (2) more than 1.

This is illustrated in Fig. 4a, the ratioof the lengths a:b.

17. Incision of gena: (0) not incised (Fig. 4b, 4e); (1) slightly incised (Fig.4a, 4c, 4d); (2) strongly incised.
18. Position of antennal pits: (0) near middle or posteroventral (lower) corner of eye (Fig. 4a, 4c, 4d); (1) near anterodorsal (upper) (Fig. 4b) corner of eye.
19. Antenna length: (0) short; (1) long; (2) very long.
20. Antennal ledge: (0) absent; (1) weakly developed (carinate or weakly carinate); (2) strongly developed (Fig. 4c).
21. Mesal margin of eye: (0) entire (Fig. 4a, 4b, 4c); (1) notched (Fig. 54b).
22. Anterior margin of head: (0) shagreen; (1) striate or irregularly textured; (2) with numerous carinae; (3) with 2 or 3 parallel carinae; (4) with a single transverse carina.
23. Crown: (0) parallel margined or somewhat produced; (1) strongly produced or elongate.
24. Crown: (0) convex; (1) flat or concave.
25. Crown texture: (0) shagreen; (1) punctate; (2) irregularly rugose; (3) radially or longitudinally striate.
26. Gena visible dorsally: (0) visble; (1) not visible.
27. Length of vertex: (0) Less than twice the width of vertex; (1) 2-3 times the width of vertex; (2) more than thrice the width of vertex.
28. Head width including eyes: (0) as wide as or wider than pronotum (Fig. 57a); (1) narrower than pronotum (Fig. 9a, 12a).
29. Position of ocelli: (0) on crown, just posteriad of anterior margin of head; (1) laterally on anterior margin; (2) posteroventrad of crown margin (3) on crown.
30. Proximity of ocelli to eyes: (0) close (1) distant
31. Crown width: (0) < or 2 times width of eye; (1) > 2 times width of eye

II. Thorax

32. Pronotum lateral carina: (0) absent; (1) present.
33. Pronotum texture: (0) without transverse striations; (1) with transverse striations.

III. Fore wings

34. Forewing veins: (0) not carinate; (1) carinate.

35. Appendix: (0) absent or reduced; (1) restricted to anal margin (Fig. 4f); (2) extending around wing apex (Fig. 9d).
36. R1: (0) basad of Rs; (1) distad of Rs; (2) absent
37. Crossvein m-cu2: (0) absent; (1) present.
38. A1 crossvein (between A1 and claval suture): (0) absent; (1) present (Fig. 9d).
39. A veins: (0) gently curved distally; (1) strongly curved distally, at right angles with commissural margin.
40. R1: (0) not confluent with costa (with 3 anteapical cells); (1) confluent with costa (with two anteapical cells) (Fig. 4f); (2) absent.
41. A1-A2 crossvein: (0) absent; (1) present (Fig. 9d).
42. Forewing reflexed costal veinlets: (0) absent; (1) present (Fig. 4g).

IV. Legs and chaetotaxy

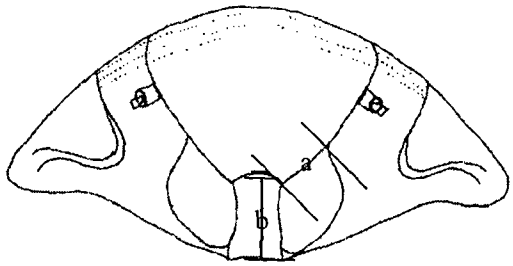
43. Protrochanter stout ventroapical seta: (0) absent; (1) present (Fig. 5c, 5d).
44. Profemur row AM: (0) with only AM1 present (Fig. 5c); (1) with 1 or more additional proximal setae (Fig. 5e); (2) absent.
45. Profemur intercallary row: (0) not in rows or scattered; (1) with more than 5 fine setae in one row (Fig. 5c, 5e); (2) greatly reduced or absent.
46. Profemur dorsoapical setae: (0) with 2 apical setae; (1) with 1 seta or absent.
47. Profemur row AV: (0) absent or highly reduced; (1) with numerous (more than 4) stout setae (Fig. 5d, 5e); (2) with a few widely spaced macrosetae.
48. Profemur row PV basal and/or median setae: (0) absent; (1) present; (2) with one median macroseta.
49. Profemur row PV apical macroseta: (0) absent or highly reduced; (1) present.
50. Protibia dorsal margins: (0) rounded; (1) bicarinate; (2) at right angles (but not carinate).
51. Protibia row AD: (0) without macrosetae; (1) 1 macroseta; (2) 2 or more macrosetae.
52. Protibia row PV macrosetae: (0) numerous; (1) 1 to 4; (2) absent.
53. Mesotrochanter stout apical PV seta: (0) absent; (1) present.
54. Mesotrochanter stout apical AV seta: (0) absent; (1) present.
55. Mesotrochanter extra setae: (0) absent; (1) with numerous extra thick or fine setae.
56. Mesofemur row AV setal length: (0) short; (1) long.

57. Mesofemur row AV basal/median setae: (0) absent or highly reduced; (1) with numerous thick setae.
58. Mesofemur row AV apical seta: (0) absent or highly reduced; (1) present.
59. Metatibia cross section: (dorsal surface compared to anterior surface): (0) square; (1) rectangular.
60. Metatibia row PD: (0) with long and short macrosetae alternating or subequal in length; (1) some macrosetae (especially distally) interspersed with 3–4 much smaller setae.
61. Metatibia row AD: (0) with macrosetae only; (1) with macrosetae and smaller intercallary setae.
62. Metatibia row AV, number of macrosetae: (0) 6 or fewer; (1) 8 or more.
63. Metatibia row AV macrosetae: (0) extending nearly to base; (1) restricted to apical two thirds.
64. Metatibia row AV: (0) with macrosetae only; (1) with macrosetae and smaller intercallary setae.
65. Metatibia shape: (0) arched throughout its length; (1) straight through most of its length and distinctly bent distally, in dorsal view.
66. Platellae at apex of metatibia: (0) absent; (1) present.
67. Metatarsomere I length: (0) shorter than tarsomeres II and III combined; (1) equal to or longer than tarsomeres II and III combined.
68. Metatarsomere I dorsoapical pair of setae: (0) absent or reduced; (1) present.
69. Metatarsomere I plantar setae: (0) all simple; (1) one or more platellate.
70. Metatarsomere I apex: (0) straight; (1) widening apically.
71. Metatarsomere I PV apical seta: (0) platellate; (1) normal.
72. Metatarsomere I apical platella: (0) 3 or fewer; (1) 4 or more.
73. Metacoxa macrosetae: (0) with several macrosetae along midline; (1) absent or reduced along midline.
74. Hind femoral spinulation: (0) 2+0+0; (1) 2+1+0 (Fig. 4i); (2) 2+1+1; (3) 2+2+1 (Fig. 4h) (4) 2+2+1+1.

V. Male genitalia

75. Valve (sternum IX): (0) free; (1) fused to pygofer; (2) subsumed under plates; (3) partially fused to pygofer.
76. Valve shape: (0) not triangular; (1) triangular, produced posteromedially.

77. Articulation of valve with pygofer: (0) an articulation point; (1) longer area of articulation.
78. Pygofer basolateral membranous cleft: (0) absent (Fig. 6b); (1) present (Fig. 6a).
79. Pygofer dorsal process (0) absent; (1) present (Fig. 39e).
80. Pygofer ventral process (0) absent; (1) present (Fig. 6a).
81. Pygofer macrosetae: (0) absent or reduced (< or=2 rows); (1) well differentiated into several rows of macrosetae.
82. Plate shape: (0) subrectangular; (1) triangular (2) expanded medially and tapered apically; (3) plates fused; (4) rounded, with a lateral lobe; (5) elongate, lobate, rising laterally.
83. Plate (0) fused; (1) not fused (Fig. 6c).
84. Plate macrosetae: (0) absent; (1) scattered, irregularly arranged; (2) uniseriate laterally; (3) two or three lateral rows near margin; (4) uniseriate medially; (5) with one or two rows near median margin.
85. Dorsolateral fold on subgenital plate, articulating with style: (0) absent; (1) present.
86. Style: (0) linear (median anterior lobe not well developed) (Fig. 10h, 11h); (1) broadly bilobed (39h, 40h) (median anterior lobe well developed).
87. Style preapical lobe: (0) absent or undeveloped; (1) present.
88. Style apophysis: (0) not elongate; (1) elongate.
89. Paraphyses of the connective or aedeagus: (0) absent; (1) present.
90. Aedeagal shaft basal hinge: (0) absent; (1) present (Fig. 6f).
91. Number of gonopores: (0) one; (1) two (Fig. 6e).
92. Position of gonopore: (0) ventral; (1) apical; (2) dorsal; (3) dorsolateral.
93. Lateral anterior arms of connective: (0) widely divergent (Fig. 6d); (1) somewhat divergent (Y-shaped or U-shaped) (Fig.11j, 14j); (2) closely appressed anteriorly; (3) linear (Fig. 6h).
94. Connective anteromedial or ventral process: (0) absent; (1) present.
95. Connective: (0) articulated with aedeagus; (1) fused to aedeagus (Fig. 6h).
96. Male 10th segment: (0) elongate 2 to 3 times as long as wide at apex, and sclerotised dorsally (Fig. 6a); (1) short, not sclerotised dorsally; (2) very broad and sclerotised dorsally.



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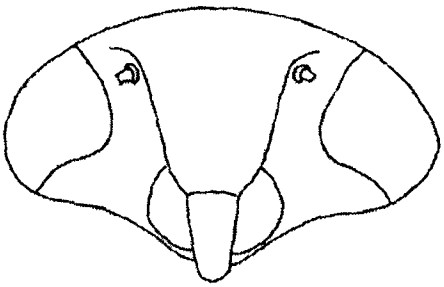

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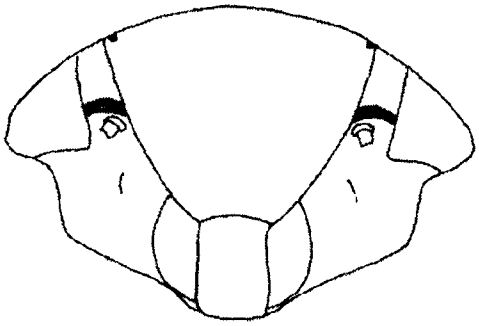

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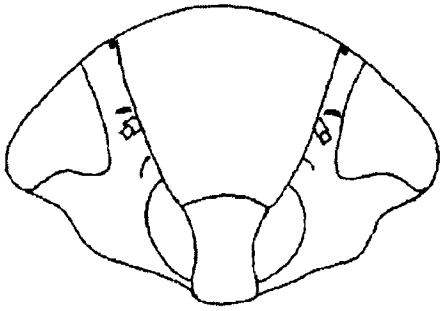

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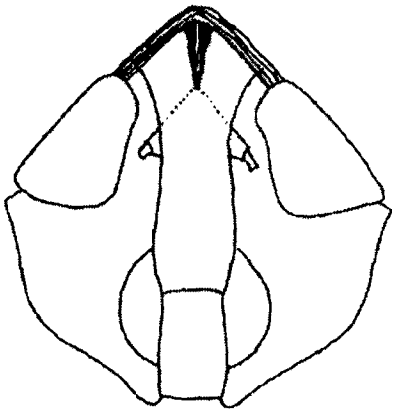

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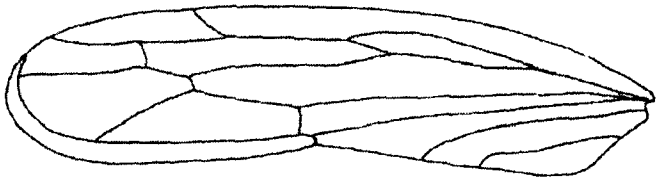

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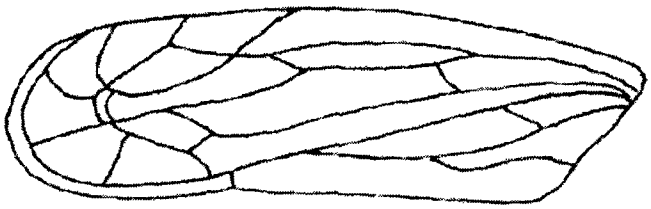

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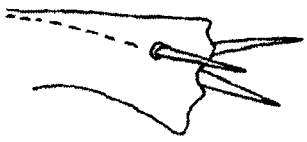


i

Fig. 4

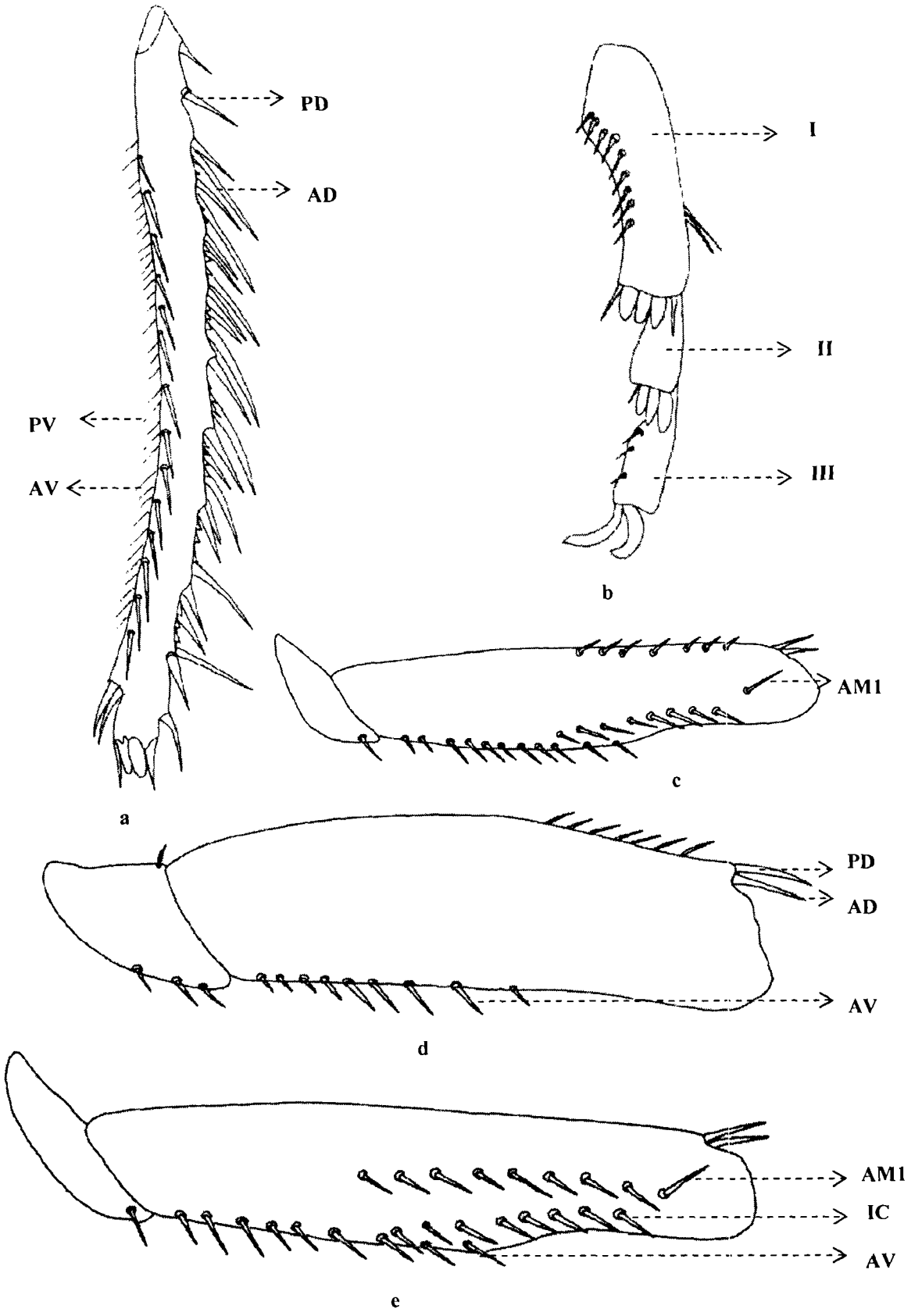


Fig. 5. Leg chaetotaxy of the leafhoppers

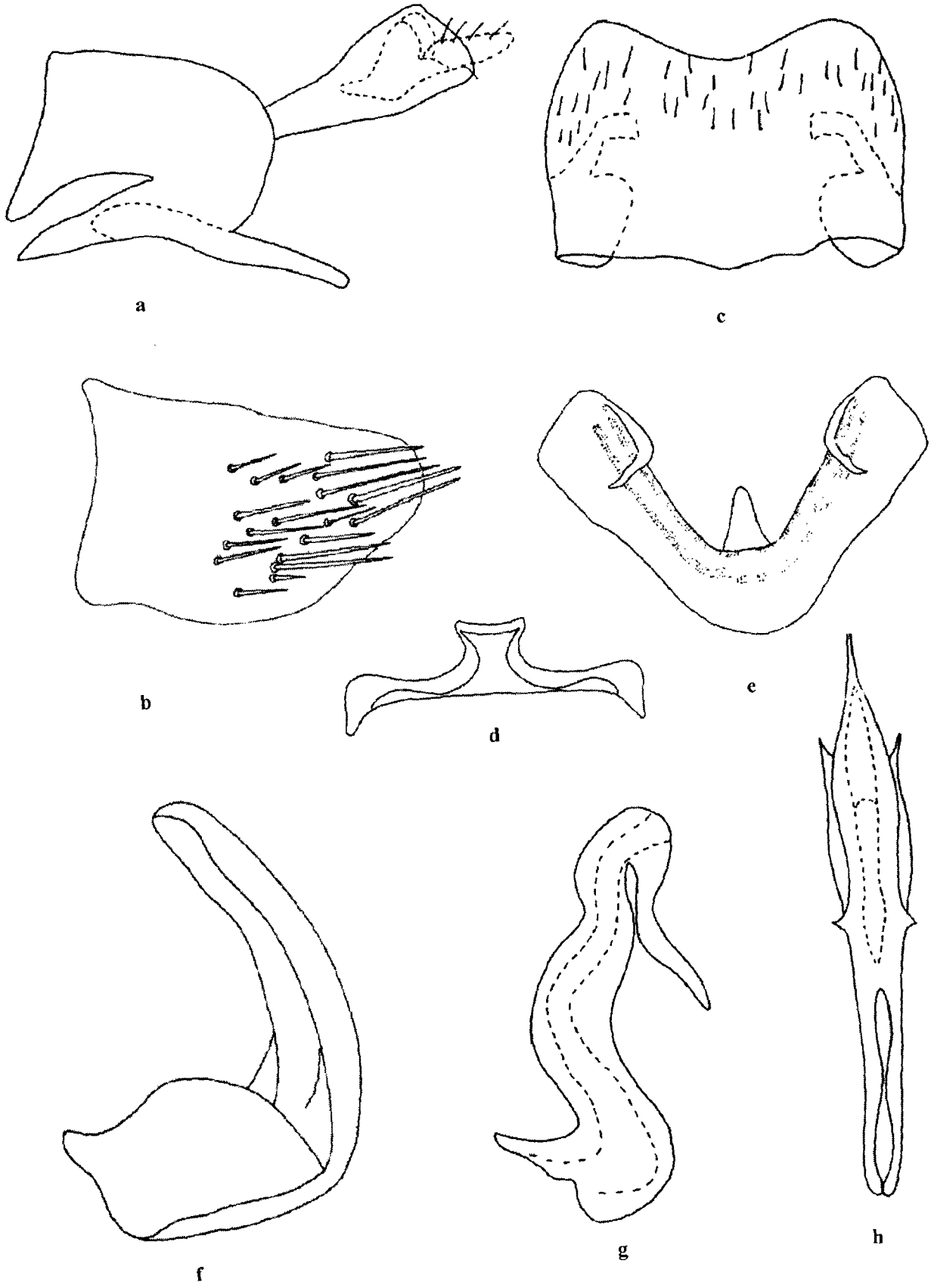


Fig. 6. Male genital structures of leafhoppers

RESULTS

IV. RESULTS

In the present study 1672 specimens (Penthimiinae 511, Stenometopiini 1161) collected from different countries of the Indian subcontinent were examined. The study revealed the presence of 39 species (including six new species, six new combinations and five new synonyms) belonging to seven genera in the subfamily Penthimiinae. In the tribe Stenometopiini, 22 species belonging to three subgenera of the genus *Stirellus* were studied. The results of the study are presented here.

4.1. Subfamily Penthimiinae

These are medium sized, rather ovoid leafhoppers with black or brown colour, rarely red or yellow, and often with reticulate pale patterns on the forewings. Head is produced with transverse carinae on the anterior margin. The ocelli are either on anterior margin (*Neodartus* Melichar) or on crown near anterior margin of head. Lateral frontal sutures either extend upto ocelli or donot. Face is usually concave in profile. Forewing venation is complete with large appendix that goes round the apex; claval cross veins are present. The male valve and subgenital plates are triangular.

The seven genera that occur on the subcontinent can be recognized by the following key.

Key to genera of Penthimiinae of the Indian subcontinent

1. Scutellum broader than long, apex not spine-like (Fig. 12a, 15a) 2
- Scutellum longer than broad, apex acute spine-like (Fig. 9a, 9c & Plate1).....***Haranga*** **Distant**

2. Ocelli on disc of vertex near anterior margin (Fig. 9a, 9c, 15a, 15c) 3
- Ocelli on anterior margin of vertex (Fig.12c, Plate 2)..... ***Neodartus*** **Melichar**

3. Head spatulate (Fig. 31c, 35c, 37c & Plate 10, 11, 12).....4
- Head not spatulate but rounded to face (Fig.15c & Plate 3)...***Penthimia*** **Germar**

4. Vertex longer than pronotum .....***Malichus*** **Distant**

- Vertex shorter than pronotum 5

5. Lateral frontal suture not reaching ocellus (Fig.35a, 35c & Plate 11).....***Uzelina* Melichar**
- Lateral frontal suture reaching ocellus (Fig.31a, 31c).....6

6. Robust species measuring more than 5 mm long; body not parallel sided (Plate 10).....***Tambila* Distant**
- Slender delicate species measuring 3-4 mm long, body parallel sided (Plate 12)..... ***Vulturnus* Kirkaldy**

4.1.1. Genus *Haranga* Distant

Black with grey waxy coating. Body elongate oval, head in profile angular with transverse striae, antero-lateral margins of vertex angulate before eyes, point where face and vertex meets slightly angular. Clypeus slightly raised, broadening upward. Clypellus slightly convex with obscure transverse striae, narrowed at base. Lorum rather tumid. Pronotum anteriorly declivous, finely punctate. Scutellum very long, some times reaching apex of clavus, broad at base, somewhat suddenly narrowed from about middle to apex. Forewing black with posterior half brown with apical cells hyaline, globose, strongly wrinkled on basal half, apical half smooth; claval veins joined by a cross vein, with seven apical, three ante-apical cells, covering entire abdomen, hind wing with four apical cells. Hind femoral spinulation 2+2+1+1, hind tibia with one macrosetae between 2-5 much smaller setae on postero-dorsal region, with 2-3 small setae between macrosetae on antero-dorsal region, meta basitarsus with four platellae.

Male subgenital plate without stout setae but with a few hair-like setae in distal half. Style slender, elongate, preapical lobe poorly developed in *H. scutellaris* and well developed in *H. orientalis*, apical apophysis variable, with corrugated surface. Aedeagus with well developed dorsal apodeme and preatrium, shaft curved caudo-dorsally, with serrated lateral margin, gonopore apical with U-shaped excavation. Female seventh sternum variable, form of first valvula dorsal sculpturing concatenate, position of dorsal sculpturing marginal; dorsal tooth on shaft of second valvula large, prominent, extended more than apical half..

Remarks: This genus has the scutellum very long, some times reaching apex of the clavus, broad at base and somewhat suddenly narrowed from about middle to apex. The shape of the hind margin of the female seventh sternum help in separating the three species reported from Indian subcontinent.

Key to species of *Haranga* Distant of the Indian subcontinent

1. Head black with grey waxy coating.....2
- Head metallic blue, shining.....***H. scutellaris* Distant**

2. Hind margin of female seventh sternite with a median U-shaped notch with pointed lateral edges (Fig. 7m1).....***H. decurtata* Distant**
- Hind margin of female seventh sternite medially excavated, with a tooth on lateral margin (Fig. 7m 2)..... ***H. orientalis* Walker**

***Haranga decurtata* Distant**

(Plate1a & Fig. 7 m1)

External structure as described by Distant (1908) with following additions. Black with grey waxy coating. Body elongate oval. Head in profile angular with transverse striae, prominent transverse carina in front of ocelli, antero-lateral margin of vertex angulate before eyes. Clypellus slightly convex with obscure transverse striae, narrowed at base. Labium slightly exceeding fore coxae. Pronotum anteriorly declivous, finely punctate. Scutellum with transverse striations on anterior half, posterior half with parabolic impression on either side, with 10-12 stout setae. Body beneath brownish, legs with stout dark brown spinules.

Female terminalia: Female seventh sternite two times wider than median length, hind margin with a median shallow U-shaped notch with pointed lateral angles.

Measurements: Female 6.6 mm long, head 2.0 mm wide across eyes, 2.9 mm wide across pronotum (Table 2)

Material examined: INDIA: 1♀ 'Type' (red disc) '*Haranga decurtata* Distant type' 'Nilgiris, Hampson' 'Distant coll. 1911-383' (BMNH). *Other material examined*: INDIA: Karnataka: 1♀, Jog falls, 8.v.1976, B. Mallik (UASB).

Remarks: This species differs from *H. orientalis* with respect to detailed structure of the head, scutellum and hind margin of the female seventh sternum. Only females of this species are known.

***Haranga orientalis* Walker**

(Plate1b & Fig. 7 m2, 8, 9)

Colouration and external structure as described by Distant (1918) with the following modifications. Head in profile rounded with dorsal transverse carinae with two transverse carinae in front of ocelli. Vertex shiny, with transverse wrinkles on disc, longitudinal wrinkles on lateral sides. Clypellus with median ridge and narrowing at base. Labium extending beyond fore coxae. Pronotum long, convex with obscure striae, sparsely punctate. Scutellum longer than broad almost reaching the apex of the clavus with median transverse impression, anterior half with indistinct tansverse rugae, posterior half raised convex with median carina, apex paler. Spines on legs reddish-brown, hind femoral spines brown. Female seventh sternum with pale areas.

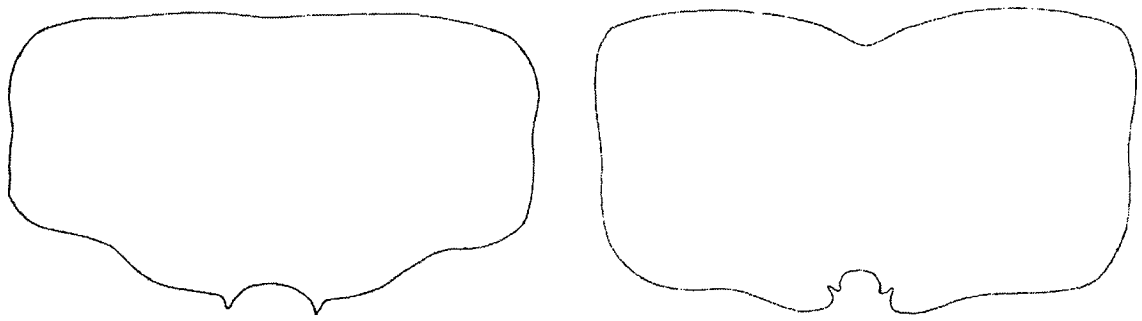
Male genitalia: Style slender elongate preapical lobe well developed, apical apophysis long, finger-like, curved laterally with corrugated surface. Aedeagus tubular with well developed dorsal apodeme, preatrium, shaft cylindrical, curved caudo-dorsally with serrated lateral margin, with two to three rows of spicules on ventral margin at posterior half, gonopore apical with U-shaped excavation.

Female terminalia: Seventh sternite two times broader than long, hind margin with median excavation, lateral margins of excavation with triangular projection.

Measurements: Male 8 mm long, head 2.44 mm wide across eyes, 3.60 mm wide across pronotum. Female 8.12 mm long, head 2.46 mm wide across eyes, 3.58 mm wide across pronotum (Table 2).

Material examined: INDIA: 1♀ 'Type (green disc)' '*H. orientalis*, 3612'. 1♂, Sikkim, Tsuntang, 7000 ft, 23.iv.1924, Maj. R.W.G. Hingston (BMNH). *Other material examined:* INDIA: West Bengal, 2♀, Algarha nr. Kalimpong, 1788m, 7.vi.2005, C. A. Viraktamath (UASB).

Remarks: This species has a distinct hind margin of the female seventh sternum compared to other two species.



m 1 m 2

Fig. 7. m 1. *H. decurtata* Distant and m 2. *H. orientalis* Walker

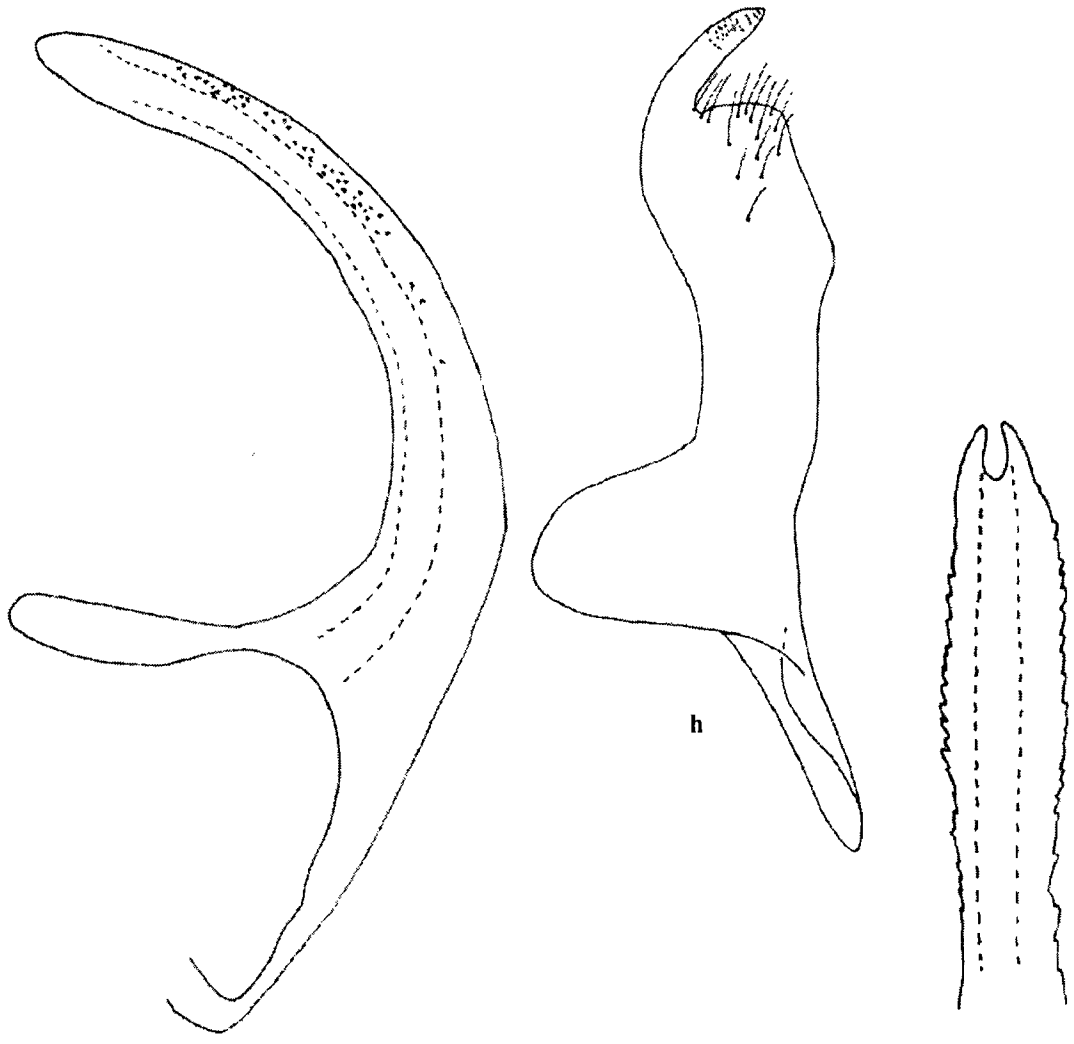


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Fig. 8. *H. orientalis* Walker

Refer legends of Fig. 2 - Fig. 3 of Chapter III for details of alphabets used

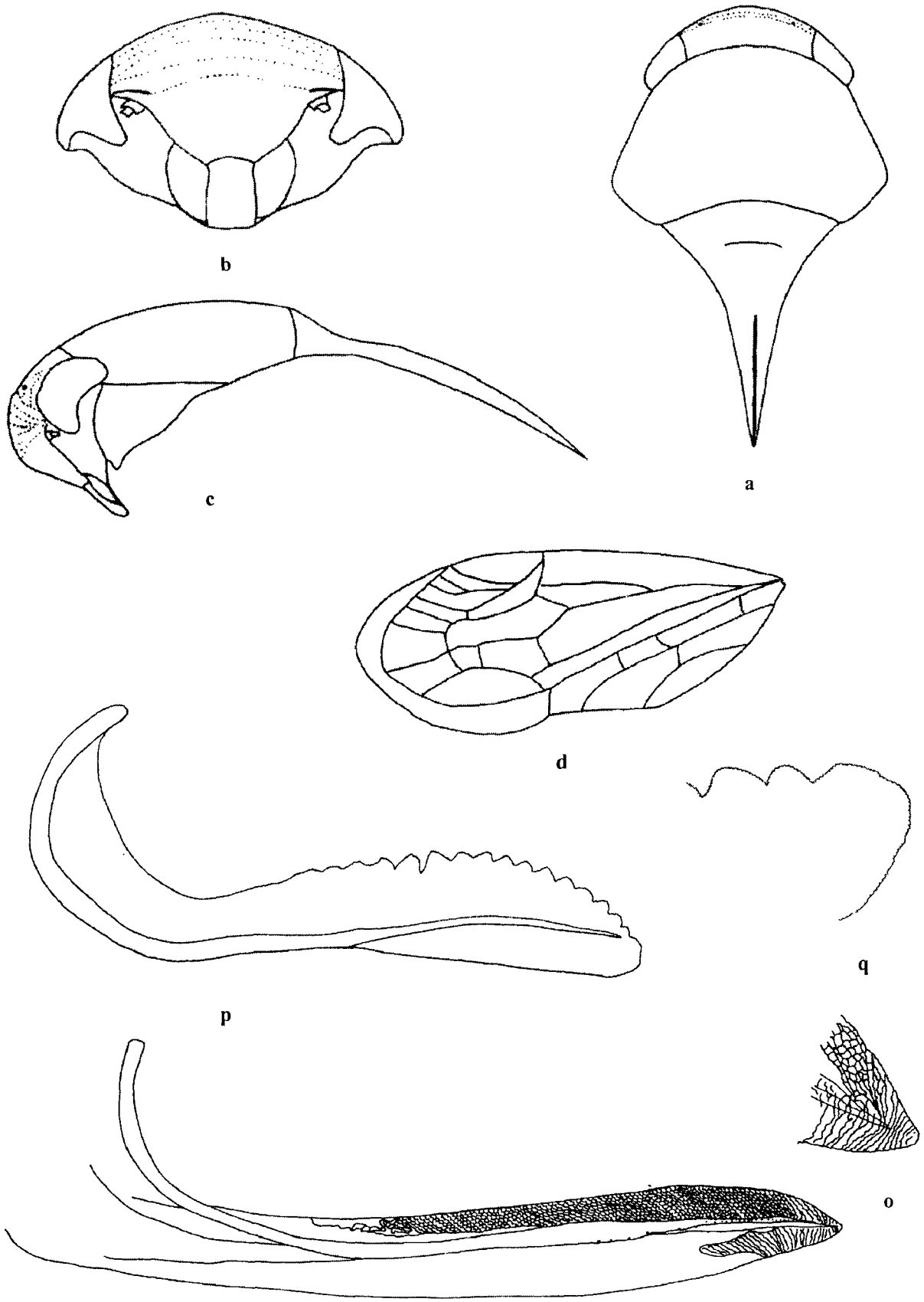
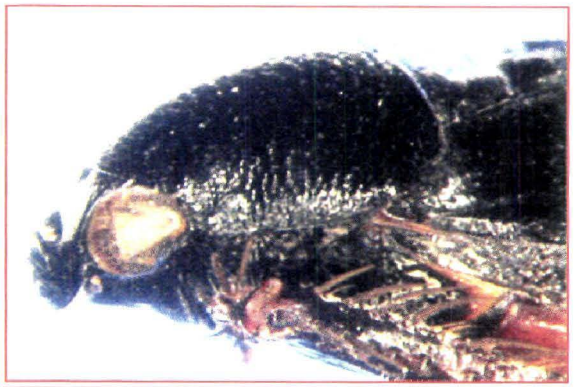
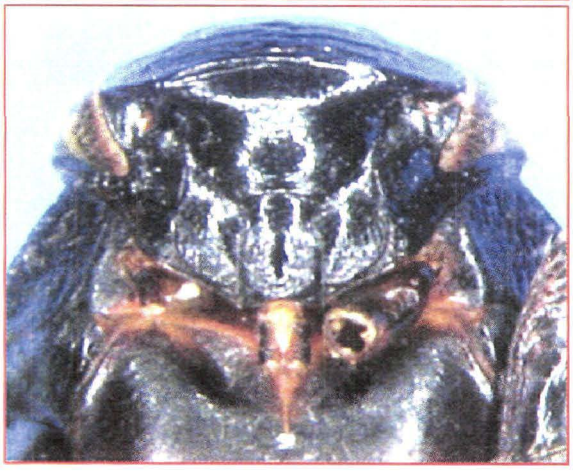


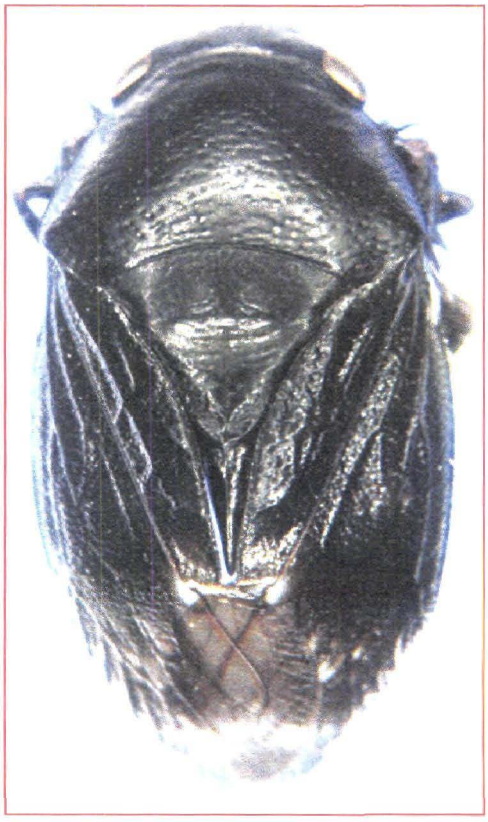
Fig. 9. *Haranga orientalis* Walker

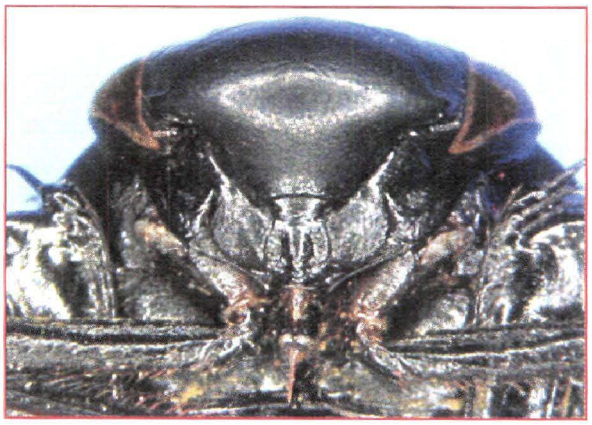
Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used





a. *Haranga decurtata* Distant





b. *Haranga orientalis* Walker

Plate 1

Table 2. Measurements (in mm) of females of the genus *Haranga* Distant

Measurements	***orientalis***	***decurtata***
	Mean±SD	Mean
LENGTH		
Total length	8.12±0.07	6.60
Wing	5.80±0.28	5.00
Clavus	3.15±0.07	2.60
Vertex	0.55±0.07	0.60
Pronotum	1.65±0.07	1.50
Scutellum	3.15±0.07	2.00
Clypellus	0.55±0.07	0.47
WIDTH		
Wing	1.75±0.07	1.50
Vertex	1.50±0.00	1.30
Pronotum	3.58±0.07	2.90
Head	2.46±0.00	2.00
Clypellus	0.31±0.01	0.30
Lorum	0.36±0.02	0.28
DISTANCE BETWEEN		
Eyes	1.60±0.00	1.50
Antennal pits	1.20±0.00	1.13
Ocelli	0.90±0.00	0.80

No. of specimens used for measurement: Two females of *H. orientalis* and one female of *H. decurtata.*

***Haranga scutellaris* Distant**

(Fig. 10)

Colouration and structure as described by Distant (1918) with the following modification. Body metallic grayish blue with shining head and thorax.

Male genitalia: Subgenital plate without stout setae but with a few hair-like setae in distal half. Style slender, elongate, preapical lobe poorly developed, apical apophysis short, finger-like, with corrugated surface. Aedeagus in lateral view stout, dorsal apodeme stout, well developed, preatrium longer than dorsal apodeme, shaft broad at base, abruptly narrowed towards apex, slightly curved dorsally with serrated lateral margin; gonopore apical.

Measurements: Male 7.60 mm long, 1.56 mm wide across eyes, 3.12 mm wide across pronotum. Female 6.40 mm long, head 2.08 mm wide across eyes, 2.88 mm wide across pronotum.

Material examined: INDIA: Assam, 1♂, Margherita, 'Distant coll. 1911-383' (BMNH).

(Type missing). *Other material examined*: ',' 'Distant coll. 1911-383'. (BMNH)

Remarks: The type with label data 'SRI LANKA: 1♀ 'Type' '*Haranga scutellaris* Distant type' 'Kandy, Sri Lanka, 6.02.1079' is missing. This species can be easily recognized from other species of *Haranga* by the colour. It is metallic grayish blue with shining head and thorax where as all other species are shiny black.

4.1.2. Genus *Malichus* Distant

Vertex large, spatulate, little shorter than pronotum and scutellum combined, with anterior margin broadly subacute, posterior margin a little concave between the eyes. Ocelli placed on disk a little before middle, nearer to lateral margins than to each other. Pronotum about twice as broad as long, the lateral margins oblique with posterior margin straight. Scutellum small, triangular with basal margin considerably longer than the lateral margins. Tegmina broad, distinctly widened near middle. Body beneath and legs more or less yellowish with bases of femora black.

Remarks: The genus *Malichus* Distant is related to *Tambila* Distant, from which it differs in having foliaceous head which is almost as long as pronotum and scutellum combined.

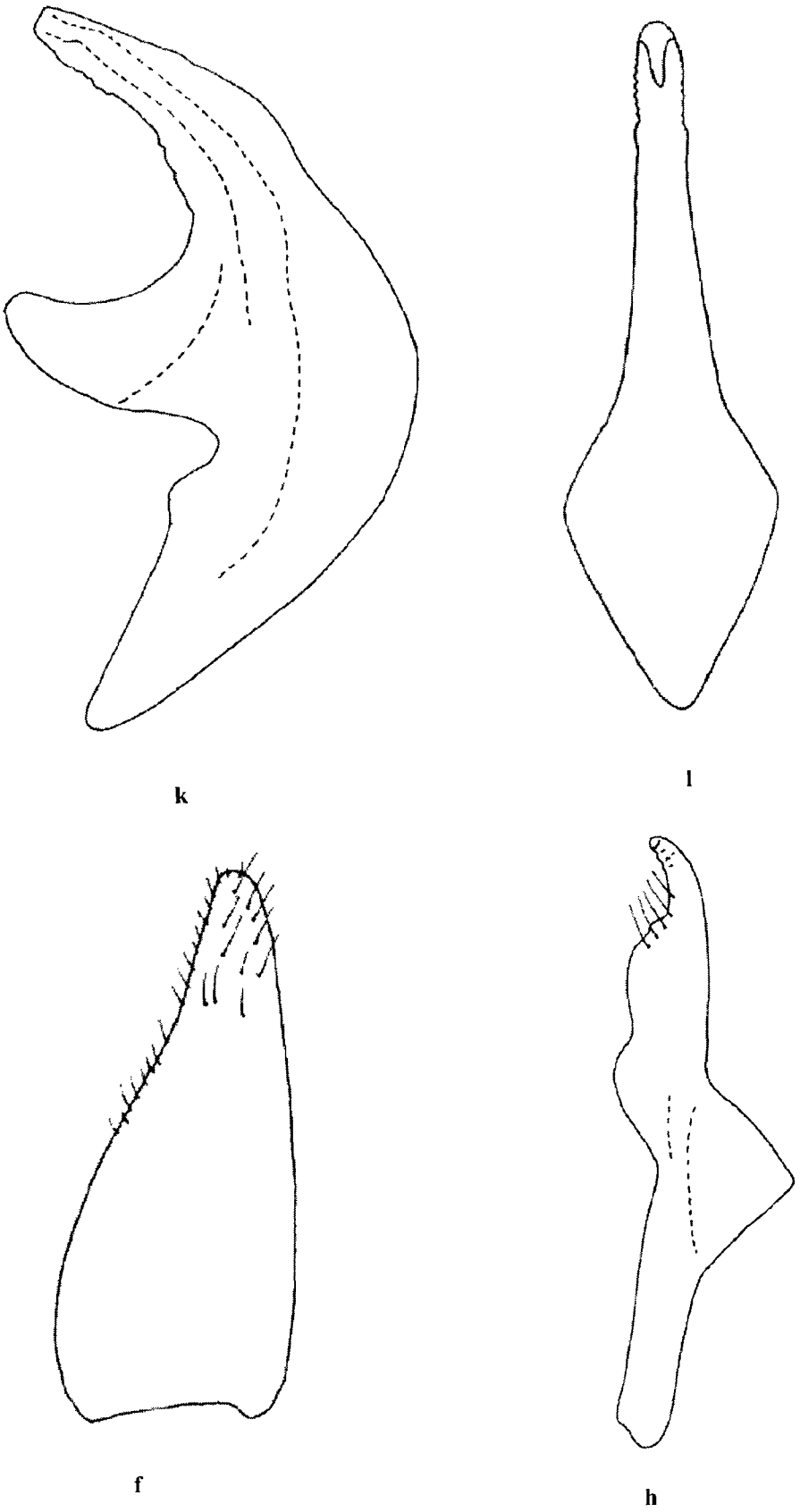


Fig. 10. *Haranga scutellaris* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

***Malichus capitatus* Distant**

Colouration and structure as described by Distant (1918) with following additions. Spots on spatulate vertex are very faint and light brown.

Measurements: Total length 5.84 mm long, 2.12 mm wide across eyes; 2.32 mm wide across hind margin of pronotum.

Material examined: SRI LANKA: 1♀ 'Type H. T'. *'Malichus capitatus* Dist. Type'. 'Peradeniya, Sri Lanka, ix.1911' 'Sri Lanka, J. C. F. Fryer 1914-3' (BMNH).

Remarks: This species has a very peculiar head which is foliaceous anteriorly.

4.1.3. Genus *Neodartus* Melichar

Head narrower than pronotum, flat, broadly parabolic, anterior margin rimmed with three carinae. Ocelli located on marginal rim of vertex, placed at distance greater than twice own diameter than from adjacent eyes. Entire face with transverse obscure striations. Clypeus convex. Clypellus narrow at base with median ridge. Lateral frontal suture reaching antennal pits. Antennal ledge well developed. Labium almost reaching mid coxae. Lorum flat. Scutellum broad with median arcuate impression. Forewing with five apical, three ante-apical cells, claval veins joined by cross vein, covering entire abdomen, hind wing with four apical cells. Hind femoral spinulation 2+2+1, hind tibia with one macrosetae between 2-3 much smaller setae on postero-dorsal region, with one small setae between one macrosetae on antero-dorsal region, meta basitarsus with three platellae.

Male pygophore depressed with caudal submarginal rows of stout setae, caudo-ventral angle blunt, ventral margin sinuate. Subgenital plate triangular, lateral margin slightly convex in basal half. Connective Y-shaped. Style sinuate, preapical lobe not prominent, apical apophysis slender curved laterally, body of style slender. Aedeagus with dorsal apodeme well developed, preatrium short plate like, shaft broadest at mid length; gonopore large on the ventral margin. The form of first valvula dorsal sculpturing concatenate, position of dorsal sculpturing marginal; dorsal tooth on shaft of second valvula large, prominent, extended more than apical half or extending more than apical half or extending more than apical half.

Remarks: This genus can be distinguished from other genera of the Penthimiinae by the ocelli being located on the marginal rim of the vertex and placed at a distance greater than twice the diameter of each ocellus away from adjacent eye. In all

other genera of the subfamily the ocelli are located on the disc of vertex near anterior margin.

Neodartus acocephaloides Melichar is the only species reported from Indian subcontinent.

***Neodartus acocephaloides* Melichar**

(Plate 2 & Fig. 11, 12)

Black, covered with sparsely distributed hair. Scutellum with pale yellow spot at middle of lateral margins, tip of scutellum paler. Tegmina black, thickly spotted with yellowish with slight tinge of brown, apex grayish white, claval area with two cross veins between outer claval vein and claval suture. Other characters as in the generic description.

Male genitalia: Connective with stem broad, twice as long as arm. Aedeagal shaft in lateral aspect of uniform width, apex obliquely truncate.

Female terminalia: Seventh sternite almost rectangular with hind margin medially produced.

Measurements: Male 3.46 mm long, 1.30 mm wide across eyes, 1.54 mm wide across pronotum. Female 3.90 mm long, head 1.48 mm wide across eyes, 1.74 mm wide across pronotum (Table 3).

Material examined: INDIA: Karnataka, 1♂, 2♀, Bagalkot, 22.x.1979, C. A. Viraktamath; Ag. Coll. 2♀, Bangalore, 21.iv.1974, C. A. Viraktamath; 1♀, Bangalore, 30.iv.976, B. Mallik; 3♂,1♀, Bangalore, 20.vi.1977, S. Viraktamath;1♀, Bangalore, 20.xi.1977, A.R.V. Kumar; 1♂,1♀, Bangalore, 22.vi.1980, A.R.V. Kumar; 3♂,1♀, Bangalore, GKVK, 14.viii.1982, H. V. A. Murthy; 3♂, 3♀, Bangalore, GKVK. 5.iii.2005, Shobharani, M; 1♂, 19.iii.2005, Shobharani, M; 1♂, 14.v.2005, Shobharani, M; 1♂, 1♀, 22.ix.2005, Shobharani, M;7♂, 3♀, 15.x.2005, Shobharani, M; 1♂,1♀, 1.v.2006, Shobharani, M; 2♂, 28.x.2006,Girish, K. S; 1♂,1♀, 3.x.2006, Shobharani, M; 2♂, 14.vii.1982, H. V. A. Murthy; 1♂, Bangalore, Lalbagh, 12.x.1982, H. V. A. Murthy; 1♂, Mysore, St. Bangalore, 4.viii.1974, C.A. Viraktamath; 1♀, Mysore, St. Bangalore, 28.iii.1975, C.A. Viraktamath; 1♀, Chikkaballapur, 14.iv.1977, C. A. Viraktamath; 1♂, Bannerghatta park, 12.ix.1976, B. Mallik;1♀, Chikkaballapur, 17.iii.1977, C. A. Viraktamath; 1♀, Chikkaballapur, 8.viii.2006,ex *Calotropis*, Shobharani, M; 1♂,1♀, Chitradurga, 4.xi.2005,Shobharani, M; 1♂, Ag. Coll, Dharwar, 25.vii.1972, C. A. Viraktamath; 1♀, Ag. Coll, Dharwar, 31.vii.72, C. A. Viraktamath;

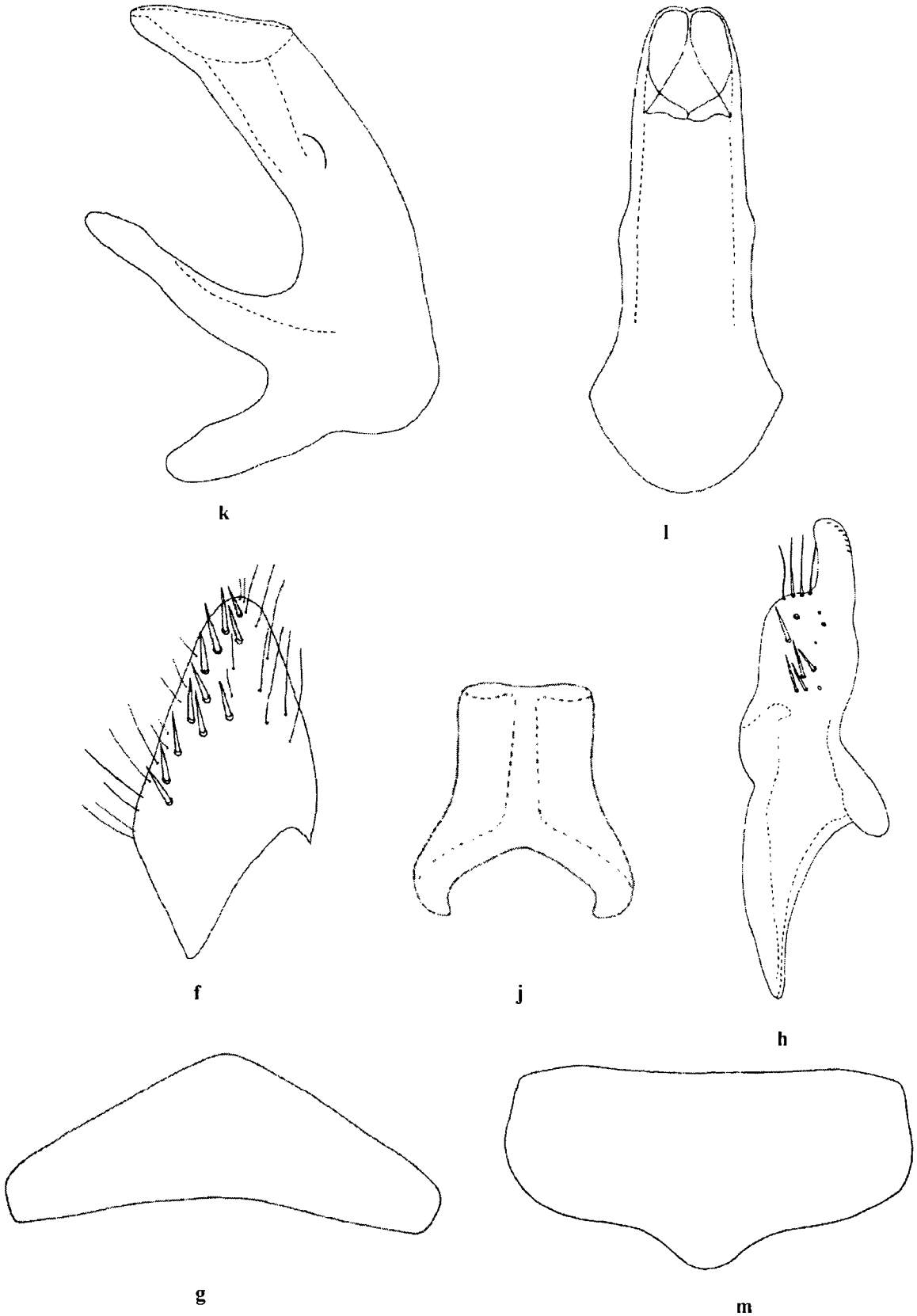


Fig. 11. ***Neodartus acocephaloides*** **Melichar**

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used

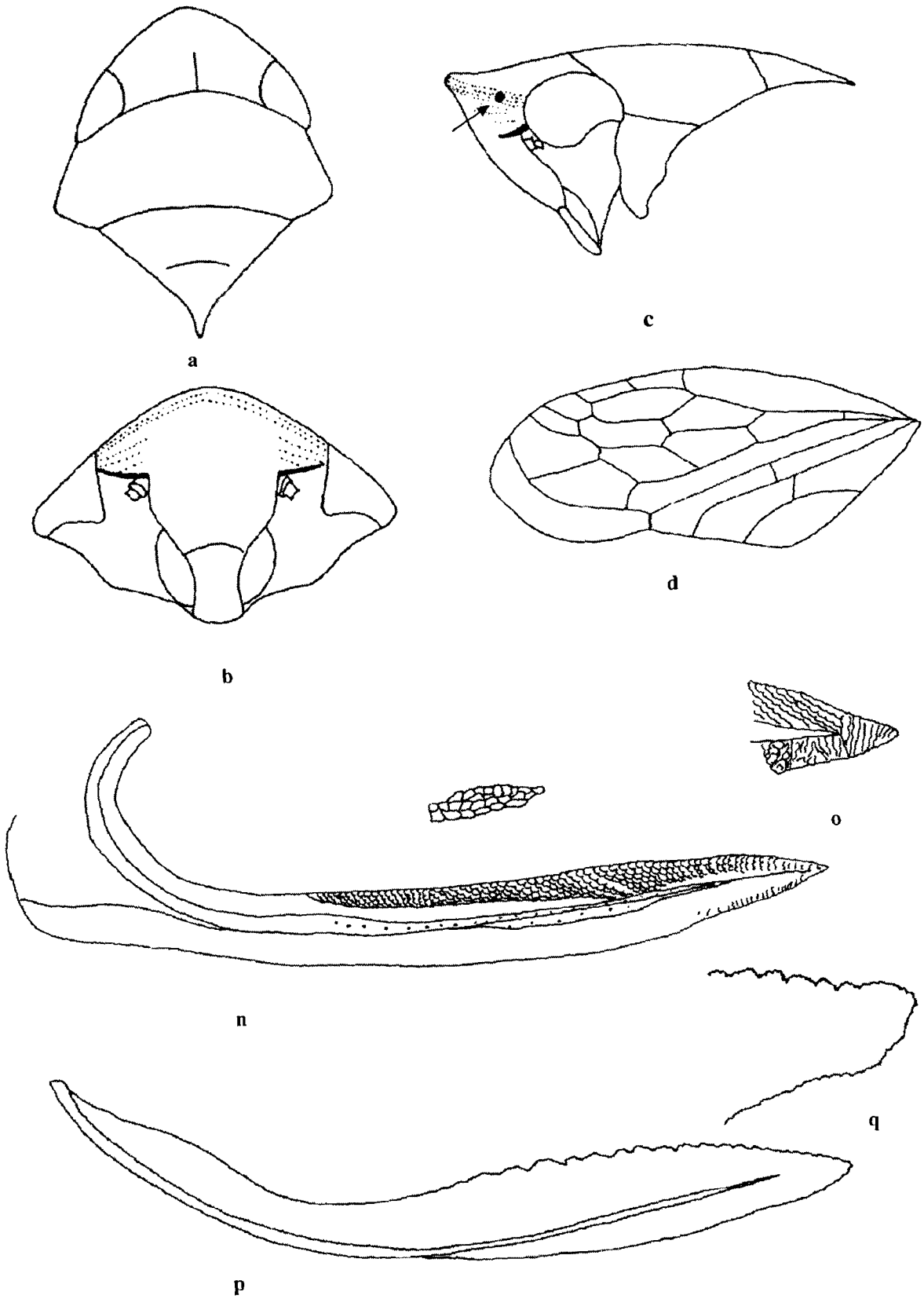
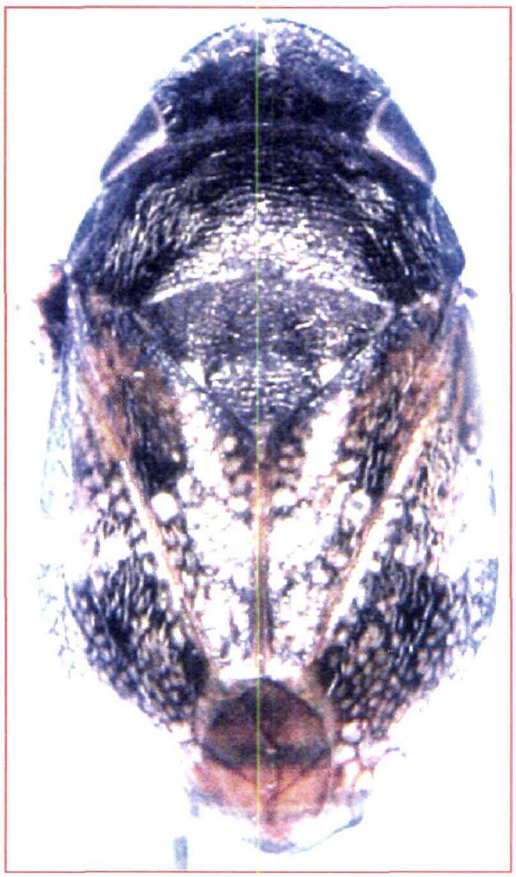
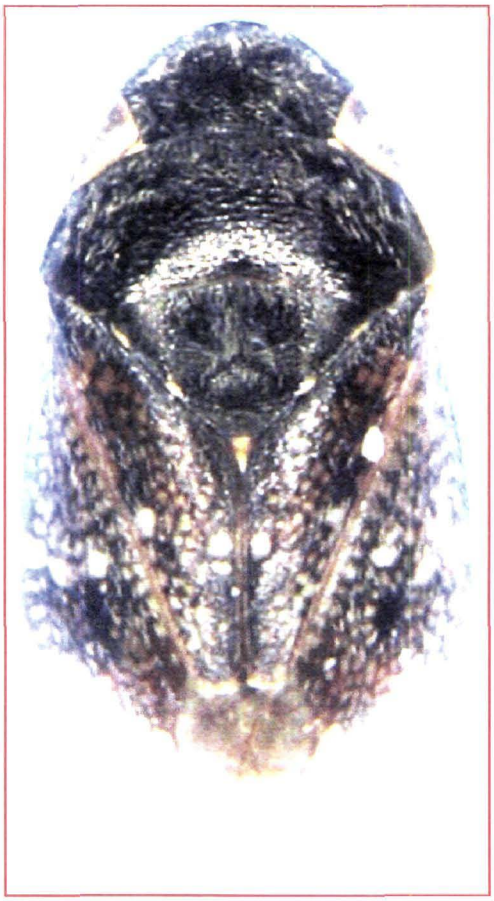


Fig. 12. *Neodartus acocephaloides* Melichar

Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used





Neodartus acocephaloides **Melichar**

Plate 2

Table 3. Measurements (in mm) of males and females of *Neodartus acocephaloides* Melichar

Measurements	Male	Female
	Mean±SD	Mean±SD
LENGTH		
Total length	3.46±0.05	3.90±0.07
Wing	2.48±0.04	2.78±0.08
Clavus	1.58±0.04	1.88±0.04
Vertex	0.40±0.00	0.50±0.00
Pronotum	0.56±0.05	0.62±0.04
Scutellum	0.80±0.00	0.80±0.00
Clypellus	0.35±0.00	0.37±0.01
WIDTH		
Wing	1.00±0.00	0.96±0.48
Vertex	0.70±0.00	0.80±0.00
Pronotum	1.54±0.09	1.74±0.05
Head	1.30±0.00	1.48±0.04
Clypellus	0.20±0.00	0.20±0.00
Lorum	0.16±0.01	0.20±0.00
DISTANCE BETWEEN		
Eyes	0.88±0.01	1.05±0.00
Antennal pits	0.53±0.01	0.62±0.01
Ocelli	0.63±0.01	0.78±o.01

1♂, Gadag, 21.ii.1978, C. A. Viraktamath; 1♂,Gulbarga, 9.ix.1980, A. R. V. Kumar; 2♀, Gulbarga, 11.ix.1980, A. R. V. Kumar; 1♂,Gulbarga, 21.xi.1980, A. R. V. Kumar; 1♂, Halebid-Belur, 11.xi.1978, C. A. Viraktamath;1♂,1♀, Hiriyur, 13.viii.1978, A. R. V. Kumar;3♀, 12 Km N W Hoskote, 10.vi.1977, C. A. Viraktamath; 3♂, 4♀, Hoskote, 6.vii.2005, C.A. Viraktamath; 2♂, 1♀, 15 Km N E Ilkalgad, 19.xii.1974, Ghorpade; 1♀, 15 Km N E Ilkalgad, 17.ii.1977, Ghorpade; 1♂, 5 Km S of Kolar, 12.iv.1977, C. A. Viraktamath; 1♀, 9 Km S E of Magadi, 16.vii.1977, C. A. Viraktamath;; 1♂, Nandi Hills, 1467m, 3.vii.1977, S. Viraktamath; Nandi Hills, 1467m, 26.i.1979, S.Viraktamath; 2♀, Raichur, 18.xi.1978, C. A. Viraktamath; 3♀, Raichur, 24.viii.1982, S. Viraktamath 1♂, Raichur, 30.viii.1982, S. Viraktamath; 2♂, Raichur,14.ix.1982, S. Viraktamath; 1♂, Raichur, 22.iii.1983, S. Viraktamath;1♂, 5 Km N Sira, 5.viii.1980,A. R. V. Kumar; 1♂, 20 Km N of Yelburga, 22.xii.1974, Ghorpade; Andhra Pradesh: 1♂, 3♀, Lam Farm Nr. Guntur, 13.xii.2006, Shobharani, M; Delhi: 1♀, IARI, 23.iv.1975, C.A. Viraktamath; Delhi, 1♂, IARI, 4.x.1980, C.A. Viraktamath. Gujarat: 1♂, 1♀, Dandi, Navsari, 16.i.1981, C. A. Viraktamath; 1♂, Ahmedabad, 27.i.1981, S. Viraktamath;3♂,1♀, Junagadh, 28.i.1981, C. A. Viraktamath; 1♂, Sasan, Gir, 1.ii.1981, S. Viraktamath; Himachal Pradesh: 1♀, 5 Km N of Kalka, 2.x.1980, C. A. Viraktamath. Kerala: 1♂, Walayar, 15.viii.1979, S. Viraktamath; 1♂, Calicut, 17.x.1976, B. Mallik; Maharashtra: 1♂, Nagpur, xi.1914, C. S. Misra, R-6276(IARI, New Delhi). Orissa: Bhubaneshwar, 27.vii.1992, P. C. Dash. Pondicherry: 1♂, Mahe, 15.ix, 1979, A. R. V. Kumar. Sikkim: 1♀, Singtam, 30.x.1981, C. A. Viraktamath (UASB); INDIA: Singara, 2♂, 1♀, Nilgiri Hills, (3400 ft.), v-1954, Coll. R. I. Sc. N. B., P.S. Nathan, det. Viraktamath (IRSNB); 1♂, Malabar Walayar Forests (1000 ft.), x-1956, Coll. R. I. Sc. N. B., P.S. Nathan, det. Viraktamath (IARI, New Delhi).

Remarks: Colouration of this species varies. Body covered with sparsely distributed hair. This is the only species of the genus *Neodartus* known from the Oriental region.

4.1.4. Genus *Penthimia* Germar

Head declivous, anteriorly convexly rounded to face with entire anterior margin transversely striated. Ocelli placed on disk of vertex, remote from each other than from eyes. Eyes notched ventrally. Lateral frontal suture not reaching ocellus or ocellar vestiges. Clypeus slightly raised, broadening upward. Clypellus ridged medially, truncate at apex. Lorum semicircular, slightly convex. Gena broad with lateral margins

carinate. Pronotum with anterior margin convex, posterior margin concave, lateral margins carinate, divergent posteriorly. Scutellum triangular, longer than pronotum, its caudal apex not produced into a spine. Forewing with five apical and three ante-apical cells, covering entire abdomen, claval veins joined by a cross vein; hind wing with four apical cells. Hind femoral spinulation 2+2+1, hind tibia with one macrosetae between with 2-4 much smaller setae on postero-dorsal region, antero-dorsal region, with small setae between macrosetae, meta basitarsus with three platellae.

Male pygophore with rounded caudal margin, ventral area with stout setae. Connective Y-shaped with broad stem (in most of the species). Valve and subgenital plate triangular. Style linear with well developed preapical lobe, its apical apophysis either short or long. Aedeagal shaft cylindrical, curved caudo-dorsally; gonopore apical. Hind margin of female seventh sternite slightly concave with median projection. First valvula with dorsal sculpturing concatenate, position of dorsal sculpturing marginal; dorsal tooth on shaft of second valvula large, prominent, extending more than apical half.

Remarks: The species of the genus *Penthimia* can be differentiated based on the male genitalia. Some species of *Penthimia* show considerable colour variation. The female seventh sternite is also more or less uniform except in a few species.

Twenty two species are reported under this genus from Indian subcontinent including five new species.

Key to species of the genus *Penthimia* Germar of the Indian subcontinent (Only males)

1 Aedeagal shaft with hooked apex (fig. 16 k, 21 k, 23 k).....2

- Aedeagal shaft without hooked apex 4

2 Style with apophysis stout, rather straight (fig. 23h.); apical hook of aedeagus thin (fig. 23 k)..... ***P. noctua* Distant**

- Style with apophysis slender, laterally uniformly curved (fig. 16h) apical hook of the style stout (fig. 16 k).....3

3 Aedeagal shaft in basal 0.75 of uniform width, then abruptly narrowed, lacks spicules and lateral serrated ledge (fig. 21 k&l)..... ***P. meghalayensis* sp. nov.**

- Aedeagal shaft gradually narrowed, with spicules and lateral serrated ledge (fig. 16 k&l).....*P. curvata* **sp. nov.**

4 Apical apophysis of the style recurved and preapical lobe not well developed (fig. 19h), subgenital plate broadly rounded at base laterally (fig. 19f,)..... ***P. maculosa* Distant**

- Apical apophysis of the style curved laterally with well developed preapical lobe (fig. 17h), subgenital plate not broadly rounded at base laterally (fig. 17f).....5

5 Aedeagal shaft with median keel on the dorsal margin (fig.17k) .....*P. erebus* **Distant**

- Aedeagal shaft without median keel on the dorsal margin (fig.13 k).....6

6 Aedeagal shaft with lateral flanges at apical one third (fig.13 k).....*P. attenuata* **Distant**

- Aedeagal shaft without lateral flanges at apical one third.....7

.

7 Apical apophysis of the style long finger-like, curved laterally with apex truncate (fig. 24h).....*P. quadrinotata* **Distant**

- Apical apophysis of the style not as above.....8

8 Aedeagal shaft curved caudo-anteriorly with large gonopore on ventral margin (fig. 20 k, 25 k) 9

- Aedeagal shaft curved caudo-dorsally with small gonopore at apex (fig. 27 k, 28 k, 29 k) 11

9 Connective with stem two times longer than arms and bifurcated at base (fig. 26 j).....*P. scapularis* **Distant**

- Connective with stem less than two times longer than arms and not bifurcated at base (fig. 25 j).....10

10 Vertex and pronotum black, Aedeagus with well developed dorsal apodeme.....***P. sahyadrica* sp. nov.**

- Vertex and pronotum greenish yellow with posterior and lateral margins slightly margined with dark brown, dorsal apodeme very short.....***P. majuscula* Distant**

11 Aedeagal shaft with serrated lateral margins (fig. 18 *l*, 22 *l*).....12

- Aedeagal shaft without serrated lateral margins 13

12 Aedeagal shaft gradually tapers towards apex (fig. 22 *l*).....***P. montana* Distant**

- Aedeagal shaft slightly constricted near the base (fig. 18 *l*)..***P. fraterna* Distant**

13 Aedeagal shaft broadest in basal half and tapering distally with a dorsal ridge (fig. 14 k).....***P. compacta* Walker**

- Aedeagal shaft tubular throughtout its length and not tapering distally (fig. 27 k , 28k , 29 k).....14

14 Forewing with yellowish spots..... ***P. scutellata* (Distant)**

- Forewing black with apical area light brown.....15

15 Aedeagal shaft with spicules on lateral margin, clypeus and clypellus not tumid (fig. 28 k*)* ..... ***P. spiculata* sp. nov.**

- Aedeagal sgaft without spicules on lateral margin (29 k), clypeus and clypellus tumid..... ***P. tumida* sp. nov.**

***Penthimia attenuata* Distant**

(Plate 3a & Fig. 13)

Colouration and structure as described by Distant (1918) with the following additions. Male dark chocolate brown to black with light brown maculae on fore wing. Some males and all females with head black, rest of the body reddish brown. Scutellum in some specimens with dark brown basal triangles. Labium almost reaching mid coxae. All femora, large areas on pronotum, meso and meta sterna, chocolate brown, hind tibia chocolate brown.

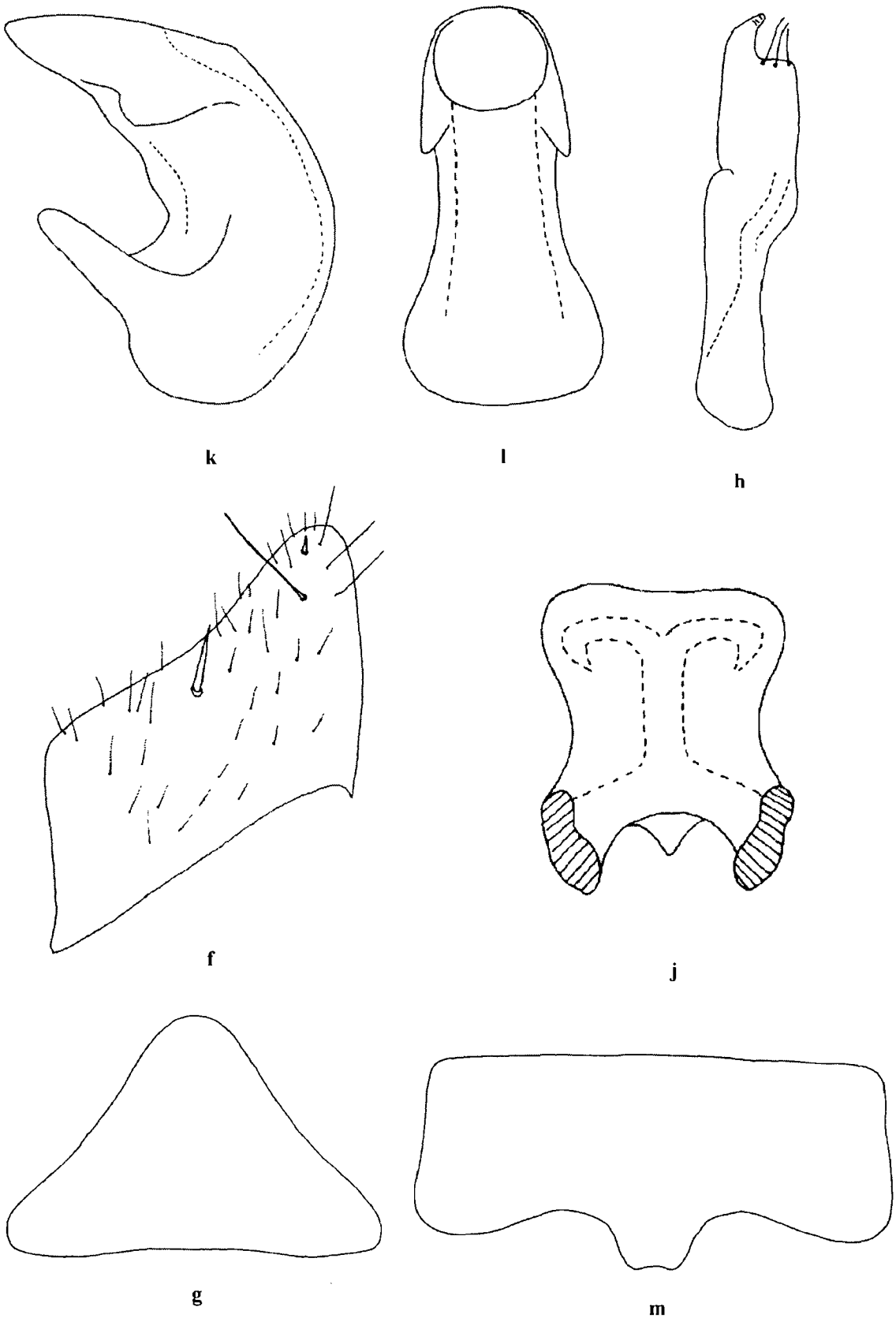
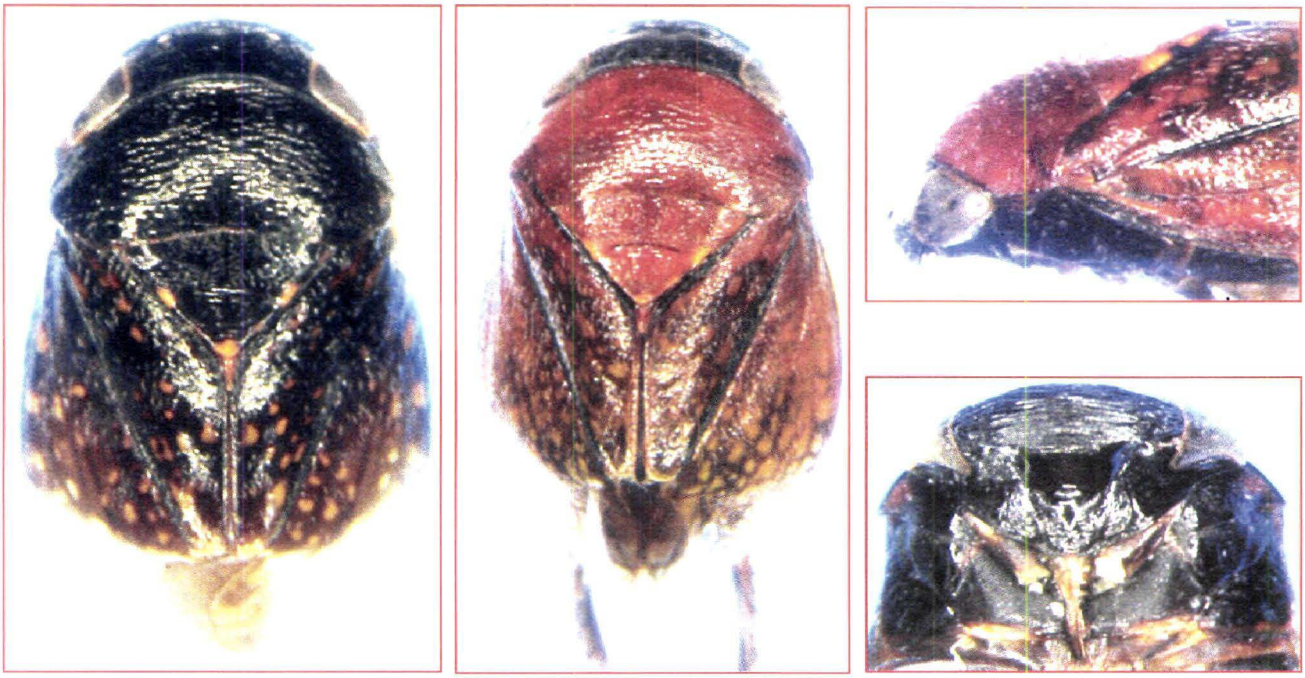


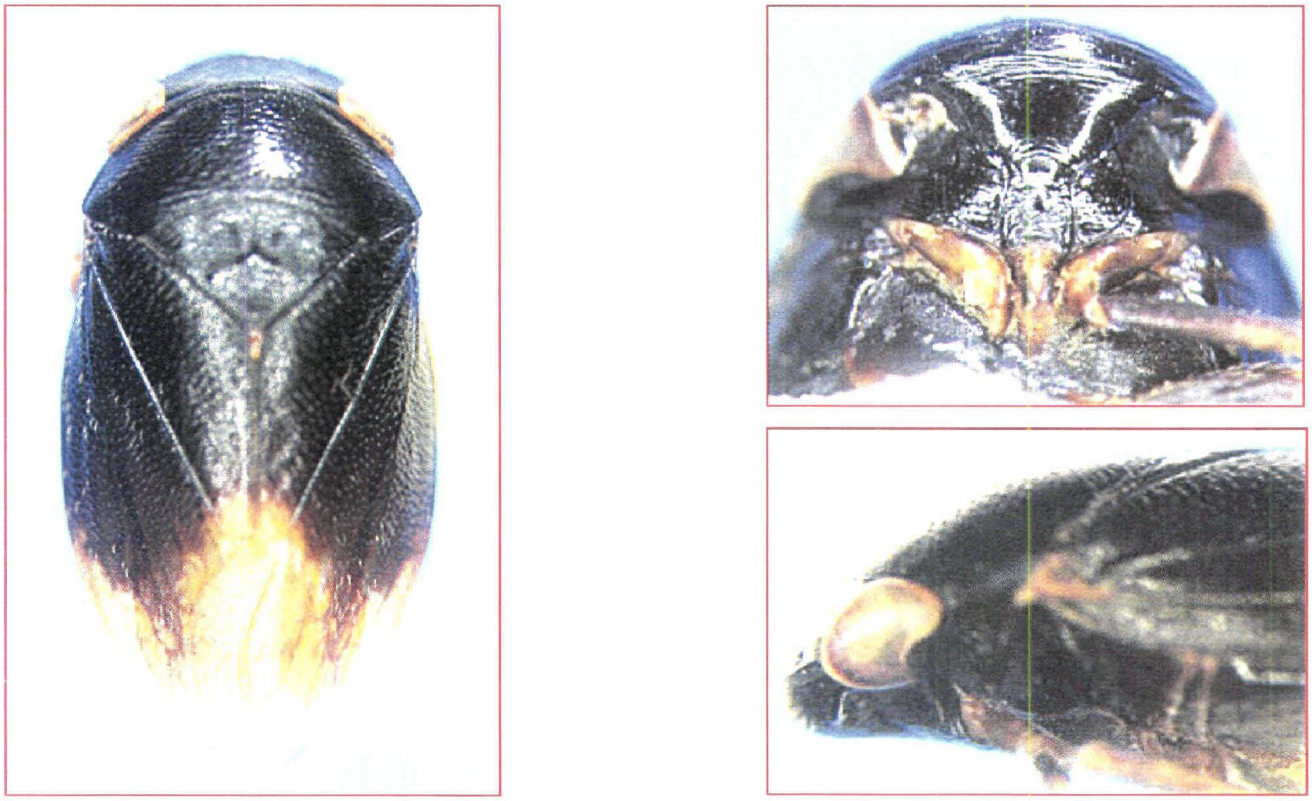
Fig. 13. *Penthimia attenuata* Distant

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Male **Female**

a. *Penthimia attenuata* Distant



b. *Penthimia curvata* sp. nov.

Plate 3

Male genitalia: Pygophore with rounded caudal margin. Subgenital plate obtusely produced laterally near base, caudal angle rounded, with short hair like setae. Style with body almost of equal width, preapical lobe well developed, apical apophysis short, thumb-like. Connective with arms shorter than stem. Aedeagus short, stout, dorsal apodeme short, preatrium not developed, shaft cylindrical, curved caudo-dorsally; gonopore apical, large, on ventral margin, with lateral flanges.

Female terminalia: Seventh sternite twice as wide as long, hind margin concave with median shallowly bilobed projection.

Measurements: Male 3.76 mm long, head 1.52 mm wide across eyes, 1.72 mm wide across pronotum. Female 3.94 mm long, head 1.66 mm wide across eyes, 1.90 mm wide across pronotum (Table 4 & 5).

Material examined: Type 1 ♀, 'Nandidrug, S. India, 92_2, T.V. Campbell' 'Type H.T.' '*Penthimia attenuata* Dist. type' 'S. India, E. A. Butler 1915-60'(BMNH). *Other material examined*: Karnataka: 3 ♂, Nandidrug, T. V. Campbell (BMNH); 2 ♂, 1 ♀, Biligirirangana hills, 16.i.1985, C. A. Viraktamath: 1♂, Kemmangundi, 11.iv.1975, C. A. Viraktamath; 1 ♀, 9.iv.1975, C. A. Viraktamath; 5 Km Panja Sullia, 8.ii.2005, Shobharani, M. 1 ♀, Mandagadde, 22.ii.2005, Gaurav and K. B. Raj; Kerala, 4♀, Munnar, 1524m, 22.iii.1977, C. A. Viraktamath; 1♀, Thekkady, 884m, 27.iii.1977, C. A. Viraktamath (UASB); Meghalaya: 1♂, Nangpoh, 762m, 4.xi.1981, S. Viraktamath; Tamil Nadu: 5 ♀, Kodaikanal, T. V. Campbell; 3 ♂, Coonoor, NilgiriHills, T. V. Campbell (BMNH); 1 ♂, Shambaganur, 17.viii.1979, Dworakowska, I; 1♂, Naduvattam, 1829m, 6.vi.1977, S. Viraktamath; West Bengal, 1♀, 8 Km E of Kalimpong, 1768m, 29.x.1981, C.A. Viraktamath; Sikkim: 1♀, Singtam, 30.x.1981, S. Viraktamath (UASB).

Remarks: Externally this species resembles *P. melanocephala* in having black head, reddish brown thorax. The forewing in females and in a few males reddish brown.

***Penthimia castanea* Walker**

External structure as described by Distant (1908) with the following additions. Uniformly polished reddish brown, face black, extending to outer margin of vertex between and in front of ocelli. Pronotum transversely wrinkled, obscurely punctate. Scutellum with five pale spots, two on each lateral margin, one at apex.

Material examined: Type 1♀, 'Type H.T (green label)' '*castanea*' 'wallace'

Measurements: Female 6.96 mm long, head 2.36 mm wide across eyes, 3.04 mm wide across pronotum.

Remarks: This species is uniformly polished reddish brown in colour; face is black, extending to outer margin of vertex between and in front of the ocelli.

***Penthimia compacta* Walker**

(Plate 4 & Fig.14, 15)

Penthimia compacta Walker 1851b: 842; Distant 1908g: 242.

Penthimia subnigra Distant 1908g: 243-244. **syn. nov.**

Reddish-brown to black. Head, anterior margin of pronotum black, posterior margin entirely brownish or some specimens with anterior margin entirely black with posterior margin black with brownish tinge. Scutellum in some specimens black with yellow spots at the middle of the lateral margins, one yellow spot at the apex, tip of scutellum brownish. In some specimens scutellum brownish with basal angles black with light yellow spot on middle of lateral margins, one yellow spot at the apex. Clypellus ridged medially. Labium extending beyond fore coxae. Hind legs black with light brown spinules. Tegmina brownish with hyaline apices.

Male genitalia: Pygophore lobes rounded caudally. Subgenital plate obtusely produced on lateral margin near base with apex rounded, surface with long hair-like setae. Style broad, short, with well developed preapical lobe, apical apophysis short, thumb-like, surface corrugated. Connective with stem twice longer than arm. Aedeagus simple, dorsal apodeme short, atrium reduced, shaft tubular, broadest in basal half and tapering distally with a dorsal ridge, apex notched; gonopore apical.

Female terminalia: Female seventh sternite two times wider than median length, hind margin slightly concave, with a median projection having lateral short angular projections.

Measurements: Male 4.56 mm long, head 1.64 mm wide across eyes, 1.06 mm wide across pronotum. Female 4.92 mm long, head 2.08 mm wide across eyes, 2.34 mm wide across pronotum (Table 4 & 5).

Material examined: 'Syntype ♀, 'Type (green disc)' 'N. India (hand written '*Penthimia compacta* Walker'. Type 'Type (red disc) 'Nilgiris (Hampson)' '*Penthimia subnigra'. Other material examined*: 7 ♀, Chikkaballapur, T. V. Campbell. S. India, 1♀, Madras, Madanapalle, T. V. Campbell. 1 ♀, Kangra Vally, 4500 ft, July, 1899,

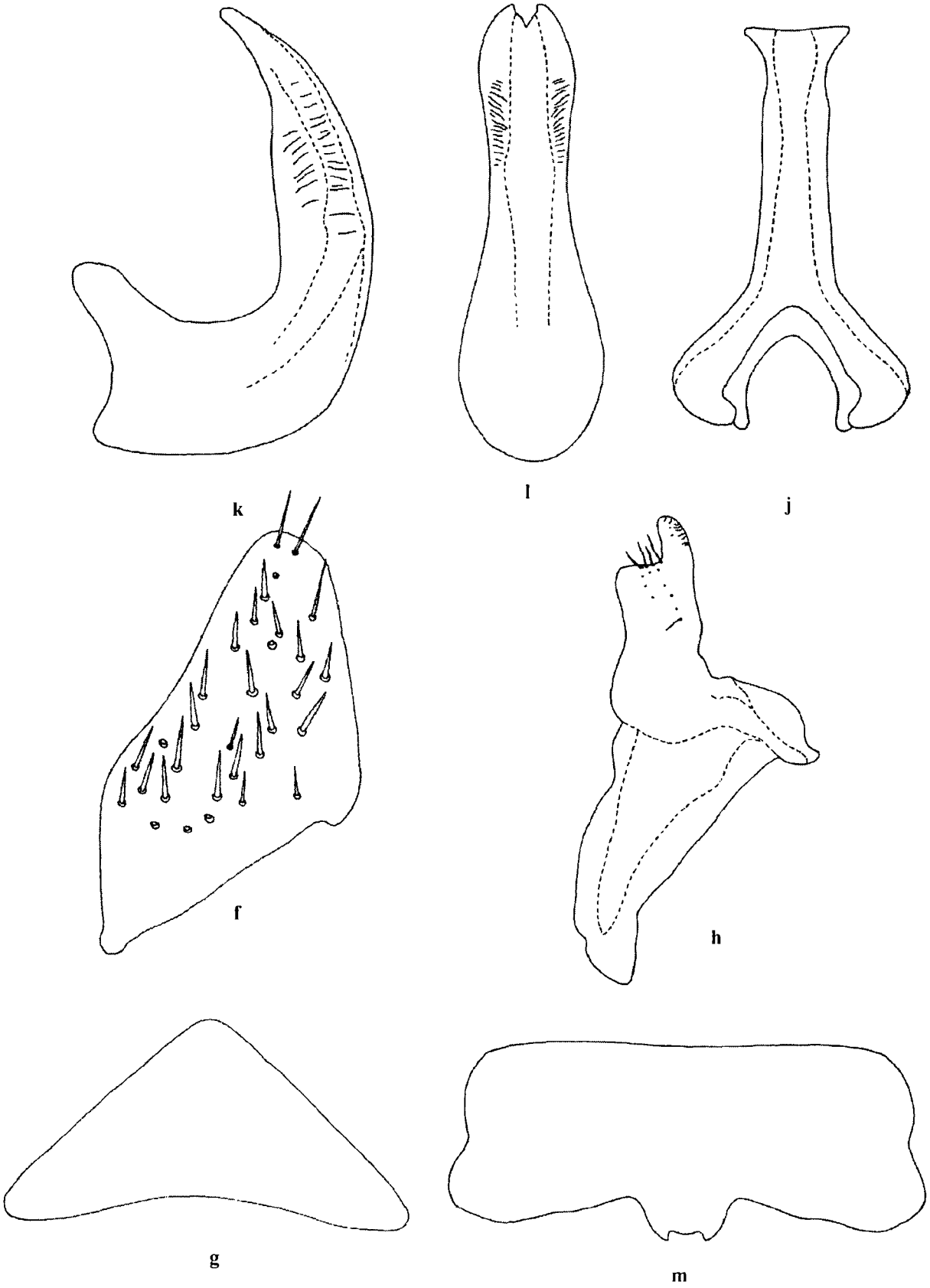


Fig. 14. *Penthimia compacta* Walker

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used

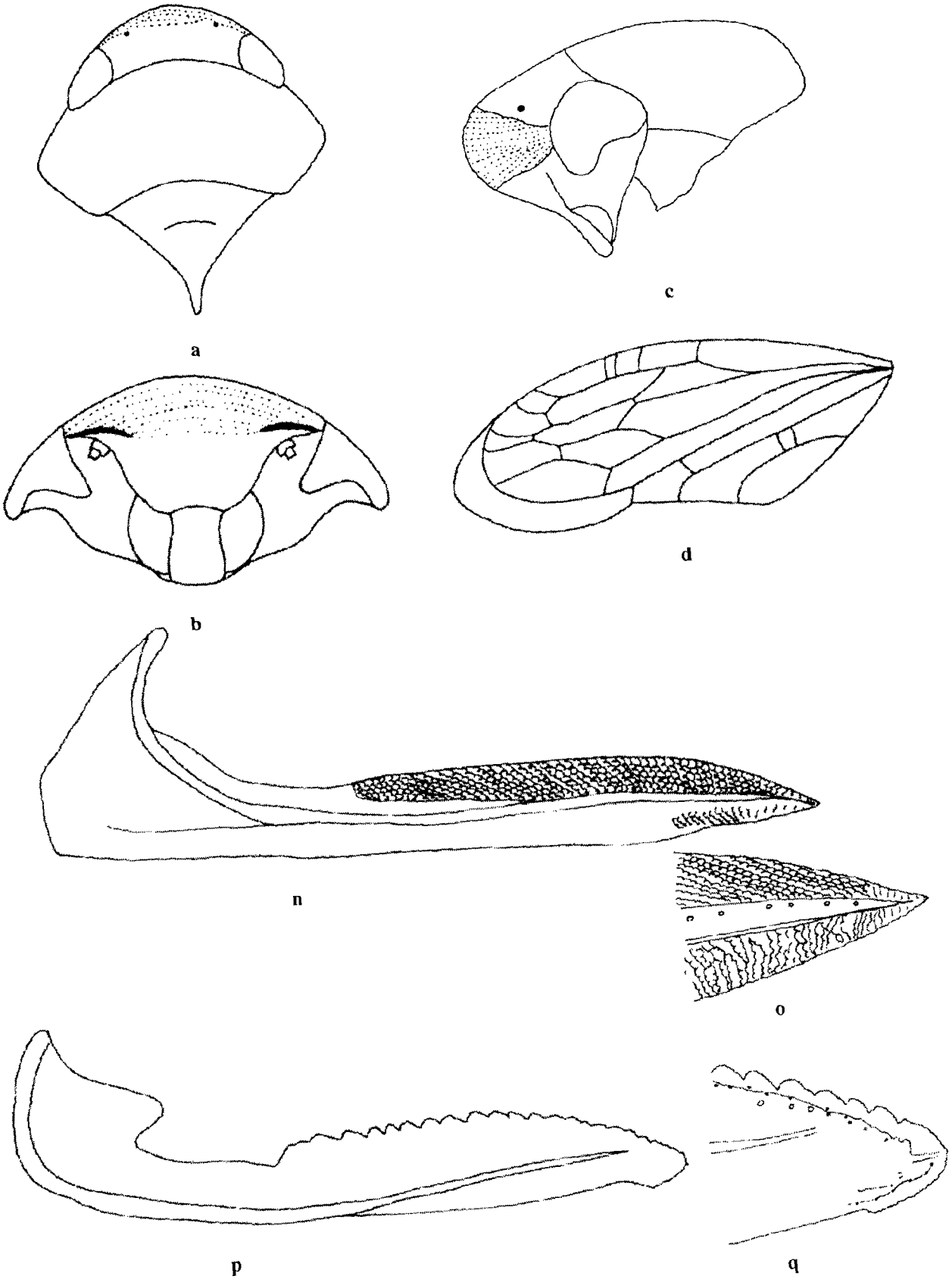
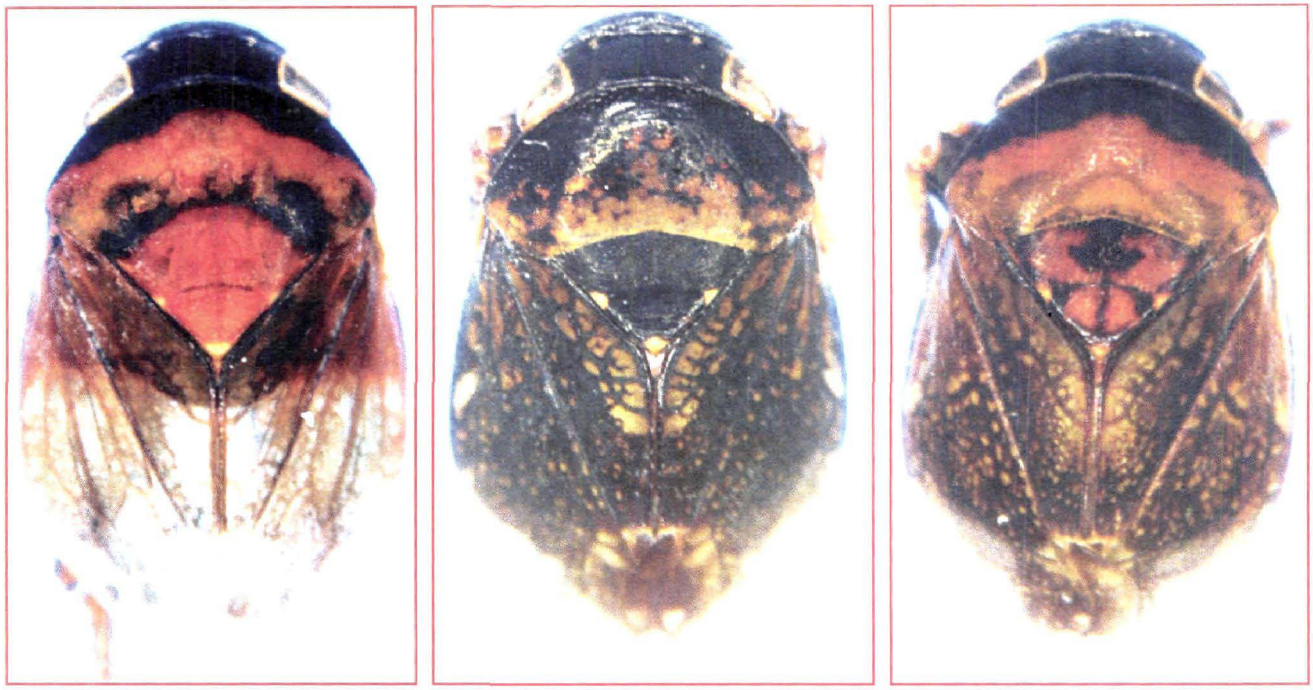
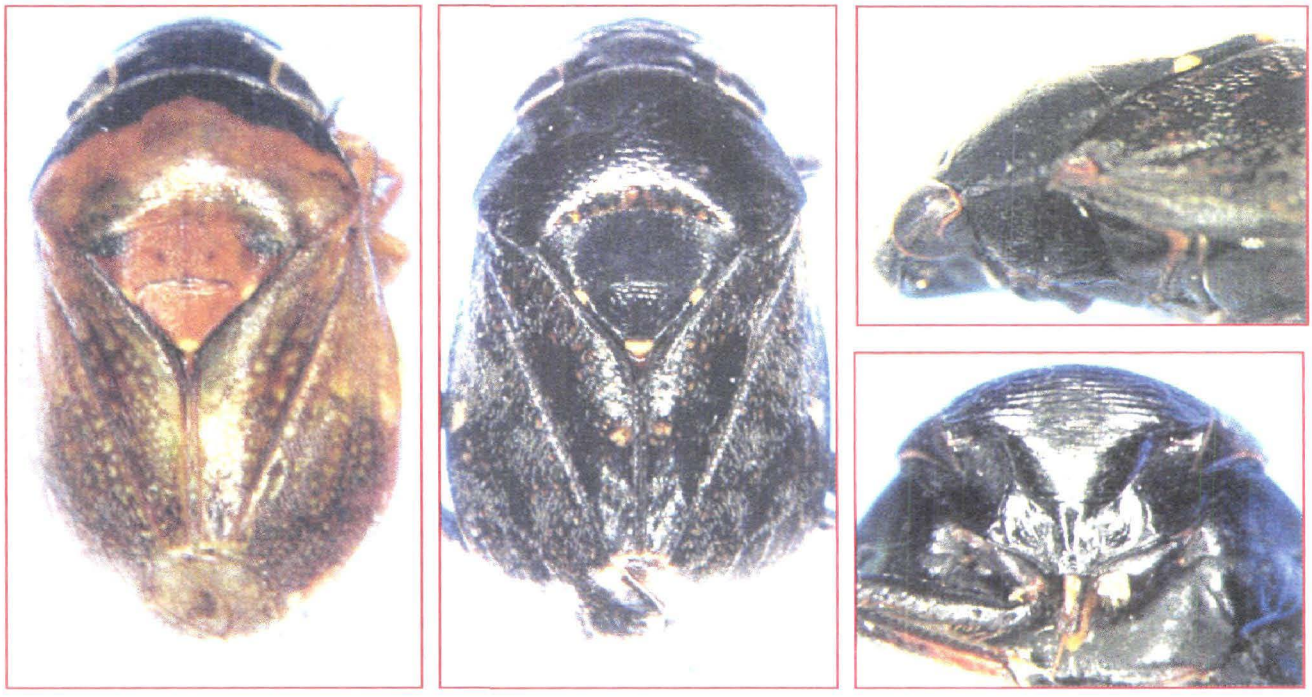


Fig. 15. *Penthimia compacta* Walker

Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used





Penthimia compacta (Walker)

Plate 4

Dudgeon; 1♀, Calcutta Museum compound (BMNH); 1♂, Indian Museum, Almora, 5500 ft, Kumoan, 20-21.xi.1911 (Paiva); 1♀, Pusa Bengal; 1♂, Thamaspur, Nepal, 18-20.iii.(19)08, 1♀, Calcutta Museum compound, 21.iii.(19)15, FHG.; 1♀, Calcutta, 26.vii.(19)07, Annandale; 1♀, Calcutta 28.vii.(19)07, C. A. Paiva (BMNH). Karnataka: 1♀, Arsikere, 4.viii.1977, HSK 31; 1♀, Bangalore, GKVK, 26.iv.2006, Shobharani, M; 1♂, 26.vi.2006, Girish, K. S; 1♂, 1♀, 10.vii.2006, Girish, K. S; 1♀, 29.vii.2006, Girish, K. S; 2♀, 29.viii.2006, ex. Red gram, Shobharani, M; 4♂, 3.x.2006, Shobharani, M;3 ♂, 3.x.2006, Girish, K. S; 2♀, 15.xi.2005, Shobharani, M; 2♂, 1♀, Bangalore, 13.iii.1974, F.R.L; 1♂, Bangalore, 11.viii.1978, F.R.L; 1♀, Bangalore, 16.iv.1976, C. A. Viraktamath (UASB); 1♂, 1♀, Bangalore, IWST, 6.ix.2005, K.B. Raj; 1♂, Fraserpet, Coorg, F.R.I. 20.ii.31, Sandal Insect Survey; 1♀, Fraserpet, Coorg, F.R.I. 13.ii.31, Sandal Insect Survey;1♂, Gotipura nr Bangalore, 10.vii.2005, K.B. Raj; 1♂,1♀, Gotipura nr Bangalore, 8.viii.2005, K.B. Raj (IWST); 1♀, Hoskote, 6.vii.2005, C. A. Viraktamath; 1♀, 10 Km N Hunsur, 16.i.1978, C. A. Viraktamath;1♀, Mudigere, 7.iv.1980, C. A. Viraktamath; 1♀, 19 Km W of Mudigere, 900m, 6.iv.1980, C. A. Viraktamath; 3♂, 1♀, Mysore st. Ag. Coll. Dharwad, 17.viii.1972, C. A. Viraktamath; 1♀, 10 Km S Periyapatna, 20.i.1978, C. A. Viraktamath; 1♀, Sulekere nr Bangalore, on *Calotropis*, 26.iv.1979, C. A. Viraktamath; 1♂, 3 Km W Yellapur, 15.xi.1977, C. A. Viraktamath; Gujarat: 2♀, Navsari, 16.i.1981, S. Viraktamath; 1♀, Junagadh, 28.i.1981, C. A. Viraktamath; 1♀, Ahwa, Dang, 19.i.1981, C. A. Viraktamath; Haryana: 2♀, Sonepat, 3.ii.1980, Ghorpade; Himachal Pradesh: 1♀, 5 Km N Kalka, 2.x.1980, C. A. Viraktamath; Maharashtra: 2♂, 2♀, Khandala, 6.xi.1991, C. A. Viraktamath. Pondichery: 1♀, Mahe, 15.ix.1979, A.R.V. Kumar; Tamil Nadu: 1♂, Yercaud, 19.ix.1979, Ghorpade; 1♂, 1♀, Yercaud, 1360m, 20.ix.1978, Ghorpade (UASB). 1♀, Ayur, N. Salem, FRI, Sandal insect survey, 29.xii.30. 1♀, Ayur, N. Salem, FRI, Sandal insect survey, 12.i.31; West Bengal: 1♀, Kalyani, 4.vi.2005, C. A. Viraktamath; 1♀, Sukna, 1.xi.1981, S. Viraktamath; S. (UASB). INDIA: Moyar campus, 1♂, 1♀, Nilgiri Hills (2900 ft.), vi-1954, Coll. R. I. Sc. N. B., P.S. Nathan, det. Viraktamath. S. INDIA: Yercaud, 1♀, Shevaroy Hills (4500 ft.) ii/iii-1955, Coll. R. I. Sc. N. B., P.S. Nathan, det. Viraktamath (IRSB); Punjab: (7500 ft.), 1♂ v.1920, Dutt; 1♂, Murrea Hills (7500 ft.), June 18, Dutt, R-8226; 1♂, Murrea Hills (7500 ft.), v.1920, Dutt, R-8228; 1♂, Murrea Hills (7500 ft.), v.1920, Dutt, R-8227; 1♂ , Hazara Dist., Dungagali (8000 ft.), 21-24.v.1915, Fletcher, R- 8231; Delhi: Pusa Reugal, MML, 15.xii.10, R-8236; Shillong: 1♀, v.1920, on apple, Fletcher (IARI, New Delhi).

Remarks: The coloration of this species varies considerably but has identical male genitalia. Distant (1908) relying on external coloration treated these variations as two distinct species. Hence the synonymy.

***Penthimia curvata* *sp.* nov.**

(Plate 3b & Fig. 16)

Black, finely striated. Labium pale brown, exceeding fore coxae. Tip of scutellum light brown. Apical area of forewing light brown. Body beneath black. Hind legs with black spinules.

Male genitalia: Pygophore with caudal angle almost truncate, ventral margin straight with long stout setae on caudal one third. Caudal margin of subgenital plate rounded, surface with fine short hair like setae. Connective with arms shorter than stem. Style linear with well developed preapical lobe, apophysis finger-like, slightly curved laterally, with corrugated surface. Aedeagus with well developed dorsal apodeme, preatrium reduced. Shaft directed caudo-dorsally, broad at basal half, gradually tapering towards apex forming a hook like structure; lateral margins at apical one third serrated, one or two rows of spicules present at apical one third. gonopore apical with U-shaped notch.

Measurements: Male 4.07 mm long, head 1.53 mm wide across eyes, 1.80 mm wide across pronotum (Table 4).

Material examined: INDIA: Karnataka, Holotype ♂, Bandipur, 19.i.1985, S. Viraktamath (UASB); 1♂, Thithimathi, 19.i.1978, C. A. Viraktamath; 1♂, Bandipur, 19.i.1985, S. Viraktamath (UASB).

Remarks: P. curvata resembles *P. noctua* externally but differs in having more slender, distally tapered apical apophysis of style compared to that in *P. noctua* and lacks the preatrial process which are well developed in *P. noctua.*

***Penthimia erebus* Distant**

(Plate 5a & Fig. 17)

Colouration and external structure as described by Distant (1908) with the following additions. Head, pronotum and scutellum shiny black. Two lateral spots, apical spot on scutellum yellow. Labium reaching mid coxae. Wings black with a few reddish brown transparent spots.

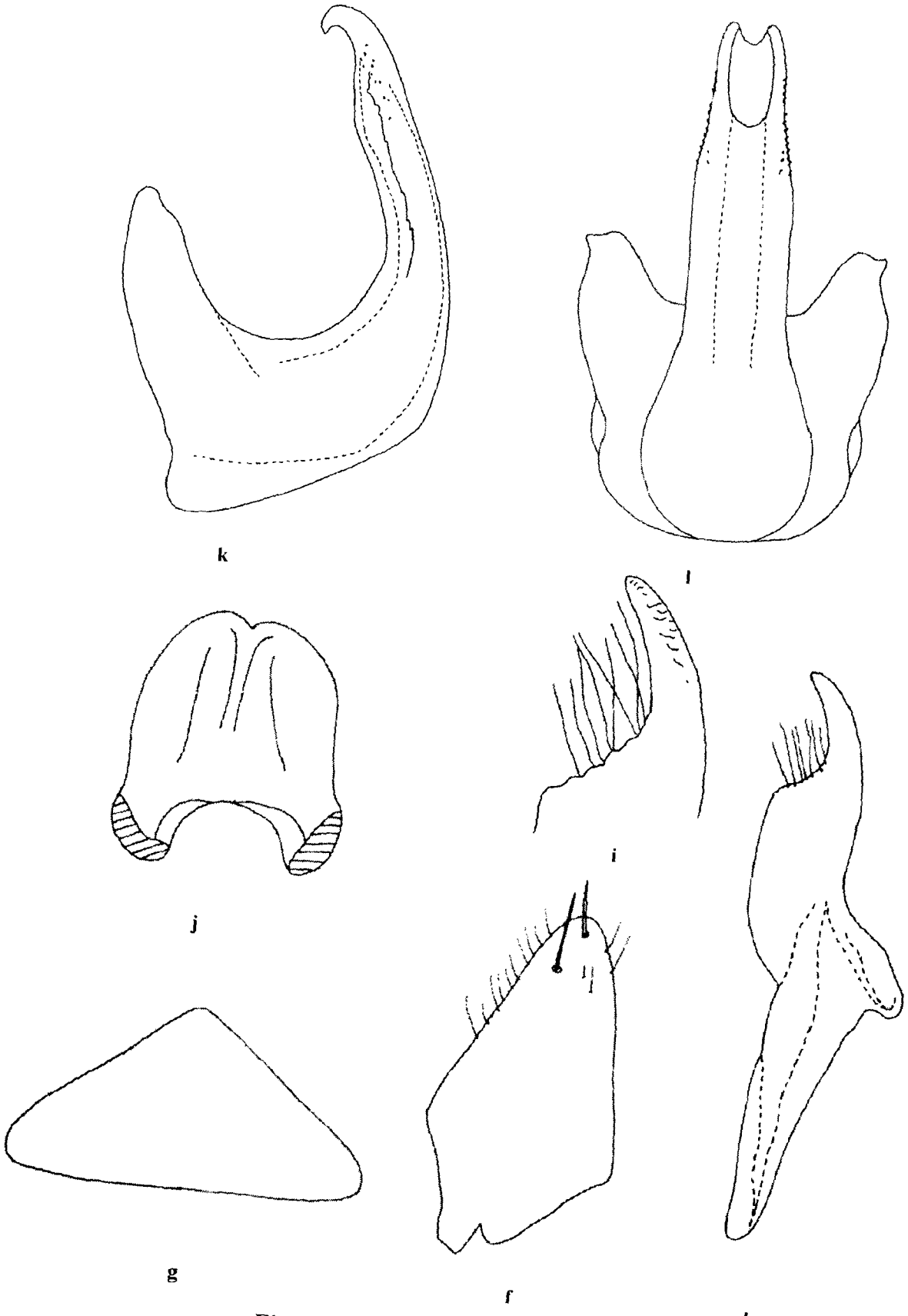


Fig. 16. *Pentimia curvata* sp. nov.

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used

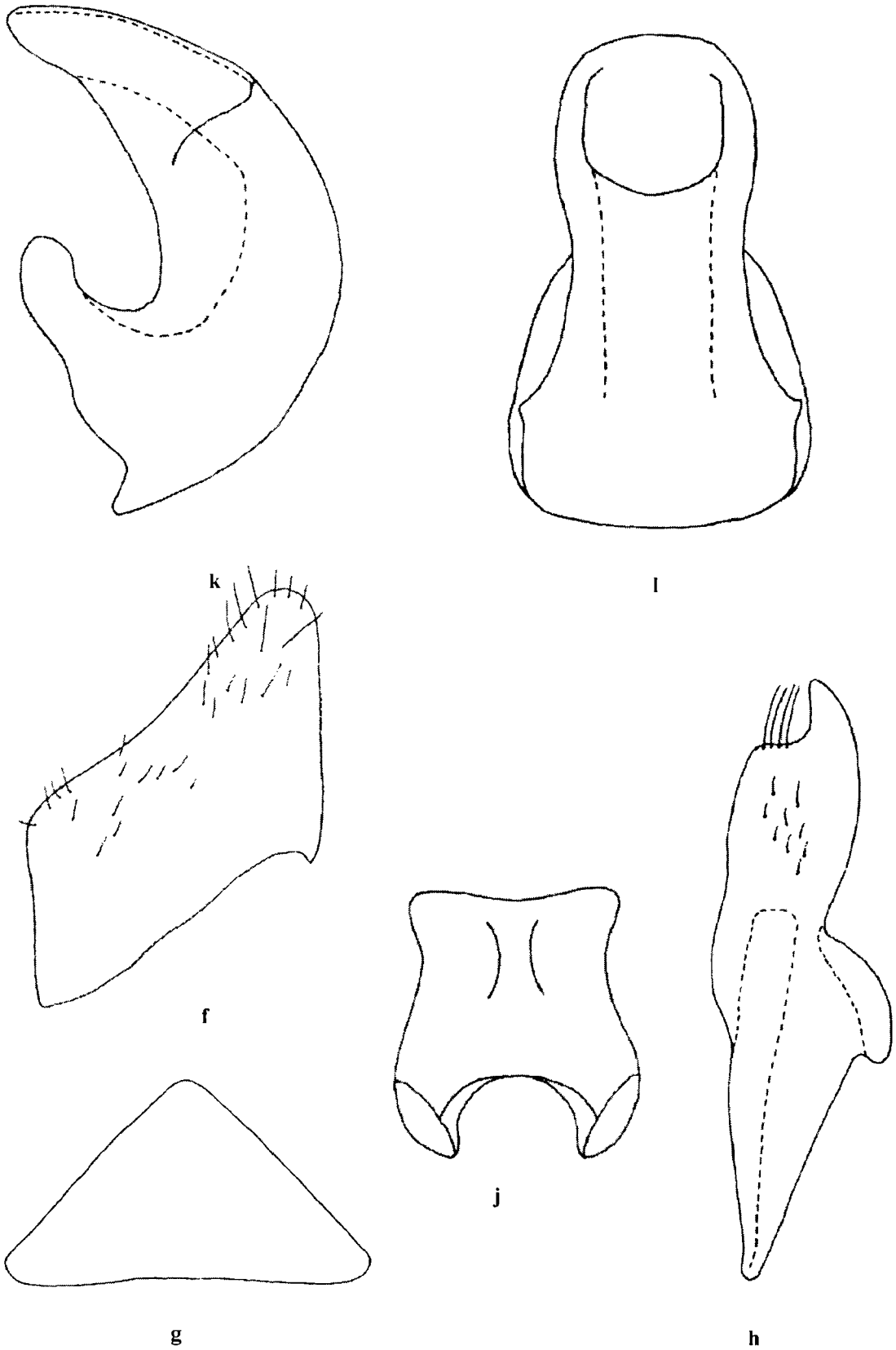


Fig. 17. *Penthimia erebus* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

Male genitalia: Similar to *P. attenuata.* Aedeagus comparatively more slender, with a large gonopore on ventral margin and a median keel on the dorsal margin. Dorsal apodeme bilobed.

Measurements: Male 3.8 mm long, head 1.6 mm wide across eyes, 1.85 mm wide across pronotum (Table 4).

Material examined: Type 1♂, 'Type H. T' 'Habarane, Sri Lanka' 'Distant Coll. 1911-383' '*erebus* Dist. type' (BMNH). *Other material examined*: INDIA: Tamil Nadu: 1♂, Nilgiris, 15.viii.2000, Prathapan, K.D (UASB).

Remarks: The male type (from Sri Lanka) was not dissected as it is very fragile. However, a male from Nilgiris, which agreed with the type, was dissected. Both *P. erebus* and *P. attenuata* resemble each other in the structure of male genitalia and colouration (dark coloured male of *P. attenuata*, female *P. erebus* not known). However, they differ in the detailed structure of aedeagal shaft. The median keel on the dorsal surface of the aedeagal shaft found in *P. erebus* is absent in *P. attenuata*. The flanges at the apex of the aedeagal shaft are present in *P. attenuata* but are poorly developed in *P. erebus*.

***Penthimia fraterna* Distant**

(Plate 5b & Fig. 18)

Structure as described by Distant (1918) with the following additions. Yellow with slight tinge of brown, face black with pale brownish spot at base of clypeus. Vertex finely striated with black obscure spot between ocelli. Scutellum with basal triangles black. Tegmina pale yellow with reddish faint veins, four cross veins between claval suture and outer claval vein.

Male genitalia: Pygophore with excavation on dorso-caudal area with stout setae at caudal one third at dorso-ventral region. Subgenital plate triangularly produced on lateral margin near base with rounded apex. Style slender with well developed preapical lobe, in line with the curvature of the apophysis, both together forms S. Connective with arms about as long as stem. Aedeagus with well developed plate-like dorsal apodeme, shaft directed caudo-dorsally, with lateral serrated flanges, apex with U-shaped excavation, surface with number of spicules in distal half; gonopore apical.

Measurements: Male 4.96 mm long, head 2.00 mm wide across eyes, 2.0 mm wide across pronotum.

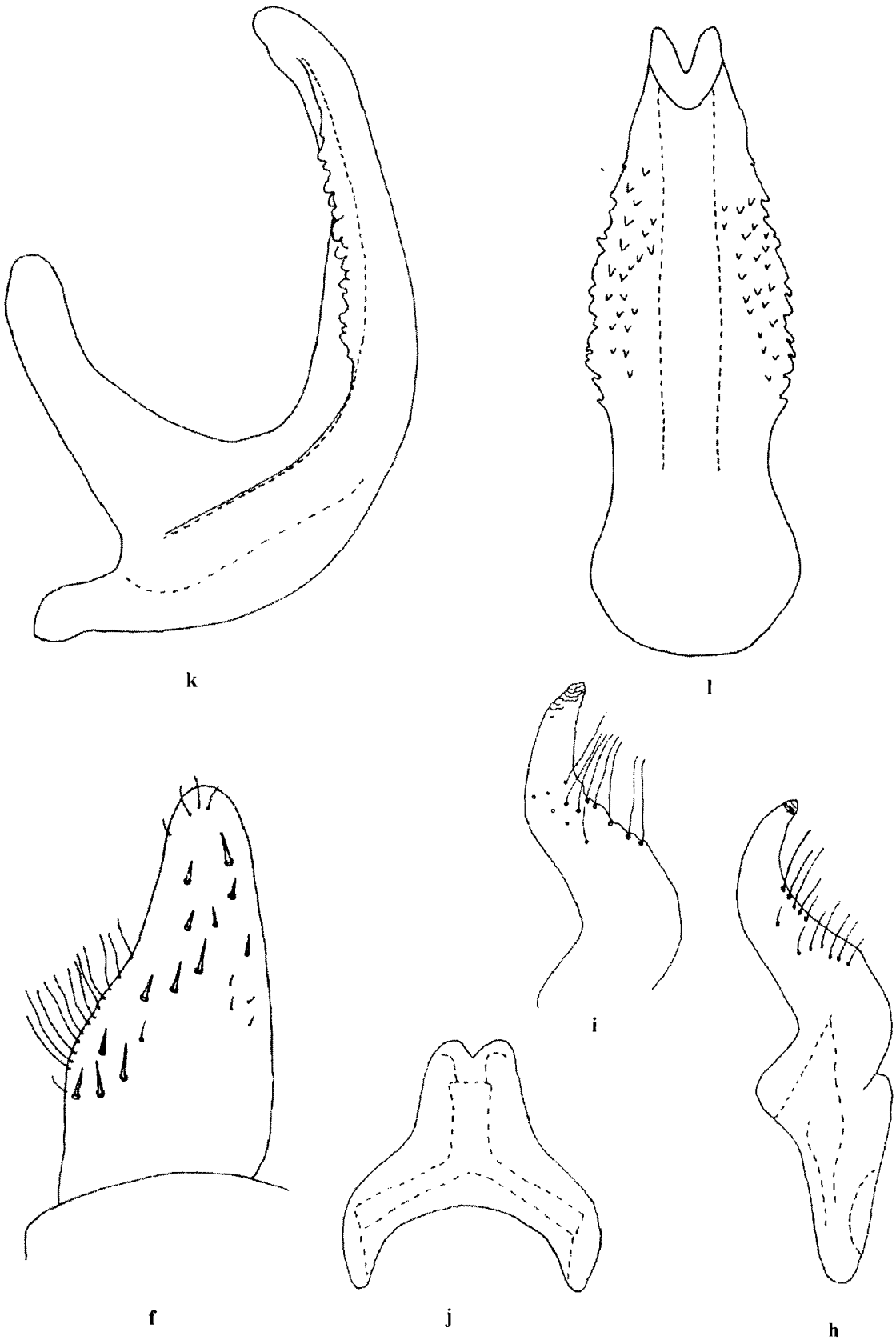
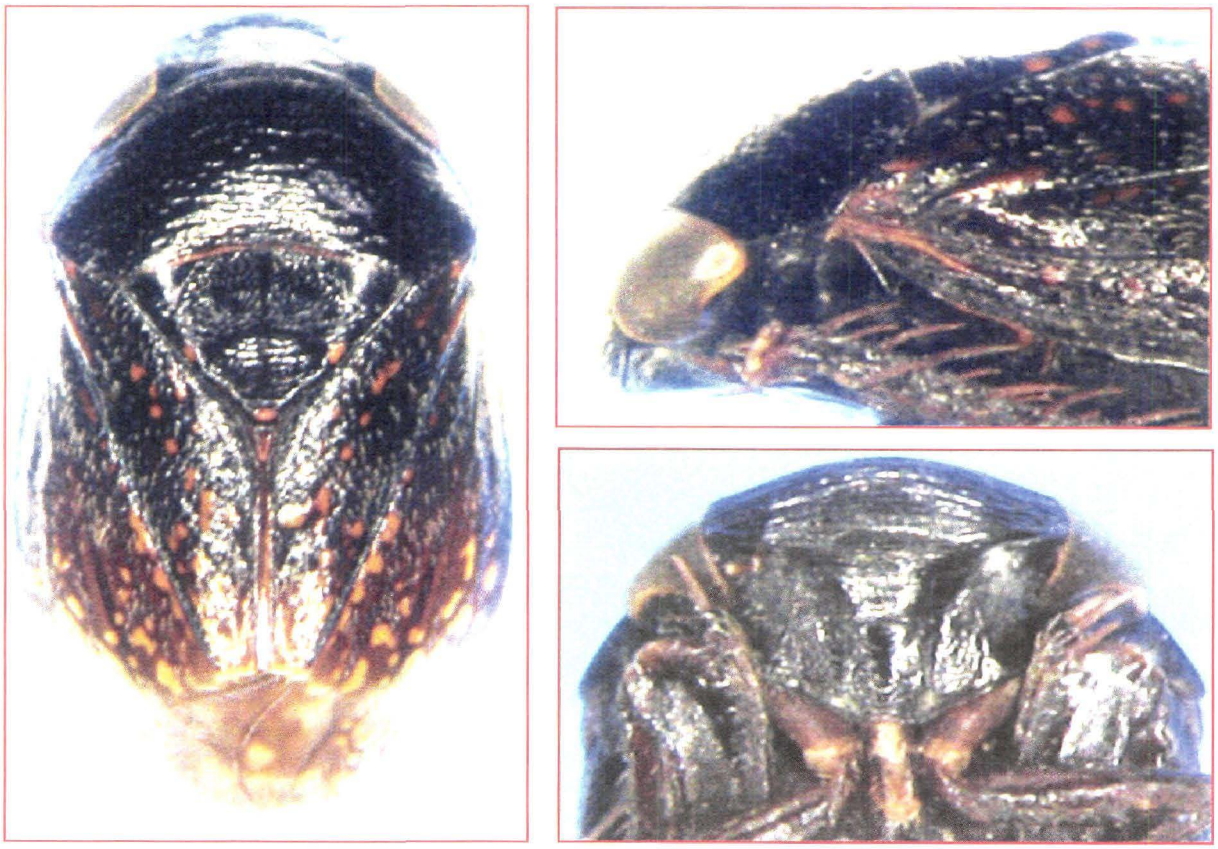
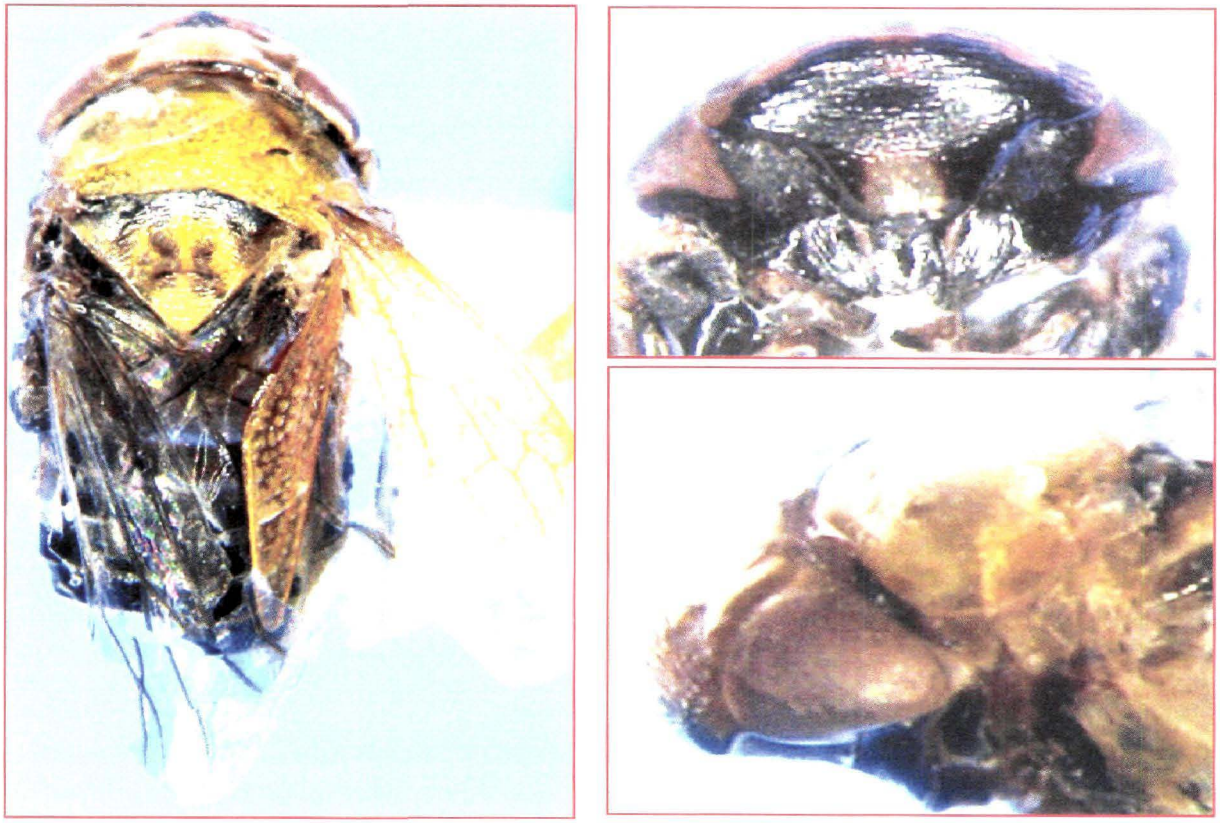


Fig. 18. *Penthimia fraterna* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used



a. *Penthimia erebus* Distant



b. *Penthimia fraterna* Distant

Plate 5

Material examined: Type 1 ♂, 'Type H.T' '*Penthimia fraterna* Dist. type' 'Kodaikanal, S. India, T. V. Campbell' 4.16, 39_9 'S. India, E A. Butler, B M.1915-60' (BMNH). *Other material examined*: INDIA: Karnataka: 1 ♂, Chikkaballapura, T.V. Campbell. 2 ♀, Madanapalle, T. V. Campbell (BMNH); Tamil Nadu: 1 ♂, S. INDIA: Coonoor, T.V. Campbell. S. India. 1 ♂, Madras, Nilgirihills, Lovedale, T.V. Campbell (BMNH). 1 ♂, Nilgiris, Thittikkal, 21.x.2003, K.D. Prathapan (UASB).

Remarks: *P. fraterna* differs from other species of *Penthimia* in having peculiar S-shaped style. The aedeagal shaft of *P. fraterna* resembles that of *P. montana*.

***Penthimia funebris* Distant**

Colouration and structure as described by Distant (1918).

Material examined: Type: 1♀'Type H.T' '*Penthimia funebris* Distant. Type' 'Lovedale, NilgiriHills, 7200ft, T.V.Campbell, 5.15, 105_6, S. India, E A Buttler 1915-16 (BMNH). *Other material examined:* INDIA: Tamil Nadu, 1♀, Coonoor, Nilgiri Hills, and T. V. Campbell, 202_{10}, 2♀, Nilgiri Hills, Lovedale, T.V. Campbell (BMNH).

Remarks: P. funebris resembles *P. scutellata* with respect to colouration of head and pronotum and can be differentiated with respect to the scutellum. The scutellum of *P. funebris* is pale brownish without black black spots whereas in the case of *P. scutellata* has black spots.

***Penthimia juno* Distant**

Colouration and structure as described by Distant (1908) with the following additions. Small black species. Punctuations on vertex visible centrally. Scutellum with depression in anterior half where it is punctate and a faint short carina (it is a shining ridge) visible. Forewing entirely black except for dark brown membrane.

Measurements: Female 3.76 mm long, head 1.6 mm wide across eyes, 1.88 mm wide across pronotum.

Material examined: Type 1♀, 'Type H.T' '*Penthimia juno* Dist. type' 'Kandy, Sri Lanka' (BMNH).

Remarks: This species has punctations on vertex which are visible centrally. The scutellum has depression in anterior half where it is punctate and a faint short carina (it is a shining ridge) is visible. This species resembles *P. scutellata* with respect to the head and the pronotum but can be differentiated based on the characters of the scutellum.

***Penthimia maculosa* Distant Stat. nov.**

(Plate 6a & Fig. 19)

Black finely striated. Disc of vertex with four obscure reddish-brown spots between eyes. Scutellum with a dark brown spot at middle of lateral margin, one spot at apex, with tip dark brown. Body beneath black. Labium almost reaching mid coxae.

Male genitalia: Caudal margin of Pygophore rounded with a few thick setae on caudo-dorsal margin, with few small setae on ventral region. Subgenital plates broadly rounded at the base, narrowing towards apex, surface with long thin setae. The connective with stem more than twice longer than arms. Style is broad at anterior half, narrowing posteriorly abruptly laterally curved in apical 0.25 and then again caudally forming a hook, body of style is covered with hair-like setae, preapical lobe absent, apical apophysis as shown in figure. Aedeagus simple, broad at base, curved caudo-dorsally, apex obliquely truncate in lateral view, dorsal apodeme and preatrium not well developed; gonopore apical.

Female terminalia: Seventh sternite rectangular, hind margin with median projection, with concavity in middle.

Measurements: Male 5.6 mm long, head 2.24 mm wide across eyes, 2.76 mm wide across pronotum. Female 5.4 mm long, head 2.20 mm wide across eyes, 2.70 mm wide across pronotum (Table 4 & 5).

Material examined: Syntypes, 1♀, 'Margherita 864_4 and Distant',1♀, Bombay, Dixon'; 1♀, Margue; 1♂, 1♀, Myitta, Doherty (BMNH). *Other material examined:* Burma: 2♂, Yedashe, 9.iii.1918, A. G. R. Coll R-8240 (IARI, New Delhi); West Bengal: 1♀, Sukhna, 1.ix.1981. C. A. Viraktamath (UASB).

Remarks: The type series of this species comprises of mixture of species. The male from Myitta is designated here as the lectotype to objectively define the species. The specimens from Mussoorie and Calcutta belong to *P. scapularis* (See remarks under *P. scapularis*).

P. maculosa can be distinguished from other species of *Penthimia* based on the peculiar style and the lateral margin of the subgenital plate being broadly rounded at base.

***Penthimia majuscula* Distant**

(Fig. 20)

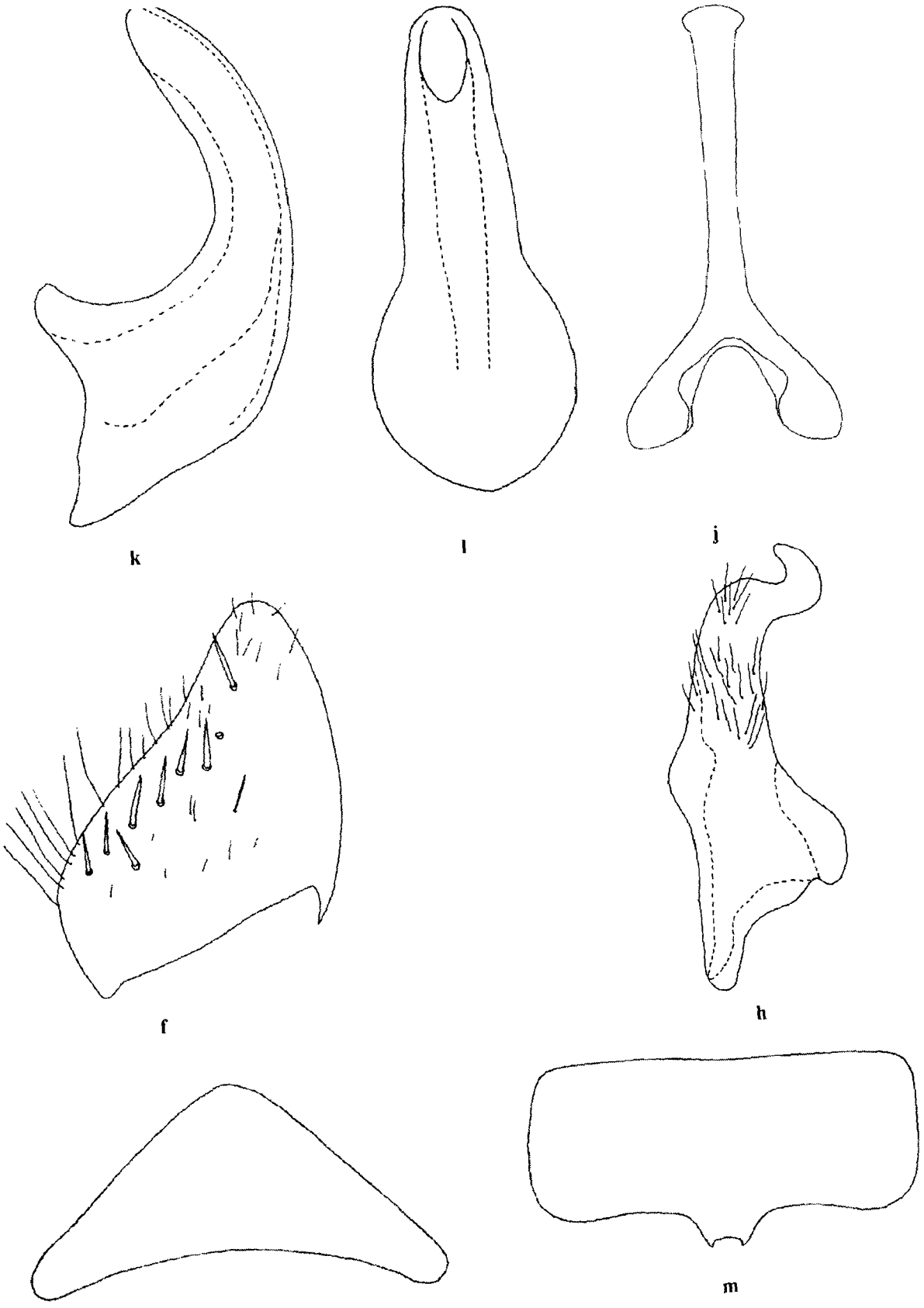


Fig. 19. *Penthimia maculosa* Distant

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used

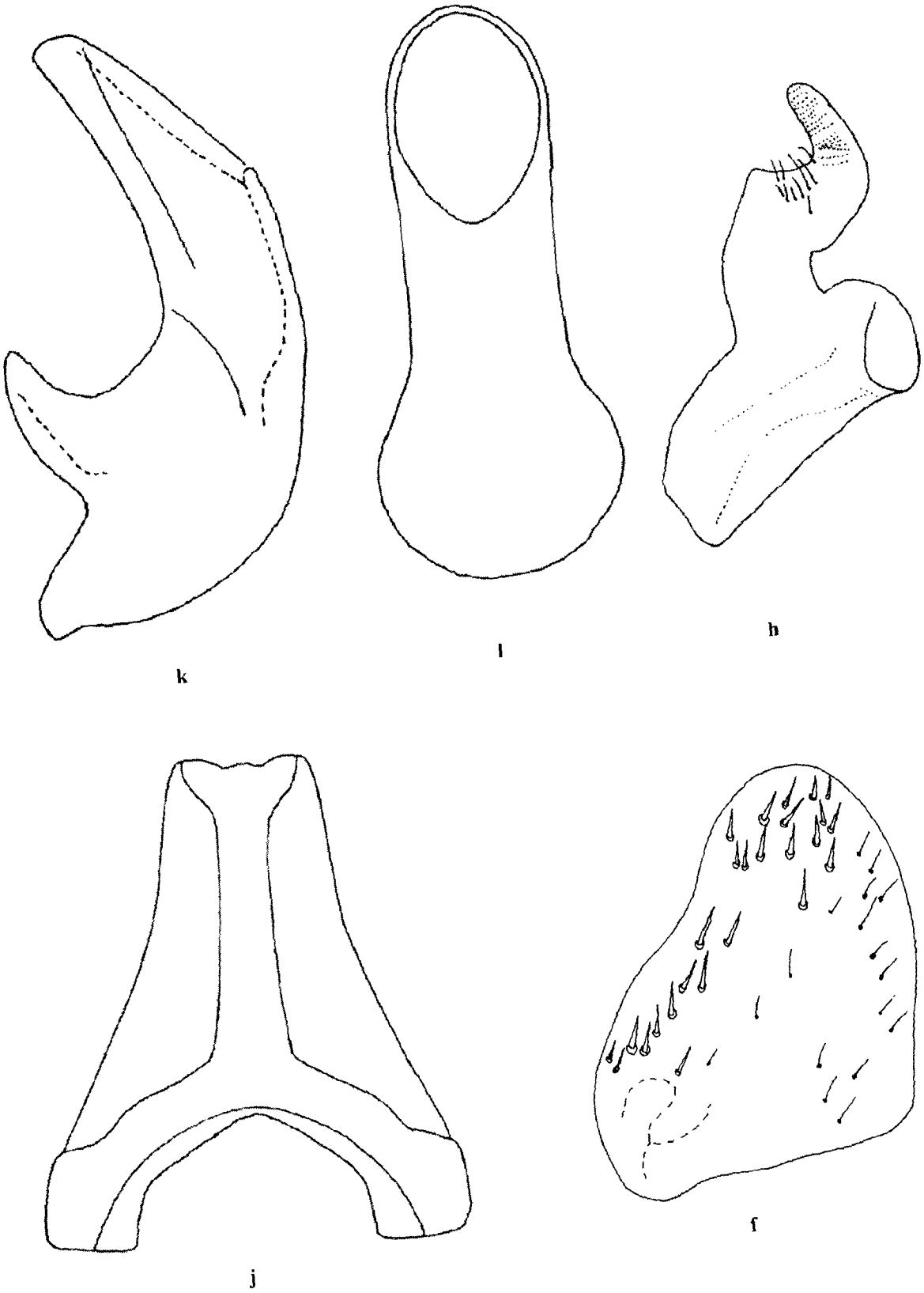


Fig. 20. *Penthimia majuscula* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

Colouration and structure as described by Distant (1918) with the following additions. Vertex and pronotum greenish yellow with posterior and lateral margins slightly margined with dark brown. Scutellum with three marginal black spots. Wings chocolate brown.

Male genitalia: Subgenital plate with rounded apex, lateral margin sinuate with stout setae at caudal one third and lateral margin. Style with well developed preapical lobe, apical apophysis finger-like, curved laterally with corrugated surface. Connective long with arms shorter than stem. Aedeagus simple, dorsal apodeme and preatrium short, shaft slightly dorso-anteriorly curved, slightly narrowed caudally with large gonopore on ventral margin, gonopore apical with U-shaped excavation.

Measurement: Male 5.6 mm long, head 2.4 mm wide across eyes, 2.64 mm wide across pronotum.

Material examined: Holotype ♂, 'Chikkaballapura, S. India, T. V. Campbell' 'C B 7/4, 72 $_{98}$' '*Penthimia majuscula* Dist. Type' 'S. India. E. A. Butler, B. M. 1915-60' (BMNH). *Other material examined:* 1♀, Fraser pet, Coorg, F.R.I. Sandal Insect Survey, 30.vi.'30. 1♂, Alagar Kovil, Madurai Dist. S. India, 8.iii.'36 (IARI, New Delhi).

Remarks: This species has greenish yellow vertex and pronotum with posterior and lateral margins slightly margined with yellowish brown. The wings are chocolate brown. The scutellum has three marginal black spots. The male from Alagar Kovil is similar to the type but has two dark spots on the pronotum.

***Penthimia meghalayensis* sp. nov.**

(Plate 6b & Fig. 21)

Black finely striated. Labium pale brown, exceeding fore coxae. Apical area of forewing light brown. Body beneath black. Hind legs with dark brown to black spines.

Male genitalia: Pygophore with caudal angle almost truncate, ventral margin straight with long stout setae on caudal one third. Subgenital plate with long hair-like setae. Aedeagus with well developed dorsal apodeme, shaft of uniform width in basal 0.75 length, then narrowed, apex curved, hooked, with a lateral feebly serrated flanges, gonopore apical.

Measurements: Male 4.20 mm long, head 1.60 mm wide across eyes, 1.8 mm wide across pronotum (Table 4).

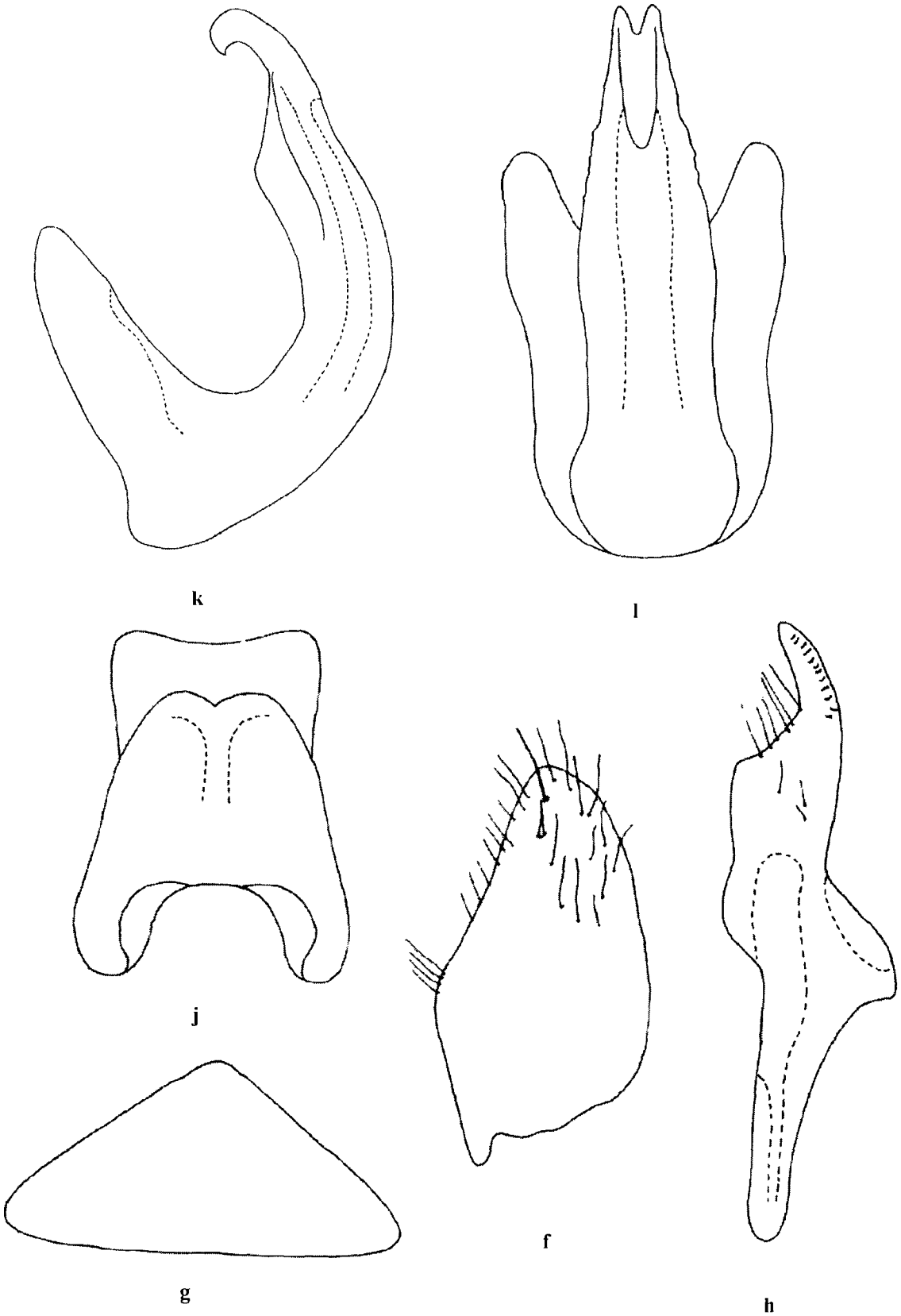
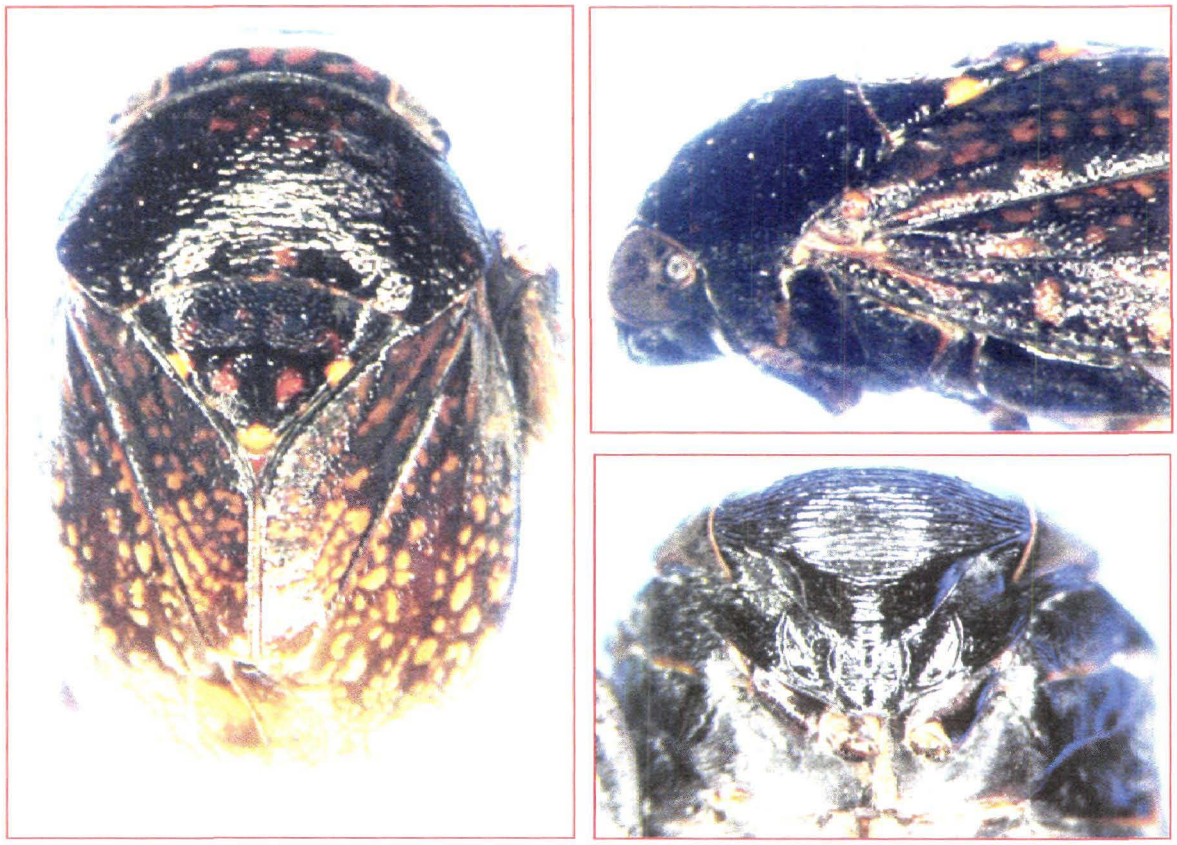
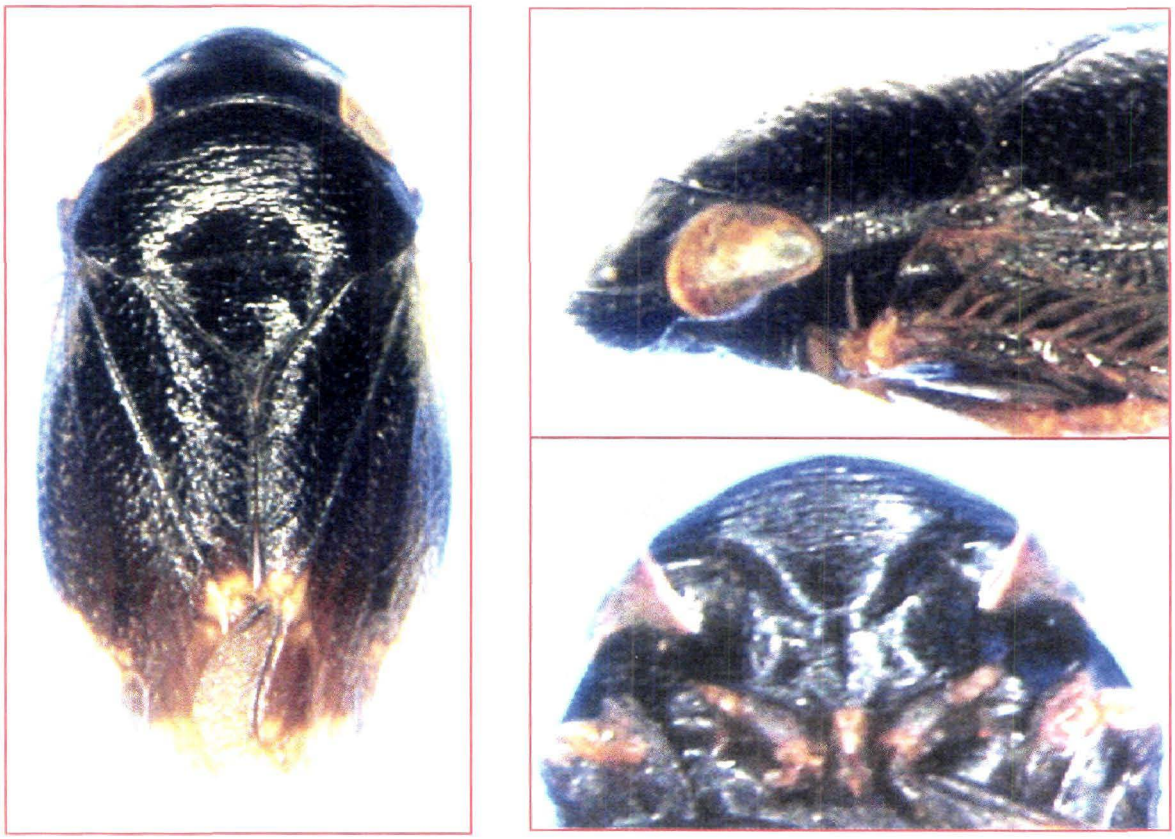


Fig. 21. *Penthimia meghalayensis* sp. nov.

Refer legends of Fig. 2 of Chapter III for details of alphabets used



a. *Penthimia maculosa* Distant



b. *Penthimia meghalayensis* sp. nov.

Plate 6

Material examined: INDIA: Meghalaya, Holotype ♂, Nangpoh, 752m, 4.xi.1981, C. A. Viraktamath: 1♂, Nangpoh, 752 m, 4.xi.1981, C. A. Viraktamath (UASB)

Remarks: P. meghalayensis externally resembles *P. noctua*. The aedeagus of *P. meghalayensis* has more prominent lateral flanges compared to that in *P. noctua* and the apical hook of shaft is slender in *P. noctua* compared to that in *P. meghalayensis*.

***Penthimia melanocephala* Motschulsky**

Colouration and structure as described by Distant (1908) with the following additions. Entire head jet black, rest of the body reddish brown.

Material examined: INDIA: Karnataka, 1♀. Nandidrug, T. V. Campbell. 1♀, Myitta (Doherty) (BMNH).

Remarks: This species has the head entirely jet black and the rest of the body reddish brown and the inner claval margin black. Some specimens of *P. atra* Fabricius are similar to this species. Type of this species has not been examined. *P. melanocephala* resembles the female of *P. attenuata.*

***Penthimia montana* Distant**

(Fig. 22)

Penthimia nilgiriensis Distant 1918b:16

Penthimia montana Distant 1918b:17. **syn. nov.**

Males with vertex and scutellum yellow with slight tinge of brown, vertex with a black spot at apex, sometimes nearly whole apical margin black. Ocelli black. Pronotum paler greenish-yellow, with two darker spots near anterior margin. Scutellum with a black spot near each basal angle, two small spots, a transverse line on disk black, scutellum a little longer than vertex of head. Face (excluding anterior margin) black; body beneath, legs black, apices of femora, anterior, intermediate tibiae, tarsi pale yellowish, tibiae longitudinally streaked with black, bases of posterior tibiae and tarsi pale yellowish. Tegmina reddish-brown, thickly mottled, two small black spots at apex of claval area, apical area paler, uniformly coloured, its inner margin with some dark suffusions.

Females with vertex, pronotum, scutellum dark yellowish or pale reddish brown. Body beneath, legs more or less yellowish , apices of posterior femora sometimes with black suffusions. Tegmina very dark yellow with slight tine of brown.

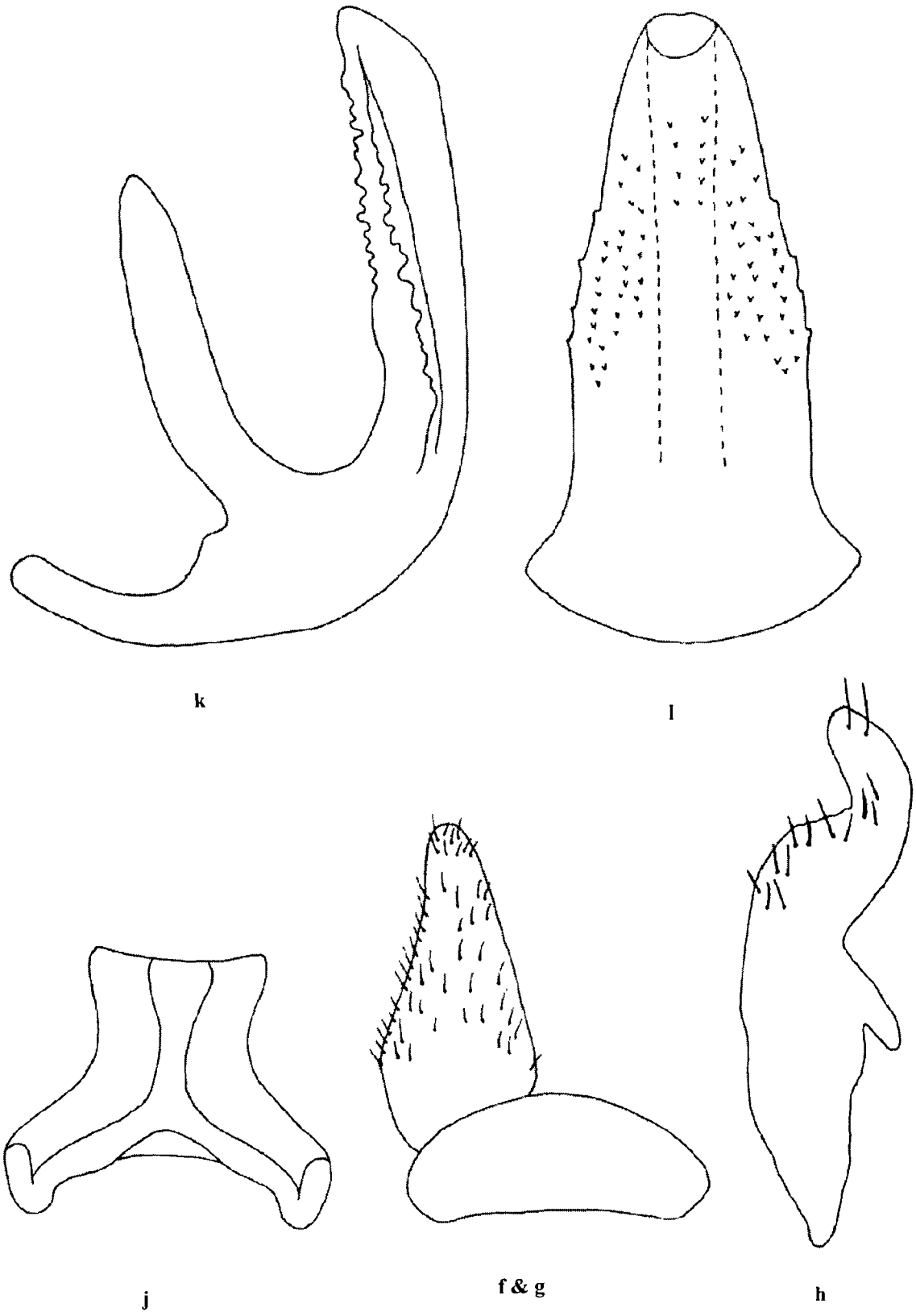


Fig. 22. *Penthimia montana* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

Vertex of head considerably shorter than scutellum, anterior margin conically, almost subacutely produced. Pronotum declivous towards vertex of head, finely but obscurely wrinkled, basal margin almost straight. Scutellum a little broader than long, transversely impressed near middle. Tegmina distinctly finely granulose, punctate. Bases of spinules to posterior tibiae sometimes black, the extreme apices of posterior tibiae black.

Male genitalia: Valve with posterior margin broadly rounded. Subgenital plate with long fine setae. Connective with arms about as long as stem. Style linear with well developed preapical lobe, apophysis finger-like, curved laterally. Aedeagus with well developed dorsal apodeme and preatrium. Shaft directed caudo-dorsally, then erect dorsally with serrated lateral margins, gradually tapering in width towards apex, basal half smooth, distal half with large number of spicules; gonopore apical.

Measurements: Male 5.20 to 5.28 mm long, 2.08 mm wide across eyes.

Material examined: Type 1♂, 'Type H.T' '*Penthimia montana* Dist. type' 'Lovedale, Nilgirihills, S. India, T. V. Campbell. L 5-15, 8/15', 'S. India, E. A. Butler 1915-60' (BMNH). *Other material examined*: 3 ♂, data as for type H. T, 1♂, S. India, Madras, Coonoor, T. V. Campbell; 1♂, S. India, Nilgirihills, Lovedale. T. V. Campbell (BMNH). 1♀ 'Type H. T.' '*Penthimia nilgiriensis* Dist. Type' on Rhododendron, Lovedale, Nilgiri Hills, S. India, T. V. Campbell, L 6.15, 45 $_{6,}$ S. India, E. A. Butler, 1915-60. 1 ♀, Same data 85 $_{6}$ 8♀, S. INDIA, Nilgiri Hills, Lovedale, T. V. Campbell (BMNH).

Remarks: Careful examination of the types of *P. montana* and *P. nilgiriensis* showed that they are male and female of the same species, the former being the male and the latter being female. Therefore they are treated as synonyms. The aedeagal shaft of *P. montana* and *P. fraterna* have spicules and serrated lateral margins, however, they differin the curvature of shaft both in lateral and caudal view (Fig).

***Penthimia mudonensis* Distant**

(Plate 7a)

External colourations and structure as described by Distant (1918).

Female terminalia: Hind margin of seventh sternite with median projection with concavity in middle.

Measurements: Female 5.30 mm long, head 2.20 mm wide across eyes, 2.60 mm wide across pronotum (Table 5).

Material examined: Burma: Yadashe, 1♀, 10.iii.1918, and A.G.R. Coll. R-8239. (IARI, New Delhi).

Remarks: This species is distinct from other species of *Penthimia* in having following characters. Body above reddish-brown, vertex of head with the anterior and basal margins, a central longitudinal line, and the eyes black. Forewing has large tassellate apical area, which is not found in other species.

***Penthimia noctua* Distant**

(Fig. 23)

Penthimia nitida Distant 1912d: 444; 1918b:21.

Penthimia distanti Baker 1924d: 367, *nom. nov. pro. nitida* Distant 1912 not Lethierry 1876.

Males shiny black, apical area of tegmina greyishly subhyline outwardly, inwardly yellowish brown, more or less extending upward the opaque black area. Head rounded in front, anterior margin somewhat acutely reflexed. Pronotum moderately convex, slightly wrinkled, sparingly coarsely punctate. Scutellum opaquely black, thickly finely punctate. Legsyellowish with slight tinge of brown, anterior femora basally suffused with black, posterior legs suffused with black, posterior tibiae strongly spinose, tarsi yellow.

Females black, apical margins of the tegmina broadly yellowish. Vertex shorter than scutellum, somewhat strongly declivous and in line with deflected anterior area of pronotum, anterior margin subconically rounded. Legs yellow with slight tinge of brown, longitudinal markings to femora, posterior tibiae black. Tegmina somewhat rugosely wrinkled, sub-truncately rounded at apices, a little narrowed at base, a small dull yellowish brown spot at apex of each claval area.

Male genitalia: Subgenital plate triangular with short hair like setae. Preapical lobe of style well developed, apical apophysis long, finger-like with corrugated lateral margin at apex. Aedeagus with well developed bilobed dorsal apodeme, preatrium short, shaft tubular directed caudally at base, then erect dorsally, abruptly tapered at apex, slightly curved forming hook-like structure, lateral margin serrated at apical one third, gonopore apical, with V- shaped excavation.

Measurement: Male 4.0 mm long, head 1.44 mm wide across the eyes, 1.68 mm wide across pronotum, 1.84 mm wide across pronotum. Female 4.4 mm long, 1.6 mm wide across head, 1.84 mm wide across pronotum.

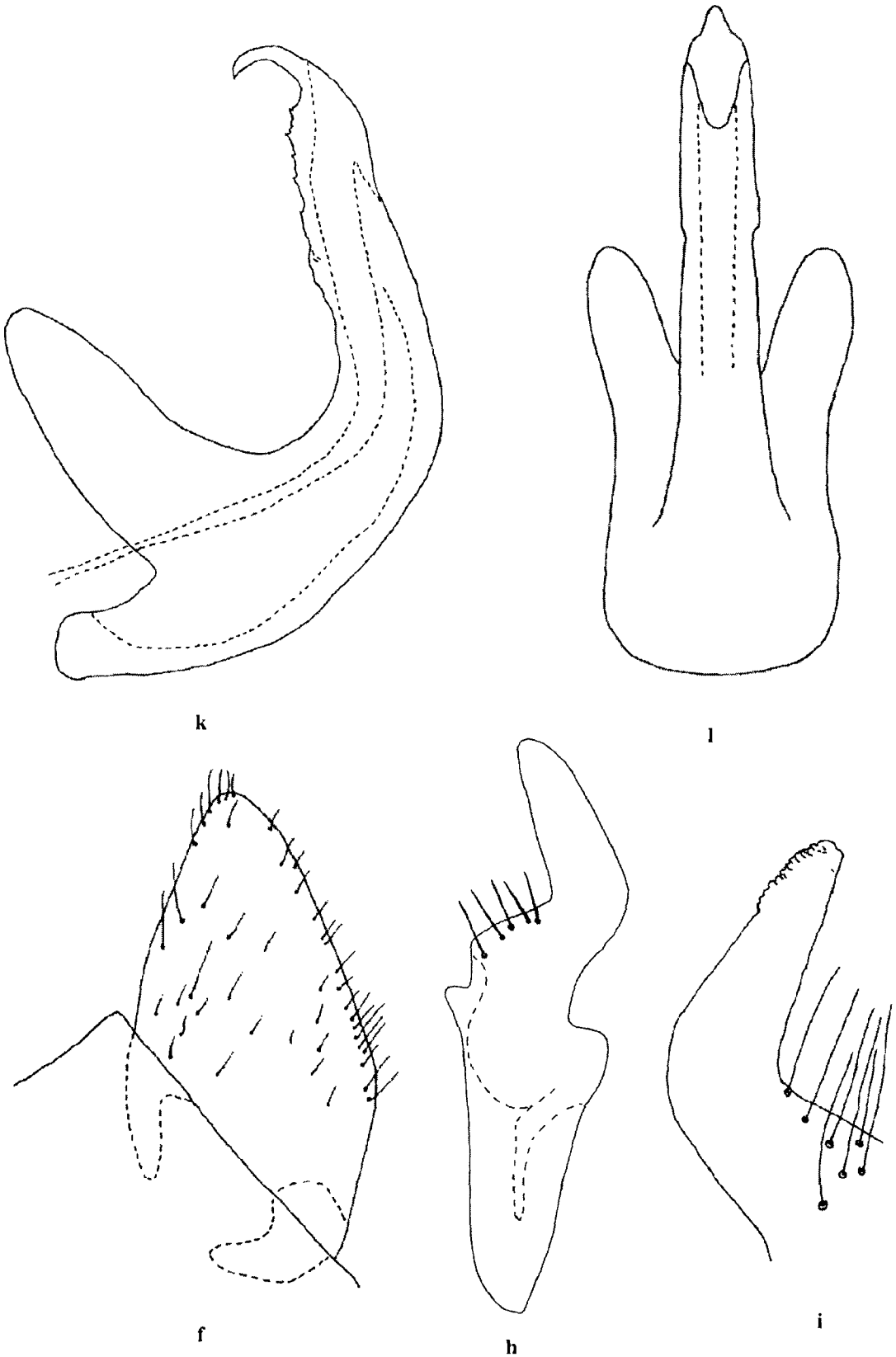


Fig. 23. *Penthimia noctua* Distant

Refer legends of Fig. 2of Chapter III for details of alphabets used

Material examined: Type 1♂, 'Type, H.T' '*Penthimia noctua* Dist. type' 'Moulmein' 'Distant coll.1911-383'. Syntype ♂, '*Penthimia nitida* Dist'. '(Burma), Moulmein, Distant coll.1911-383' (BMNH). 1♀, 'Type H. T' '*Penthimia noctua* Dist. Type' 'Darjiling, Himalaya, Railway 1600ft, 23.iv.15. Distant coll. 1911-383. *Other material examined*: 1♀, INDIA: Namkum, 20.ii.1957, on *Butea monosperma* det. M. S. K. Ghauri (BMNH).

Remarks: Careful examination of types of *P. distanti* and *P. noctua* revealed that they are male and female of the same species. The former being male and the latter female and hence the synonymy. *P. meghalayensis* and *P. curvata* externally resemble *P. noctua* (Distant) but differ in the structure of the aedeagal shaft. The hook at the apex of shaft is much slender and broader in *P. noctua* compared to *P. curvata* and *P. meghalayensis*.

***Penthimia quadrinotata* Distant**

(Fig. 24)

Colouration and structure as described by Distant (1918).

Male genitalia: Connective with stem twice longer than arms, lateral margins of arms strongly pigmented. Style broad medially with well developed preapical lobe, apical apophysis finger-like, curved laterally with apex truncate. Aedeagus with plate like dorsal apodeme, preatrium reduced, shaft cylindrical, curved caudo-anteriorly with well developed median ridge ventrally; gonopore large on ventral margin.

Material examined: Type 1♂ 'Type H.T' '*Penthimia quadrinotata* Dist. type' 'Kodaikanal', 'S. India, T. V. Campbell' (BMNH). *Other material examined*: 12 ♂, 1♀ from Kodaikanal, T. V. Campbell (BMNH).

Remarks: This species has very distinct aedeagal shaft with well developed median ridge on ventral margin and slender, elongate apophysis of the style.

***Penthimia sahyadrica* sp. nov.**

(Plate 7b & Fig. 25)

Black, with light brown spots on forewings. Scutellum broad, posterior half raised with a light brown spot at middle of lateral margin, a yellow spot at apex; tip of scutellum brownish. Labium reaching fore coxae. Hind femoral spinules dark brown.

Male genitalia: Pygophore with rounded caudal margin, ventral area with short setae. Subgenital plate angularly produced on lateral margin near base with caudal

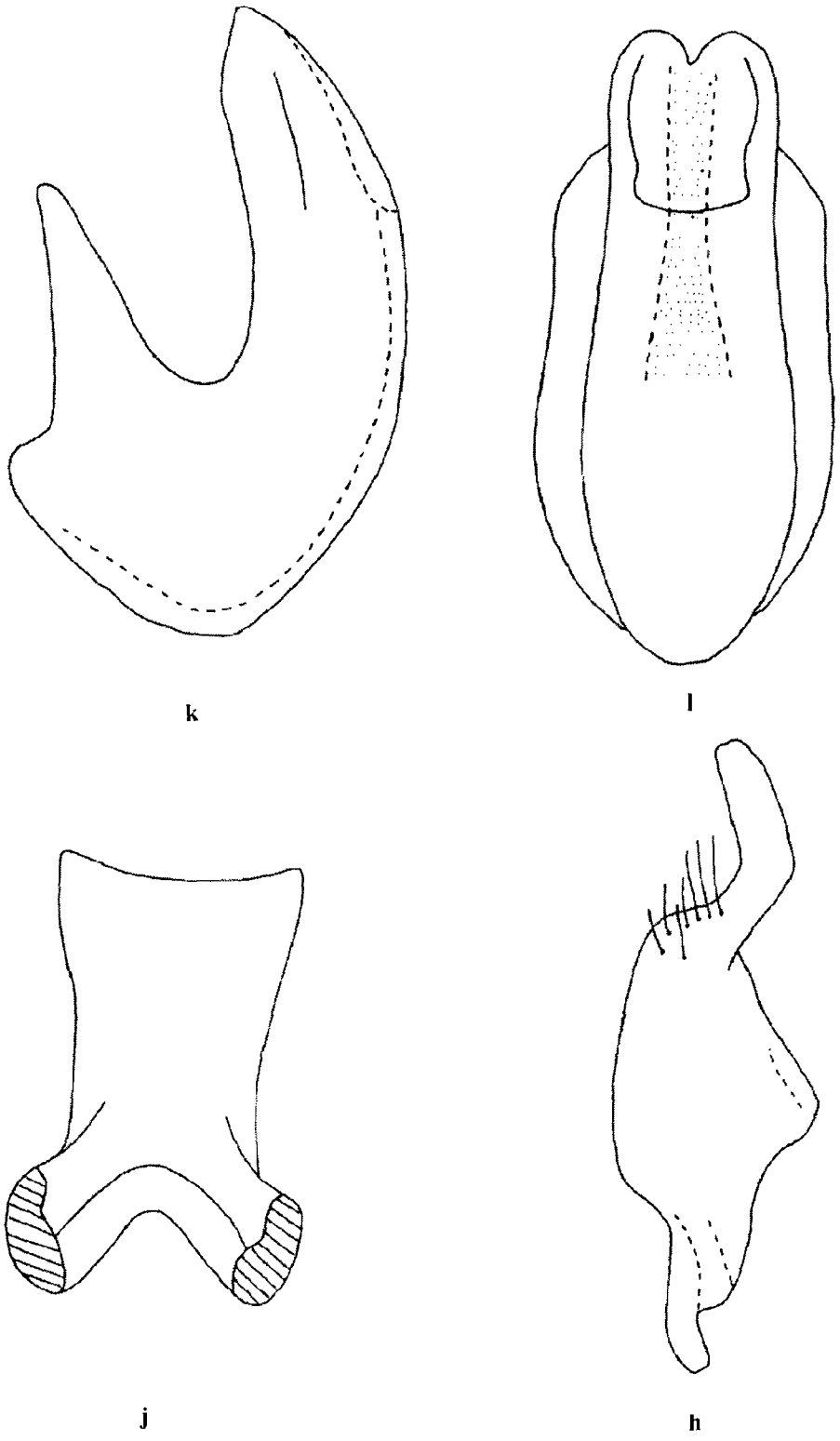


Fig. 24. *Penthimia quadrinotata* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

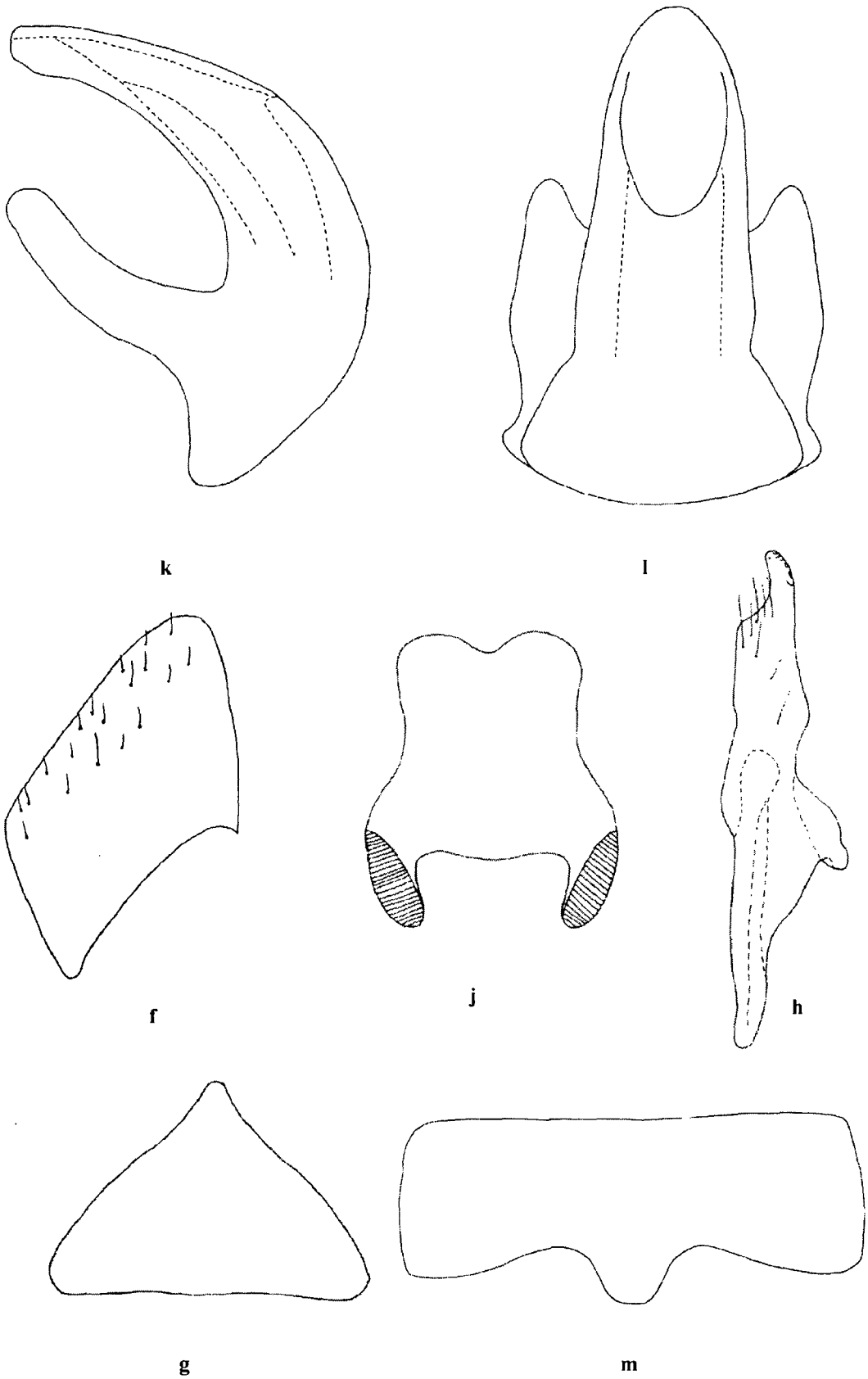
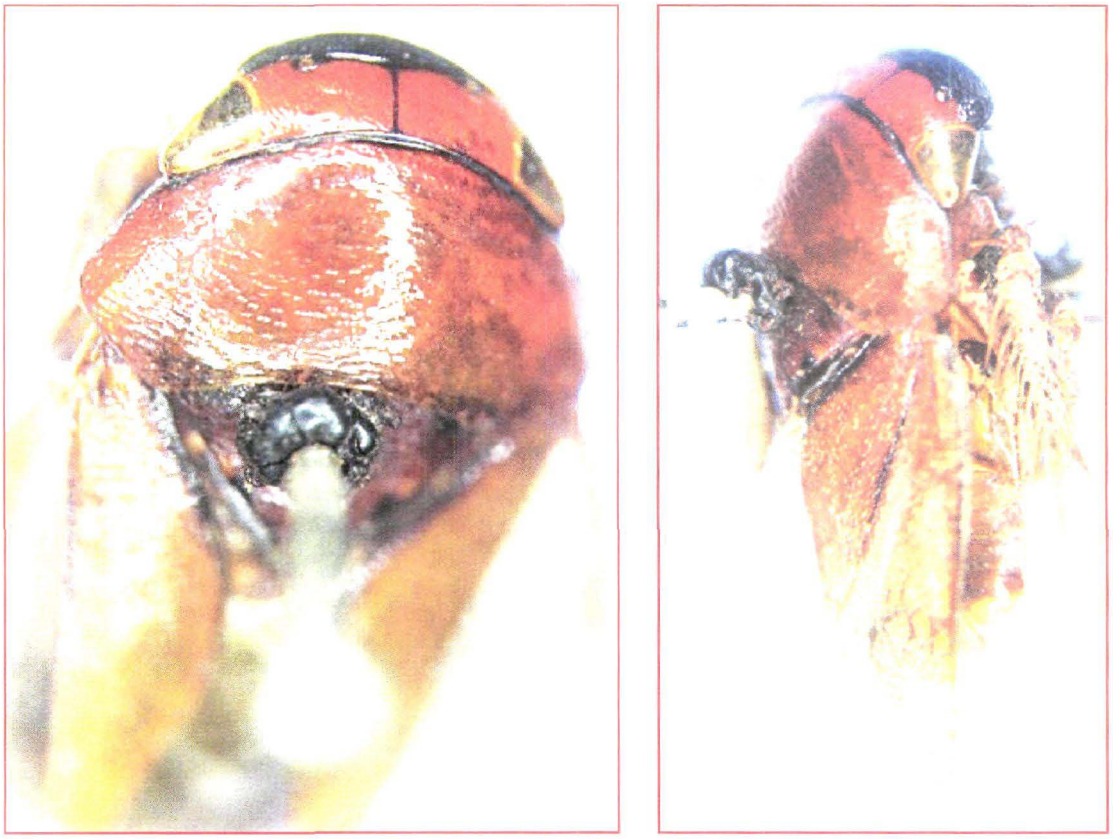
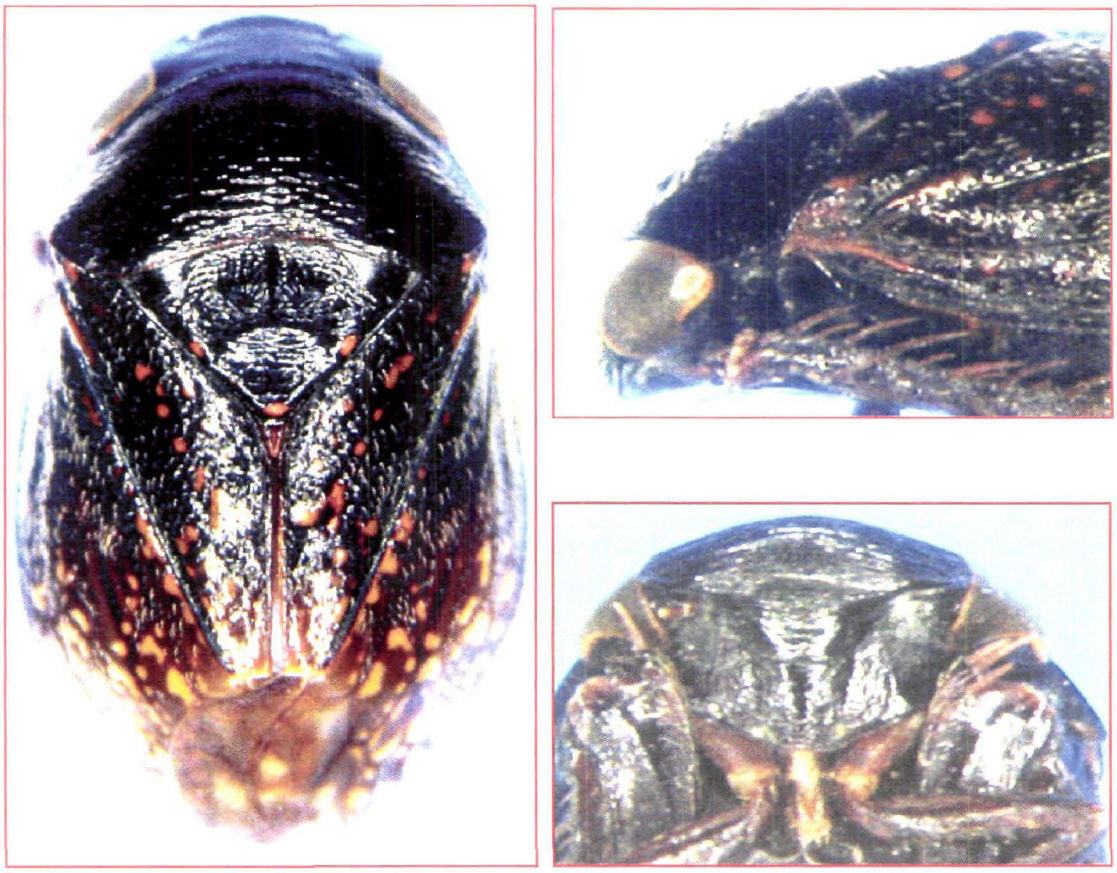


Fig. 25. *Penthimia sahyadrica* sp. nov.

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used



a. *Penthimia mudonensis* Distant



b. *Penthimia sahyadrica* sp. nov.

Plate 7

angle rounded, surface with short hair like setae. Style linear with well developed preapical lobe, apical apophysis short thumb-like. Connective with arms 0.33 as long as stem. Aedeagus simple, dorsal apodeme long, well developed, preatrium reduced, shaft curved dorso-anteriorly and slightly narrowed caudally, with large gonopore on ventral margin.

Female terminalia: Seventh sternite rectangular, more than twice broader than median length, hind margin concave with median projection.

Measurements: Male 3.80 mm long, head 1.70 mm wide across eyes, 1.95 mm wide across hind margins of pronotum. Female 3.80 mm long, head 1.67 mm wide across eyes, 1.93 mm wide across pronotum (Table 4 & 5).

Material examined: INDIA: Karnataka, Holotype ♂, Dharmasthala, 23. xi. 1984, S. Viraktamath: 1♀, Dharmasthala, 23. xi. 1984, S. Viraktamath: 1♂, Agumbe, 5.i.1984, S. Viraktamath. Kerala: 1♂, Thekkady, 27.iii.1977, S. Viraktamath (UASB).

Remarks: This species has male genitalia similar to those of *P. majuscula*, however the aedeagus in the new species has large, well developed dorsal apodeme compared to that in *P. majuscula* and differently shaped style and subgenital plates.

***Penthimia scapularis* Distant**

(Fig. 26)

Colouration and structure as described by Distant (1908).

Male genitalia: Valve triangular with rounded caudal margin. Subgenital plate triangularly produced on lateral margin near base, caudal margin rounded, surface with stout setae. Connective with stem two times longer than arms. Style broad with well developed preapical lobe, apical apophysis short thumb-like. Aedeagus simple with both dorsal apodeme and preatrium not well developed, shaft curved caudo-dorsally, gonopore apical on ventral margin.

Measurements: Male 4.8mm long, 1.72 mm wide across head, 2.00 mm wide across pronotum.

Material examined: Type 1♀, 'Type H.T' '*Penthimia scapularis*' Dist. type' 'Calcutta' 'Distant Coll.1911-383'. 1♀ 'Calcutta, 27.vi.07.Distant Coll., 1911-383' (BMNH). Syntypes, 1♀ Indian Museum, Calcutta, Indain museum compound, 1.vi.12, Distant coll. 1911-383, F.H. Gravely'. 1♂, 1♀, 'Mussoorie, N. India, alt circa 7000' 20-24.vi.o5, Brunnetti'. *Other material examined*: 1♂, 1♀, mounted together, Calcutta

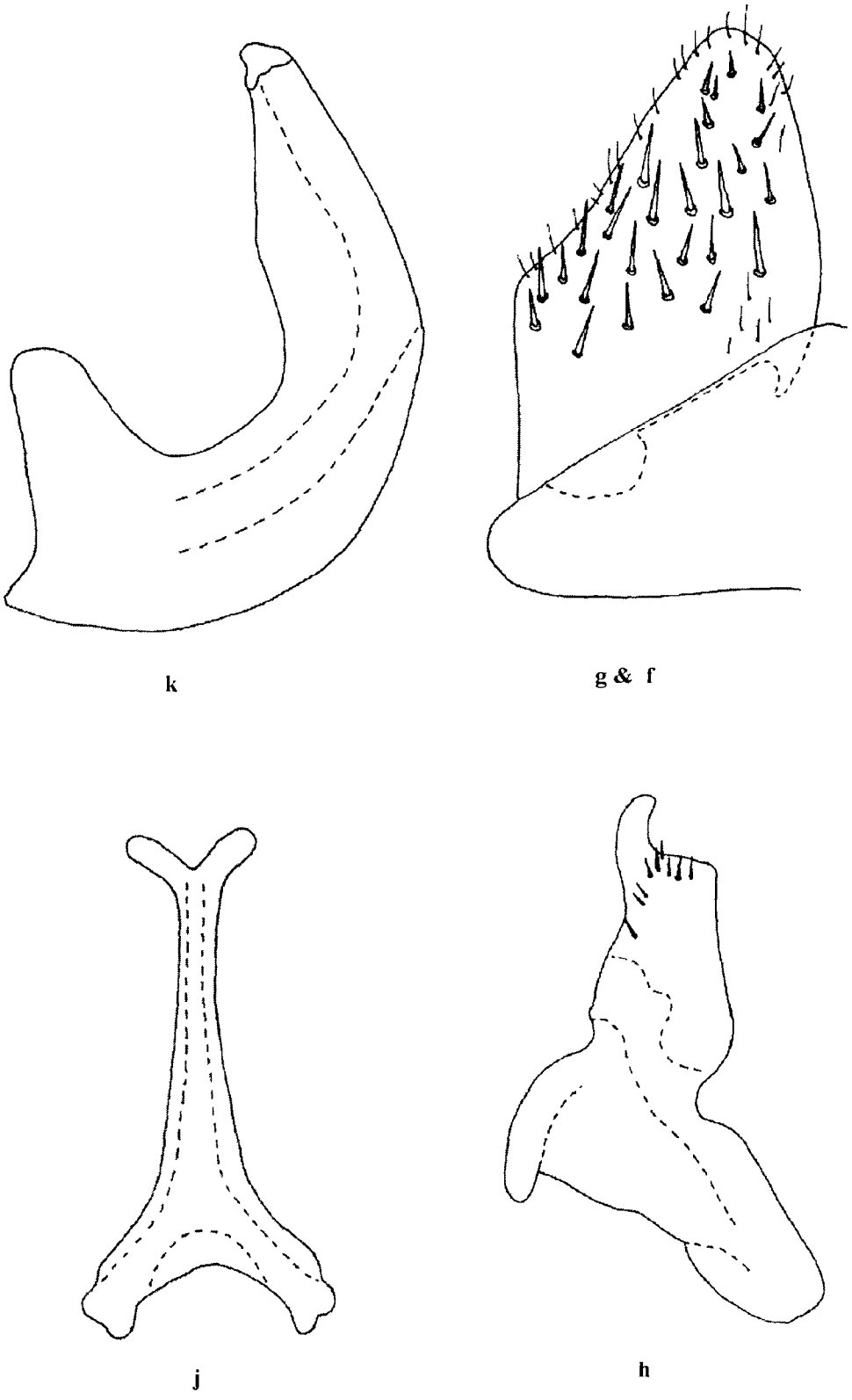


Fig. 26. *Penthimia scapularis* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

museum compound. 14. iii.15, 2424/21, Dist. Coll. 1911-383'; 1♀, Bombay 302; 1♀, Bengal; 2♂, Ind. Museum, Almora, 5,500ft, 29.ix.11, C. Paiva (BMNH).

Remarks: The type of *P. scapularis* is a female and an associated male from the type locality illustrated by Dr. C. A. Viraktamath has been given here. The synonymy of *P. maculosa* with *P. scapularis* made by Distant (1918) is erroneous as only few specimens of the syntype series of *P. maculosa* belonged to *P. scapularis*. With the designation of lectotype for *P. montana* the synonymy is now removed. *P. maculosa* differs from *P. scapularis* in the structure of apical apophysis of style.

***Penthimia scutellata* (Distant) comb. nov.**

(Plate 8 & Fig. 27)

Neodartus scutellatus Distant 1908g: 246; 1918b:25

Colouration and structure as described by Distant (1908) with the following additions. Male black, scutellum with yellow spots on middle of lateral margin, one spot at apex. Forewing with yellowish-brown spots; female with head black, pronotum yellowih-brown on posterior margin, scutellum bright yellow with basal margin black, markings on scutellum variable.

Male genitalia: Pygophore with rounded caudal margin, ventro-caudal area with long stout setae. Subgenital plate more strongly narrowed caudally, surface with long stout setae on distal half. Connective with arms shorter than stem. Style with preapical lobe well developed, apical apophysis short, thumb-like, slightly curved laterally, with pointed apex. Aedeagus with well developed dorsal apodeme, preatrium short, shaft compressed, curved caudo-dorsally with three to four rows of spicules on lateral margin ventrally, apex with U-shaped excavation; gonopore apical.

Female terminalia: Seventh sternite twice as wide as long, hind margin slightly concave with median projection, with concavity in the middle.

Measurements: Male 3.36 mm long, head 1.36 mm wide across eyes, 1.54 mm wide across pronotum. Female 3.82 mm long, head 1.49 mm wide across eyes, 1.69 mm wide across pronotum (Table 4 & 5).

Material examined: Syntypes: One specimen abdomen missing 'Type H. T' 'Neduukulam, 12.05, Sri Lanka, Green' '*Neodartus scutellatus* Dist. type' (BMNH). *Other material examined:* INDIA: Tamil Nadu: 1♀, Coimbatore, 18.ix.13, A.G.R. Coll; 1 ♀, 7.ix.12, A.G.R. Coll (BMNH). Karnataka: 1♀, Chikkaballapur, T. V. Campbell; 1

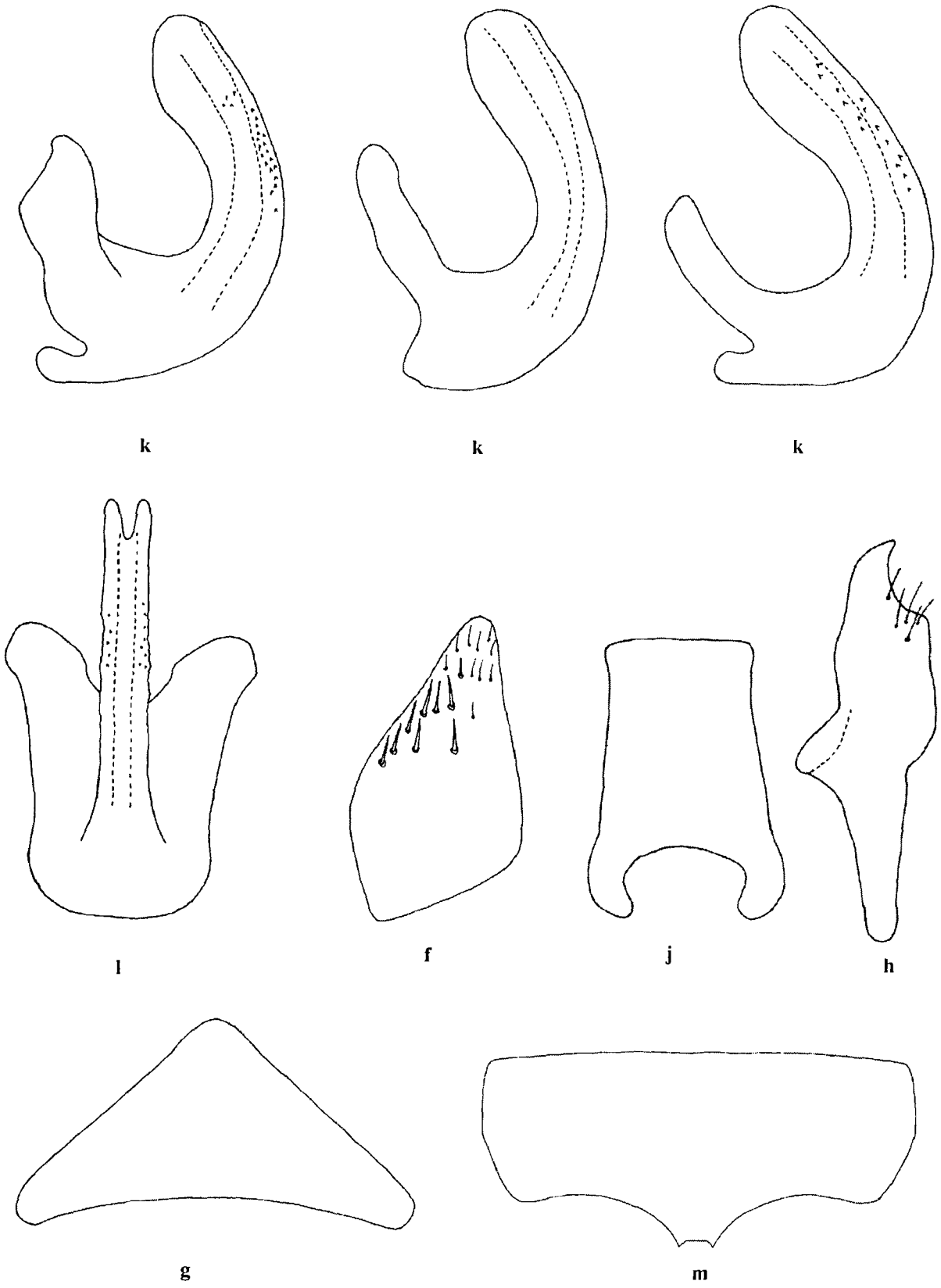
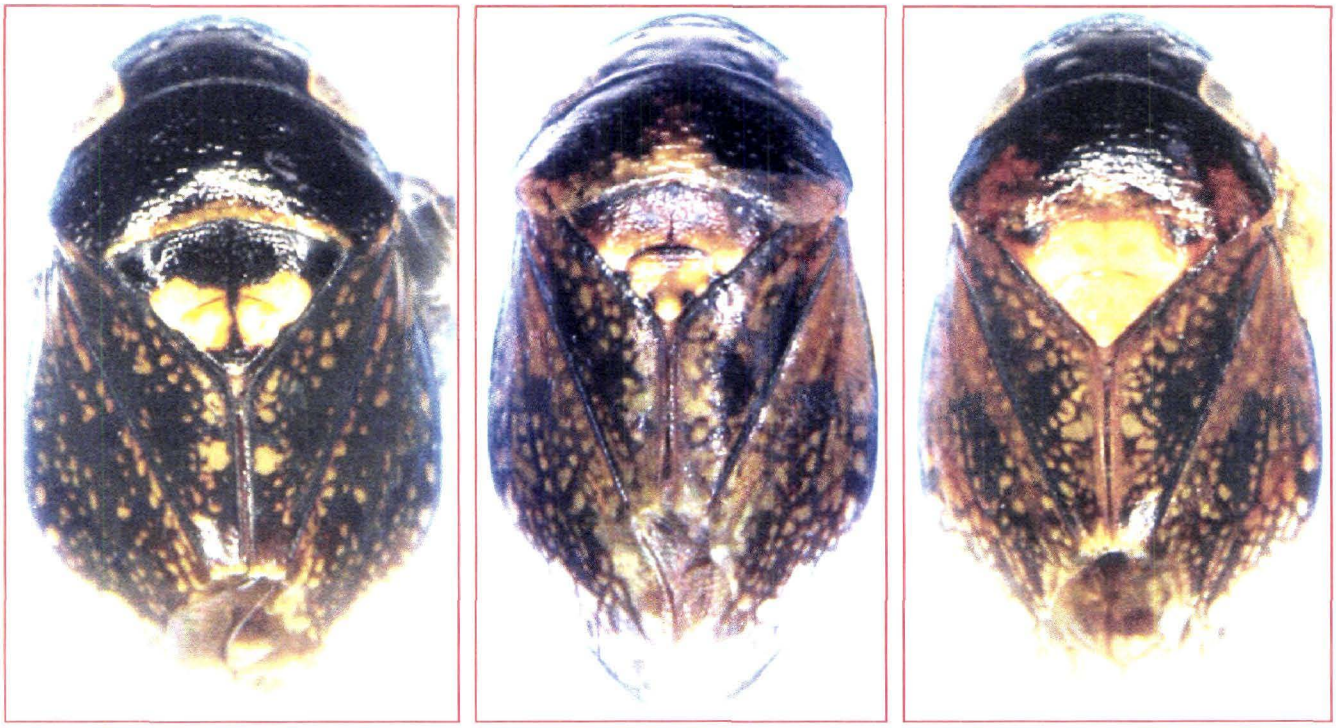
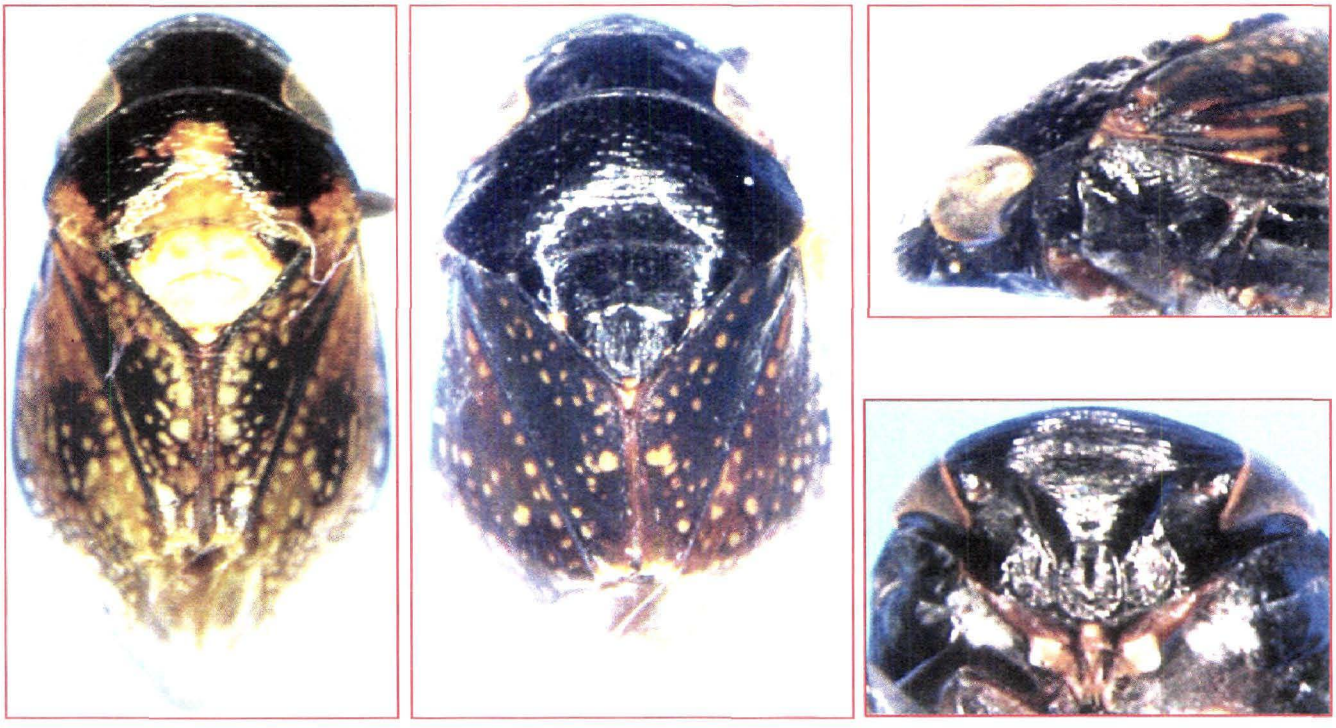


Fig. 27. *Penthimia scutellata* (Distant)

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Females



Female **Male**

Penthimia scutellata **(Disatnt)**

Plate 8

♀, Devaraya Drug, T. V. Campbell 203 $_{10}$ (BMNH). 1♀, 24 Km N Arsikere, 23.vii.1978, C. A. Viraktamath; 2♀, Bangalore, 16.iv.1976, C. A. Viraktamath; 1♀, Bangalore, 916 m, GKVK, 26.v.1982, H.V.A. Murthy; 3♂, 2♀, 26.iv.2006, Girish, K. S; 2♀, 1.v.2006. Shobharani; 6♀, 10.vii.2006, ex sandal, Shobharani, M; 1♂, Bangalore, FRL 916, 13.iii.1974, Sivaramakrishnan; 1♂, 119 Km N Bagepalli, 14.iv.1977, C. A. Viraktamath; 1♂, 20 Km S Belgaum, 12.xii.1983, S. Viraktamath; 1♀, Chikkaballapur, 3.viii.1976, B. Mallik; 2♂, 5♀, Chikkaballapur, 9.xii.2005, Shobharani, M; 3♂, 2♀, 27.ix.2005, Shobharani, M. 1♀ Chintamani, 16.x.2006, Shobharani, M; 1♂ , 4♀,10 Km N Hunsur, 16.i.1978, C.A. Viraktamath; 1♂,12-15 m S W of Hunsur, 18.i.1978, C. A. Viraktamath; 1 ♀, 20 Km N W of Doddaballapur, 18.vi.1977, C. A. Viraktamath; 1♂, Gulberga, 30.xi.1980, A.R. V. Kumar; 1♂,15 Km NE Ilkalgad, 17.ii.1977, K. D. Ghorpade; 1♂, Jog falls, 534m, 17.xi.1976, C. A. Viraktamath; 1♂, 17.xi.1976, B. Mallik; 1♂, 20.xii.1983, S. Viraktamath; 1♂, 12 Km, W Jog falls, 18.xi.1976, B. Mallik; 1♂, 2♀,8-12 Km of Karwar, 18.xii.1983, S. Viraktamath;1♂, 1♀, 27 Km E Kollegal, 8.viii.1977, C. A. Viraktamath; 1♀, Mudigere, 970m, 6.iv.1980, C. A. Viraktamath; 1♂, 18 Km, W Mudigre, 900m, 7.iv.1980, C. A. Viraktamath; 1♀, Nagarahole, 15.iii.2006, K. B. Raj; 1♂, 1♀, Nandi Hills, 1380 m, 9.vi.1977, C.A. Viraktamath; 2♂, Nandi hills, 1300m, 9.vi.1977, C. A. Viraktamath; 1♀, 3.vii.1977, C. A. Viraktamat; 1♂, Ramandrug, 990m, 17.vii.1982, Ghorpade; 1♂, 12 Km S W Shimoga, 6.i.1984, Ghorpade; 1♂,16 Km N Sullia, 8.ii.2005, C. A. Viraktamath; 2♂, 1♀, 6 Km N Vijayapura, 9.vi.1977, C. A. Viraktamath (UASB); Gujarat: 1♂, 25.i.1981, S. Viraktamath; Maharashtra: 1♂, Matheran, 915m, 23.xi.1977, C. A. Viraktamath; 1♂, 24.xi.1977, C. A. Viraktamath; Rajasthan: 3♀, Mt. Abu, 1200m, 25.i.1981, C. A. Viraktamath; Tamil Nadu: 1♂, Burliar, 860m, 5.vi.1977, C. A. Viraktamath; 1♂, 5.vi.1977, C. A. Viraktamath (UASB); 1♂, Ayur, N. Salem, 4.i.1930, FRI, Sandal Insect survey; MYANMAR: 1 ♀, Myitta, Doherty (BMNH).

Remarks: This species is sexually dimorphic. The scutellum of the male is black whereas that of the female is bright yellow. *P. scutellata* resembles *P. erebus* externally. However, it lacks a median dorsal ridge on the aedeagal shaft present in *P. erebus*. Distant (1918) placed this species in the genus *Neodartus* but structure of head and position of ocelli indicate that it belongs to the genus *Penthimia*.

***Penthimia spiculata* sp. nov.**

(Plate 9a & Fig. 28)

Black, body slender long parallel sided. Lorum flat. Labium pale brown exceeding fore coxae. Pronotum declivous in anterior half. Scutellum broad and slightly raised at posterior half. Tegmina with apical area light brown.

Male genitalia: Pygophore with rounded caudal margin with long stout setae at caudal third, much shorter setae along the mid line between dorsal and ventral margin of pygophore. Subgenital plate with lateral margin slightly convex, caudal angles rounded; surface with stout setae at posterior half. Style slender long with well developed preapical lobe; apophysis short, thumb-like, slightly curved laterally with serrated lateral margin. Connective with stem more than twice longer than arms. Aedeagus with well developed dorsal apodeme and preatrium, shaft directed caudally at base and slightly curved dorsally, surface with spicules on lateral aspect, apex with U-shaped notch; gonopore apical.

Measurements: Male 4.20 mm long, head 1.63 mm wide across eyes, 1.83 mm wide across pronotum (Table 4).

Material examined: INDIA: Karnataka, Holotype ♂, Nagarahole, 16.iii.2006, K. B. Raj (UASB).

Remarks: The male genitalia of *P. spiculata* resembles those of *P. tumida*. In both the species the aedeagus has well developed dorsal apodeme and the shaft curved dorsally. In *P. spiculata* the shaft of the aedeagus has spicules on lateral margin compared to *P. tumida* that lacks them.

***Penthimia thoracica* Distant**

Structure as described by Distant (1918). Head and pronotum bright greenish, margin between head and pronotum marked with red transverse bow. Scutellum marked with bright red. Wings red with brownish hue, with granulated yellow spots.

Measurements: Female 4.64 mm long, head 2.0 mm wide across eyes, 1.96 mm wide across pronotum.

Material examined: 1♀ 'Type H.T' '*Penthimia thoracica* Dist. type' 'Kodaikanal, S. India, T. V. Campbell K K 4.14 59_4' 'S. India, E.A. Butler, 1915-60' (BMNH).

Remarks: The coloration of this species is very distinctive in having head and thorax greenish with red marking.

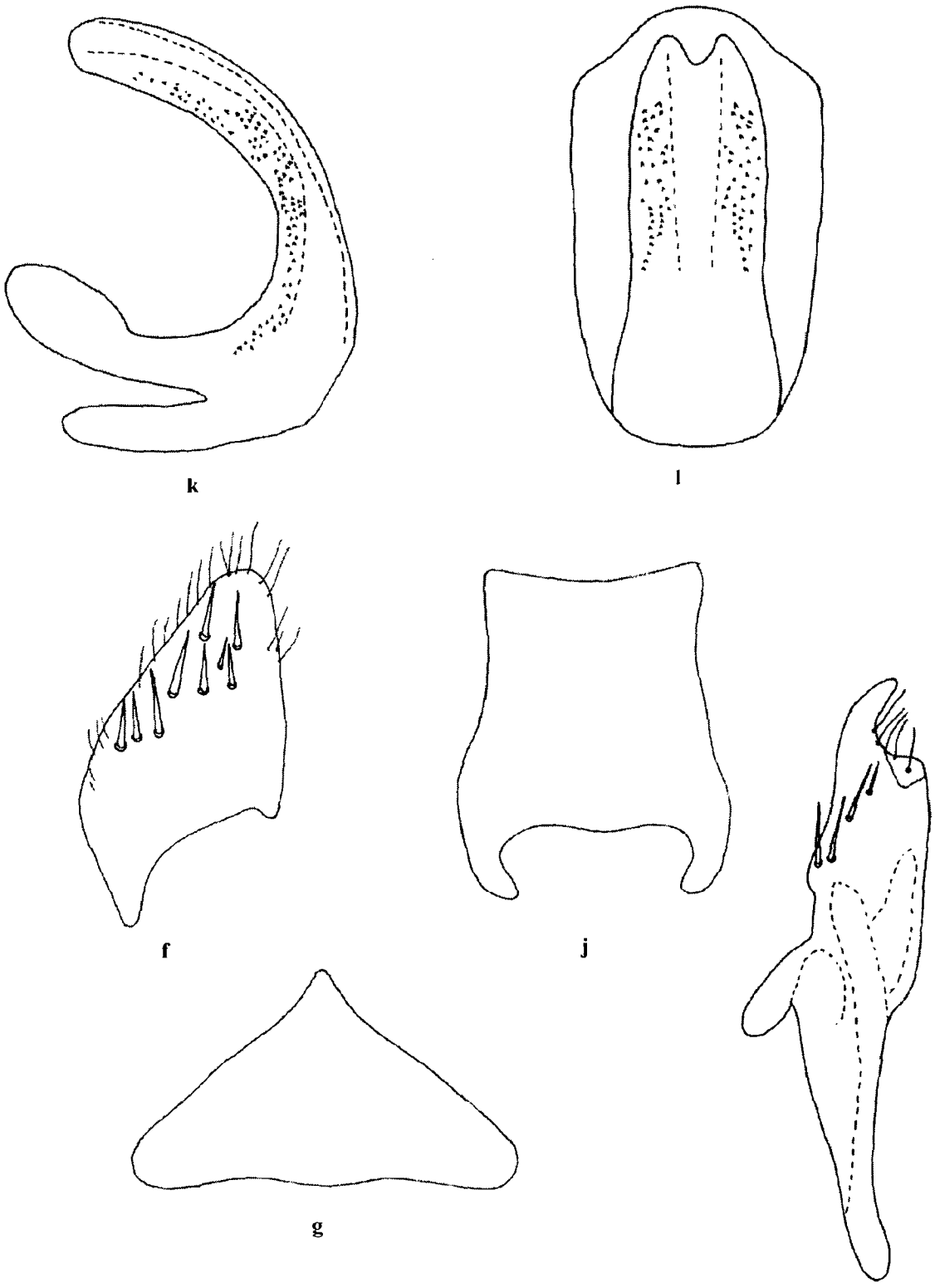


Fig. 28. *Penthimia spiculata* sp. nov.

Refer legends of Fig. 2 of Chapter III for details of alphabets used

***Penthimia tumida* sp. nov.**

(Plate 9b & Fig. 29)

Black, forewing with light brown caudal area. Head declivous anteriorly convexly rounded to face, with entire anterior margin transversely striated. Clypeus and clypellus tumid. Lorum flat. Labium almost reaching mid coxae. Tip of scutellum dark brown. Hind femoral spines dark brown.

Male genitalia: Caudal margin of pygophore rounded with long stout setae on caudal one third at dorsal region. Subgenital plate with long stout setae. Style linear with well developed preapical lobe, apical apophysis short, thumb-like. Connective with arms shorter than stem. Aedeagus with well developed dorsal apodeme, preatrium short, shaft cylindrical, curved caudo-dorsally, apex with V- shaped notch; gonopore apical.

Female terminalia: Seventh sternite more than one and half times broader than median length, hind margin with median projection.

Measurements: Male 3.8 mm long, head 1.53 mm wide across eyes, 1.65 mm wide across pronotum. Female 4.04 mm long, head 1.60 mm wide across eyes, 1.80 mm wide across pronotum (Table 4 & 5).

Material examined: INDIA: Tamil Nadu, Holotype ♂, Ootacamund, 4.vi.1977, C. A. Viraktamath (UASB). Paratypes: 1♂, 4♀ data as for holotype; 2♂. data as for holotype but collected by S. Viraktamath; INDIA: Kerala; 1♂, Munnar, 22.iv.1977, B. Mallik (UASB).

Remarks: This species has a thicker anterior margin of head. The clypeus and the clypellus are tumid. The male genitalia of *P. tumida* resemble those of *P. spiculata.* However, morphologically they are very distinct. *P.* spiculata is black with the body slender, long, parallel sided, the clypeus and the clypellus not tumid but *P. tumida* is a small species with the clypeus and the clypellus tumid.

4.1.5. Genus *Tambila* Distant

Colour variable, head in profile spatulate, marginally rimmed with five to six transverse carinae; vertex medially sulcate. Clypellus medially ridged in basal half. Lorum flat. Lateral frontal suture extending beyond antennal pit near to ocelli or ocellar vestiges. Forewing with six apical, three anteapical cells, covering entire abdomen, claval veins joined by a cross vein; hind wing with four apical cells. Hind femoral spinulation 2+2+1, hind tibia with one macrosetae between with 1-2 much smaller setae

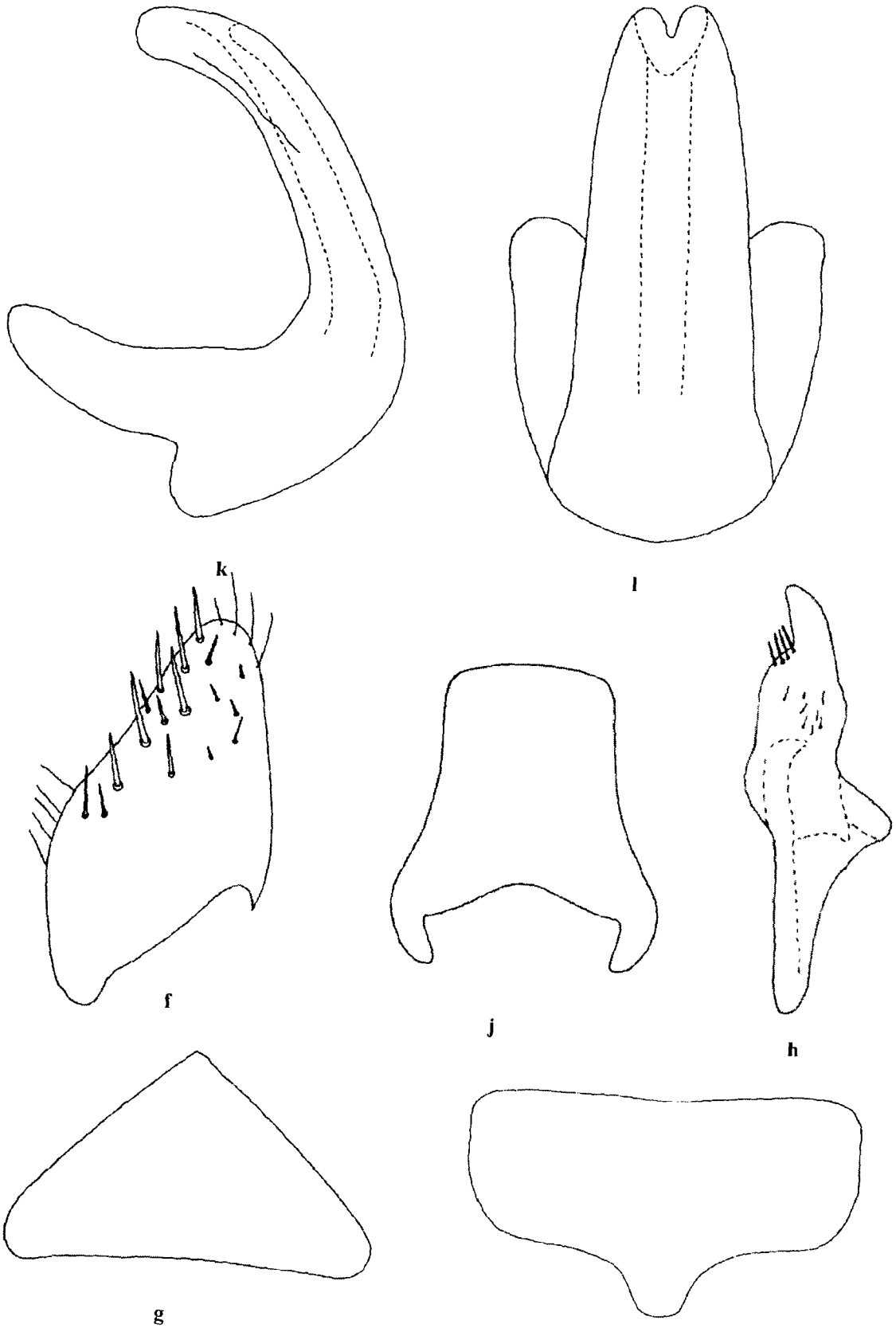
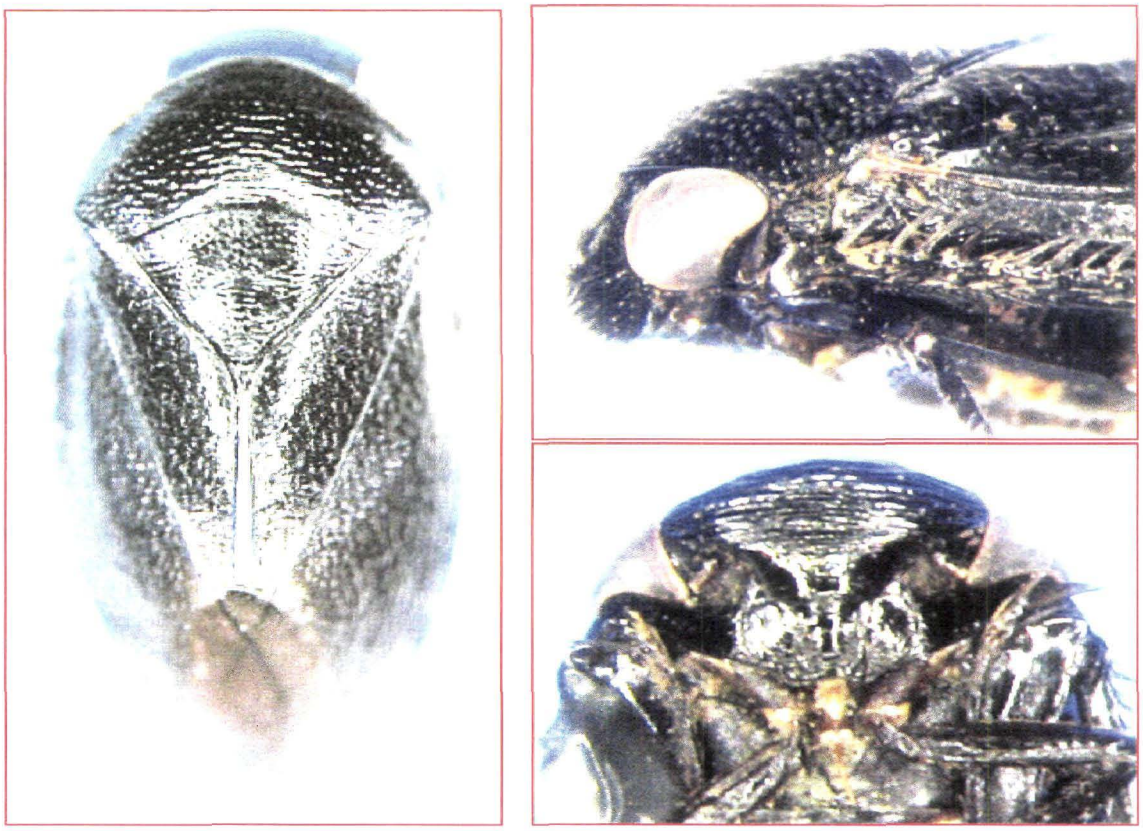
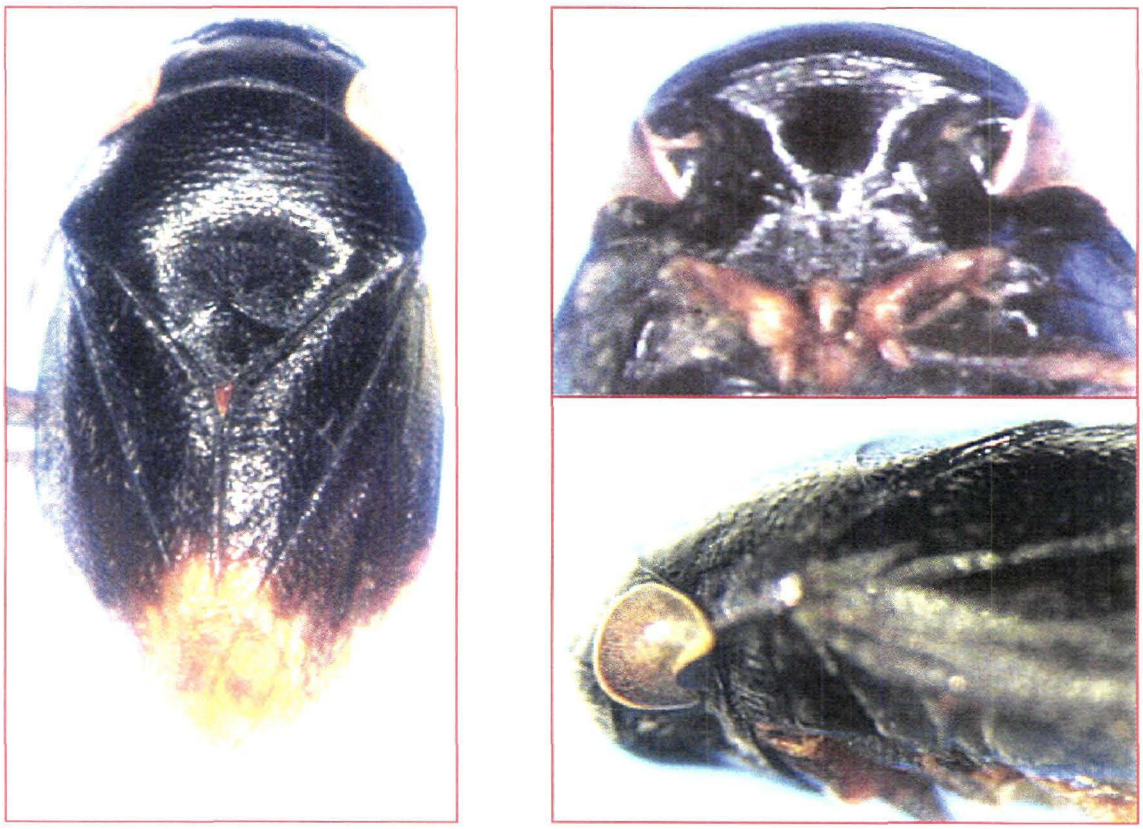


Fig 29. *Penthimia tumida* sp. nov.

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used



a. *Penthimia spiculata* sp. nov.



b. *Penthimia tumida* sp. nov.

Plate 9

Table 4. Measurements (in mm) of males of the genus *Penthimia* Germar

Measurements	***attenuata***	***compacta***	***curvata***	***erebus***	***meghalayensis***	***sahyadrica***	***scutellata***	***spiculata***	***tumida***
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean	Mean±SD	Mean±SD	Mean±SD	Mean±SD
LENGTH									
Total length	3.76±0.19	4.56±0.15	4.07±0.25	3.80	4.20	3.80±0.10	3.36±0.03	4.20	3.80±0.08
Wing	2.78±0.19	3.40±0.12	3.07±0.15	2.60	3.20	2.90±0.00	2.38±0.03	3.10	2.88±0.05
Clavus	1.84±0.09	2.08±0.04	1.87±0.06	1.80	2.00	2.00±0.00	1.52±0.01	2.10	1.80±0.00
Vertex	0.36±0.05	0.48±0.04	0.40±0.00	0.35	0.50	0.43±0.06	0.36±0.03	0.43	0.40±0.00
Pronotum	0.78±0.08	0.92±0.08	0.70±0.00	0.88	0.75	0.87±0.06	0.67±0.02	0.85	0.73±0.05
Scutellum	0.84±0.05	2.06±0.05	0.93±0.06	0.85	0.90	0.97±0.06	0.74±0.05	1.03	0.88±0.05
Clypellus	0.33±0.02	0.38±0.01	0.21±0.01	0.33	0.33	0.32±0.03	0.30±0.00	0.30	0.34±0.01
WIDTH									
Wing	1.22±0.04	1.28±0.08	1.00±0.00	1.10	1.00	1.20±0.00	0.80±0.02	1.10	1.20±0.00
Vertex	0.84±0.05	0.96±0.05	0.93±0.06	0.90	0.90	0.87±0.06	0.77±0.02	0.95	0.80±0.00
Pronotum	1.72±0.04	1.06±0.05	1.80±0.01	1.85	1.80	1.93±0.06	1.54±0.04	1.83	1.65±0.06
Head	1.52±0.04	1.64±0.09	1.53±0.06	1.60	1.60	1.67±0.12	1.36±0.03	1.63	1.53±0.05
Clypellus	0.21±0.01	0.23±0.01	0.31±0.01	0.23	0.20	0.21±0.01	0.20±0.00	0.18	0.25±0.00
Lorum	0.18±0.00	0.21±0.01	0.22±0.01	0.20	0.20	0.18±0.03	0.15±0.02	0.21	0.19±0.01
DISTANCE BETWEEN									
Eyes	0.99±0.05	1.12±0.02	1.07±0.07	1.08	1.05	1.02±0.03	0.88±0.03	0.95	0.98±0.00
Antennal pits	0.66±0.02	0.76±0.02	0.70±0.04	0.70	0.68	0.65±0.00	0.60±0.03	0.73	0.65±0.00
Ocelli	0.50±0.00	0.55±0.01	0.500.01	0.50	0.53	0.48±0.04	0.47±0.03	0.30	0.46±0.01

No. of specimens used for measurement: One male of *P. erebus*, two males of *P. meghalayensis* and one male of *P. spiculata.*

Table 5. Measurements (in mm) of females of the genus *Penthimia* Germar

Measurements	*attenuata*	*compacta*	*maculosa*	*mudongensis*	*sahyadrica*	*scutellata*	*tumida*
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
LENGTH							
Total length	3.94±0.13	4.92±0.16	5.40	5.30	3.80	3.82±0.20	4.04±0.09
Wing	2.94±0.13	3.66±0.05	4.00	4.20	2.90	2.82±0.16	3.04±0.05
Clavus	1.98±0.04	2.32±0.16	2.50	2.80	2.00	1.70±0.16	1.94±0.05
Vertex	0.42±0.04	0.13±0.00	0.70	0.50	0.40	0.41±0.05	0.40±0.00
Pronotum	0.80±0.00	0.27±0.03	1.30	1.30	0.97	0.72±0.06	0.72±0.04
Scutellum	0.88±0.04	0.28±0.03	1.40	1.20	0.10	0.83±0.27	0.86±0.05
Clypellus	0.35±0.00	0.39±0.03	0.45	0.43	0.30	0.32±0.04	
WIDTH							
Wing	1.20±0.10	1.54±0.05	1.70	1.80	1.20	0.86±0.09	1.08±0.11
Vertex	0.90±0.00	0.20±0.00	1.30	1.50	0.80	0.84±0.05	0.88±0.04
Pronotum	1.90±0.00	2.34±0.04	2.70	2.60	1.90	1.69±0.10	1.80±0.00
Head	1.66±0.05	2.08±0.01	2.20	2.20	1.60	1.49±0.26	1.60±0.00
Clypellus	0.23±0.00	0.26±0.01	0.30	0.35	0.20	0.21±0.08	0.35±0.02
Lorum	0.22±0.01	0.19±0.01	0.27	0.25	0.20	0.17±0.08	0.24±0.01
DISTANCE BETWEEN							
Eyes	1.06±0.01	1.19±0.04	1.50	1.50	1.00	1.00±0.24	1.00±0.06
Antennal pits	0.75±0.01	0.82±0.01	1.05	1.08	0.65	0.66±0.19	0.70±0.03
Ocelli	0.13±0.00	0.59±0.04	0.75	0.75	0.45	0.49±0.08	0.46±0.03

No. of specimens used for measurement: One female of *P. maculosa, P. mudonensis* and *P. sahyadrica.*

on postero-dorsal region, with small setae between macrosetae on antero-dorsal region, meta basitarsus with three platellae.

Male pygophore with rounded caudal lobe. Subgenital plate large with rounded caudal margin. Style short with well developed preapical lobe, apophysis finger-like, curved laterally. Connective Y-shaped. Aedeagus simple, shaft dorso-anteriorly curved, slightly narrowed caudally with large gonopore on ventral margin. Hind margin of female seventh sternite produced in middle with median concavity. Dorsal sculpturing of first valvula concatenate, position of dorsal sculpturing marginal; dorsal tooth on shaft of second valvula large, prominent, exceeding apical half.

Remarks: Head in profile spatulate and marginally rimmed with five to six transverse carinae. *Tambila* is distantly related to the genus *Vulturnus* in having lateral frontal sutures reaching ocelli. The aedeagal shaft in *Tambila* is dorso-anteriorly curved and slightly narrowed caudally with large gonopore on the ventral margin. It differs from *Penthimia* in having spatulate head compared to rounded and thicker anterior part of head in *Penthimia*.

Seven species have been reported under this genus from the Indian subcontinent.

Key to species of *Tambila* Distant of the Indian subcontinent (Only males)

1 Apical apophysis of the style with median protuberance laterally (fig. 33h) and Aedeagal shaft lacks folded plate like area on dorsal margin near base ((fig. 33 k).....***T. variabilis*** **(Distant)**

- Apical apophysis of the style without median protuberance laterally and Aedeagal shaft has folded plate like area on dorsal margin near base.....2

2 Folded plate like area on dorsal margin near base distinguishable with rounded lateral lobe (fig. 30 k)..... ***T. gravelyi*** **Distant**

- Folded plate like area on dorsal margin near base is not distinguishable or not prominent (fig. 32 k)..... ***T. greeni*** **(Distant)**

Tambila badia **(Distant) comb. nov**

Penthimia badia Distant 1918b: 17.

Colouration and structure as described by Distant (1918).

Measurement: 6.4 mm long, head 2.64 mm wide across eyes, 3.04 mm across pronotum.

Material examined: INDIA: 'Type H.T', '*Penthimia badia* Distant. Type' 728 $_{CB'}$ 613, Chikkaballapura, S. India, T. V. Campbell 72_8, 'S. India, E A Butler B M. 1915-60' (BMNH).

Remarks: Distant (1918) placed this species in *Penthimia.* However, it has spatulate head and the lateral frontal sutures almost reach the ocelli.

***Tambila conspersa* Distant**

Colouration and structure as described by Distant (1918).

Material examined: SRI LANKA: 1♀, 'Type H.T', '*Tambila conspersa* Dist. type' 'Namanukula, Sri Lanka, 2.1910, T. B. Fletcher' 1909-80' (BMNH).

Measurement: Total length 5.52 mm long, head 2.24 mm wide across eyes, pronotum 2.36 mm wide across pronotum.

Remarks: This species is much more brownish than other species of *Tambila*, and scutellum is not pale though Distant described "Scutellum with a small spot near each basal angle and the apex stramineous".

***Tambila fletcheri* Distant**

Head, thorax and scutellum greenish yellow. Head, both anterior and posterior margins of pronotum darker with brown suffusions. Forewing without any maculae.

Female terminalia: Hind margin of seventh sternite concave with shallow median projection, with median notch.

Measurement: Female 6.08mm long, head 2.52mm wide across eyes and 2.76 mm wide across pronotum.

Material examined: SRI LANKA: 1♀ 'Type H. T' '*Tambila fletcheri* Dist. type' 'Nuwara Eliya, Sri Lanka, iv.1912' 'Sri Lanka, T. B. Fletcher, 1909-80' (BMNH).

Remarks: This species can be recognized by the greenish head and thorax.

***Tambila gravelyi* Distant**

(Plate 10a & Fig. 30, 31)

Colour variable from dark brown to pale brown with pale markings. Head in profile spatulate and marginally rimmed with 5-6 transverse carinae. Vertex medially

sulcate. Clypeus flat and raised. Clypellus ridged medially. Lorum flat. Lateral frontal suture extending beyond antennal pit near to ocelli or ocellar vestiges. Labium reaching end of fore coxae. Two cross veins between outer claval vein and claval suture. Hind femoral spinulation 2+2+1.

Male genitalia: Pygophore with caudal lobe rounded, with a few short stout setae in caudal third, much shorter setae along midline between dorsal and ventral margins. Subgenital plate larger with a rounded apex, lateral margin sinuate with sparsely distributed setae in caudal half. Style short with well developed preapical lobe, apical apophysis finger-like, curved laterally. Connective with arms shorter than stem. Aedeagus simple, dorsal apodeme short, preatrium large, shaft slightly dorso-anteriorly curved, slightly narrowed caudally with large gonopore on ventral margin; folded plate like area on dorsal margin near base distinguishable with rounded lateral lobe.

Female terminalia: Seventh sternite broad, three times as broad as long, with hind margin produced in the middle with median concavity.

Measurements: Male 5.82 mm long, head 2.3 mm wide across eyes and 2.58 mm wide across pronotum. Female 6.2 mm long, head 2.4 mm wide across eyes and 2.7 mm wide across pronotum (Table 6).

Material examined: INDIA: 1♂, 'Type H.T' '*Tambila gravelyi* Dist. type' 'Indian Mus. Medha Yanna Valley, Satara Dist. 2200ft, 17-23.iv.12 H. F. Gravely 2967/21' (BMNH).*Other material examined* : INDIA: Karnataka, 1♂, Bangalore, GKVK, 6.vi.2006, ex Jackfruit, Kengegowda; 1♂, Bangalore, GKVK, 29.vii.2006, Girish; 1♀, Bangalore, FRL, 916m, Sandal, 14.viii.1973, Sivaramakrishnan; 1♂, Bangalore, 12.xi.1982, C. A. Viraktamath; 1♂, 7.vi.1976, C. A. Viraktamath; 1♂, Bangalore, 2.vii.1983, Parvathi, C; 1♀, Bangalore, 10.ix.1975, C. A. Viraktamath; 1♂, Bangalore, 22.iii.2003, C. A. Viraktamath; 1♂, 13 Km W Bagepalli, 14.iv.1977, C. A. Viraktamath; 1♀, Dharmastala, 22.xi.1984, S. Viraktamath; 1♀, 12 Km W Jog falls, 18.xi.1976, B. Mallik; 1♂, Jog falls, 534 m, 2.xii.1982, H.V.A. Murthy; 1♀, 5 Km W Koppal, 29.xi.1982, H.V.A. Murthy; 1♀, Malayamaruta hills nr Mudigere, 29.v.2005, Shobharani, M; 1♀, Mudigere, 22.v.1976, B. Mallik; 19 Km W Mudigere, 9000 m, 6.iv.1980, C.A. Viraktamath. 1♂, Raichur, 3.xi.1988, Shashidhar; 1♂, Raichur, 18.x.1988, Shashidhar; 1♂, Raichur, 12.x.1988, Shashidhar; 1♀, Yellapur, 22.ix.1973, C. A. Viraktamath; Kerala: 1♂, 3♀, Meppadi, 690m, 18.x.1975, C. A. Viraktamath; 1♂, 1♀, Thekkady, 27.iii.1977, C. A. Viraktamath; 1♂, Thekkady, 26.iii.1977, C. A. Viraktamath; Tamil Nadu: 1♀, Shambhaganur, 1800m, 18.viii.1979, Dworakowska

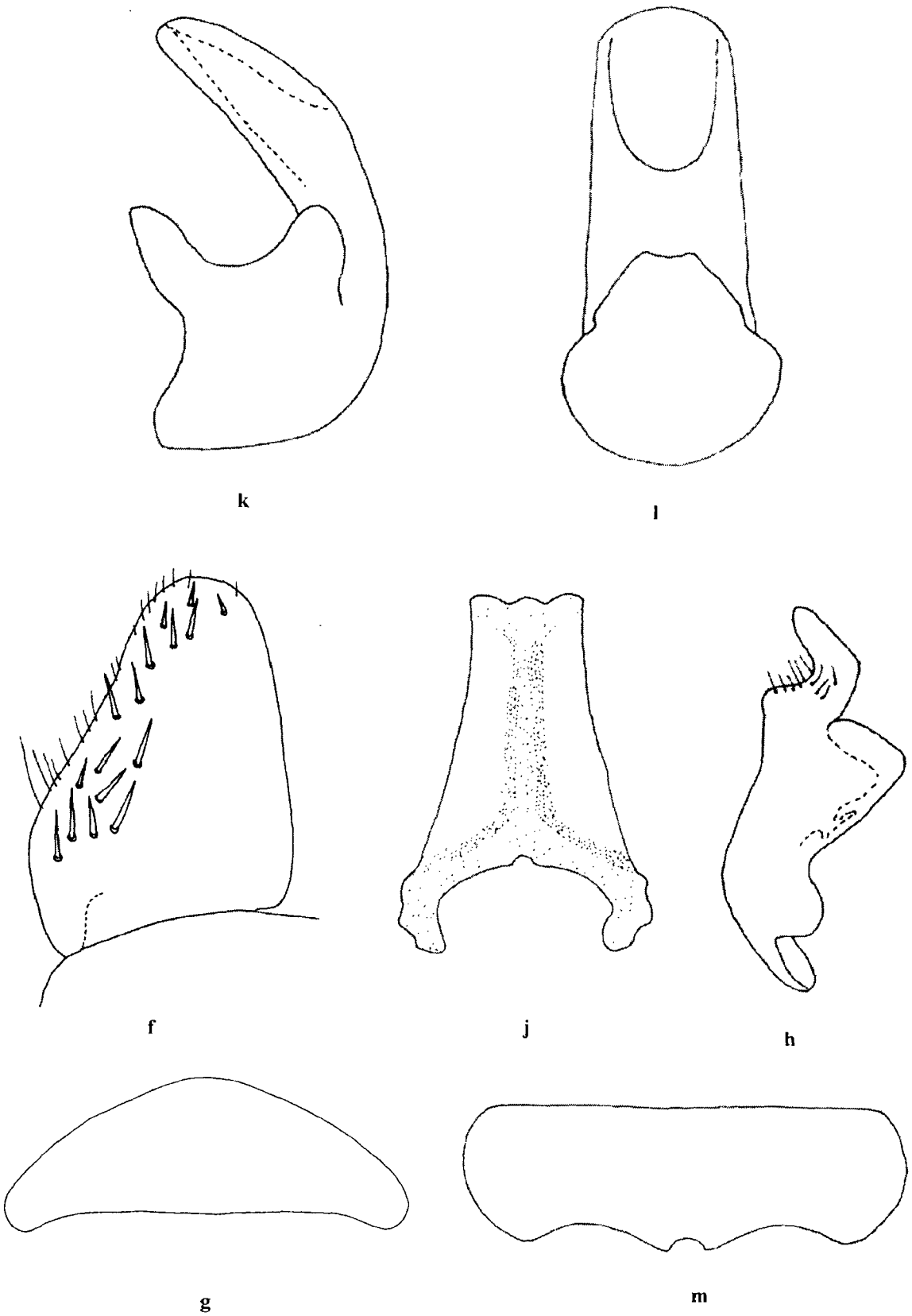


Fig. 30. *Tambila gravelyi* Distant

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used

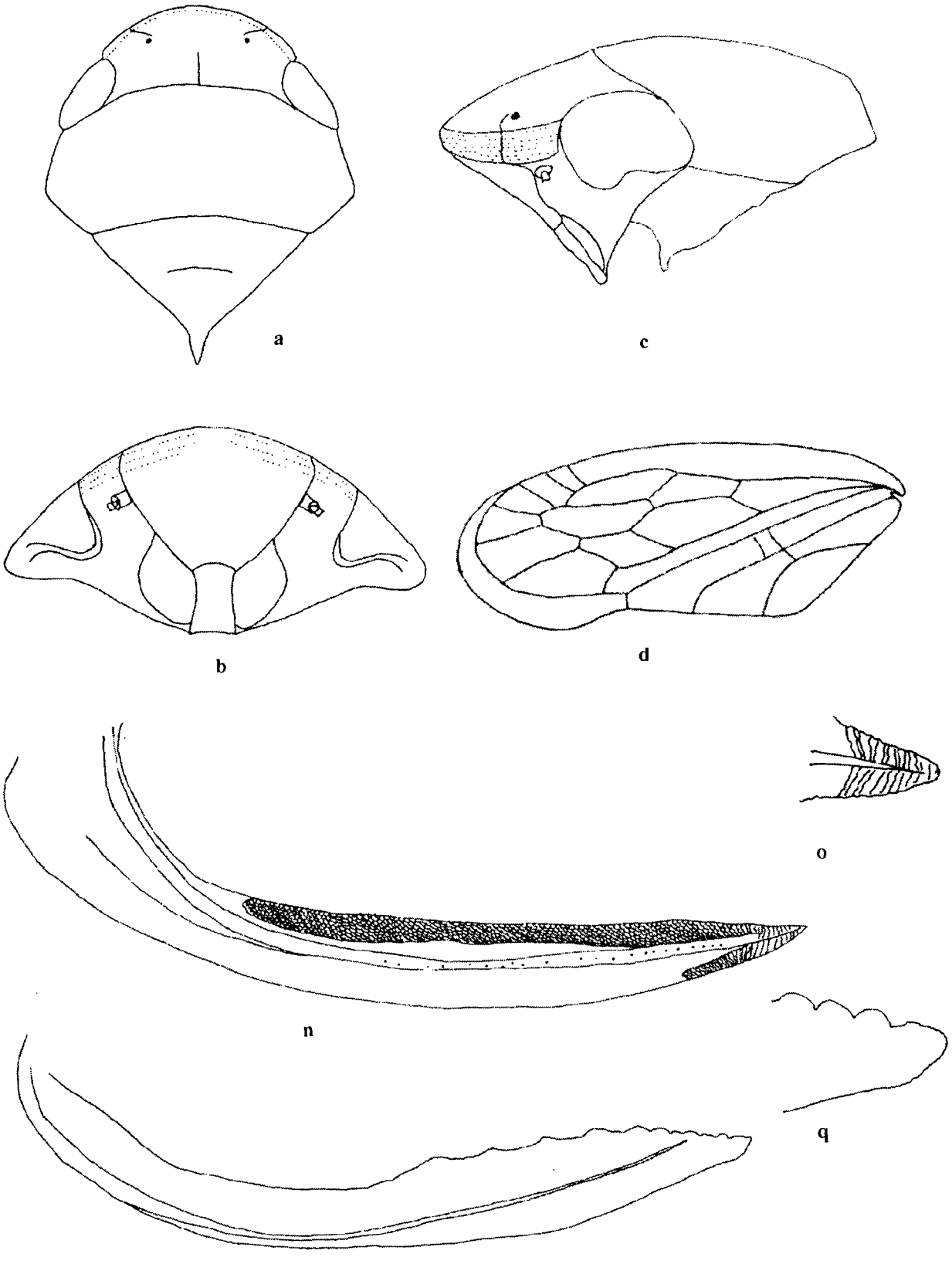


Fig. 31. *Tambila gravelyi* Distant

Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used

Table 6. Measurements (in mm) of males and females of *Tambila gravelyi* Distant

Measurements	Male	Female
	Mean±SD	Mean±SD
LENGTH		
Total length	5.82±0.15	6.20±0.12
Total length *	4.26±0.15	4.62±0.15
Wing	2.80±0.07	3.00±0.00
Clavus	0.76±0.01	0.72±0.08
Vertex	1.08±0.08	1.14±0.05
Pronotum	1.32±0.04	1.28±0.08
Scutellum	0.39±0.01	0.41±0.01
Clypeus	5.82±0.15	6.20±0.12
Clypellus	4.26±0.15	4.62±0.15
WIDTH		
Wing	1.50±0.07	1.48±0.08
Vertex	1.30±0.00	1.36±0.05
Pronotum	2.58±0.04	2.70±0.07
Head	2.30±0.00	2.40±0.07
Clypellus	0.25±0.02	0.30±0.00
Lorum	0.29±0.01	0.30±0.02
DISTANCE BETWEEN		
Eyes	1.67±0.00	1.68±0.03
Antennal pits	1.10±0.03	1.13±0.03
Ant. E to ant. V	0.21±0.00	0.21±0.02

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex

(UASB); S. INDIA: Moyar Campus, 1♀, Nilgirihills (2900 ft) vi.1954, Rec. P. S. Nathan. Singara, 1♀, Nilgirihills, (3400 ft.) v-1954, Rec. P. S. Nathan (IRSNB); 1♀, Palnis (7000 ft.), Kodaikanal shola, 26.viii.1921, Fletcher (IARI, New Delhi).

Remarks: The apical apophysis of the style is more slender in the specimens from Thekkady compared to the type from Yenna valley, Satara. Colouration is also variable from pale reddish brown to dark brown. Often dark brown markings on the head and the pronotum forming well defined patches. The scutellum may or may not be pale or yellow and in most of the specimens the scutellum has the same colour as the rest of the thorax.

***Tambila greeni* Distant**

(Fig. 32)

Tambila greeni Distant 1908g: 247-248; 1918: 23.

Tambila opulenta Distant 1918b: 23. **syn. nov.**

Male: Vertex of head, pronotum, scutellum reddish-yellow. Vertex of head about half as long as breadth between eyes, apex rounded, with two curved fasciae. Pronotum with two black fasciae commencing behind eyes, centrally connected, then angularly extended posteriorly on disk. Scutellum about as long as vertex, basal margin only slightly longer than lateral margins, transversely roundly impressed near middle, before which centrally, longitudinally carinated. Body beneath black, margins of sternal, abdominal segments sanguineous. Legs mostly black, anterior legs, intermediate tibiae, tarsi, extreme apices of the posterior femora sanguineous. Tegmina black, minutely, obscurely spotted withwn, the apical area paler, minutely spotted with grayish.

Female: Head yellowish-brown with two reddish-brown curved fasciae. Vertex and pronotum obscurely punctate, latter a little transversely wrinkled. Pronotum reddish-brown, a transverse spot at anterior margin, a large spot on either side of median line yellowish-brown. Scutellum yellowish-brown with a transverse line before apical area. Forewing pale brownish, finely punctate, costal, apical areas somewhat thickly, finely spotted with reddish brown, paler at apex. Body beneath reddish, margins of abdominal segments pale yellowish-brown. Legs reddish-yellow, a black spot on each side near anterior coxae.

Male genitalia: Style short with well developed preapical lobe, apical apophysis finger-like laterally curved with corrugated surface. Aedeagus simple, dorsal apodeme

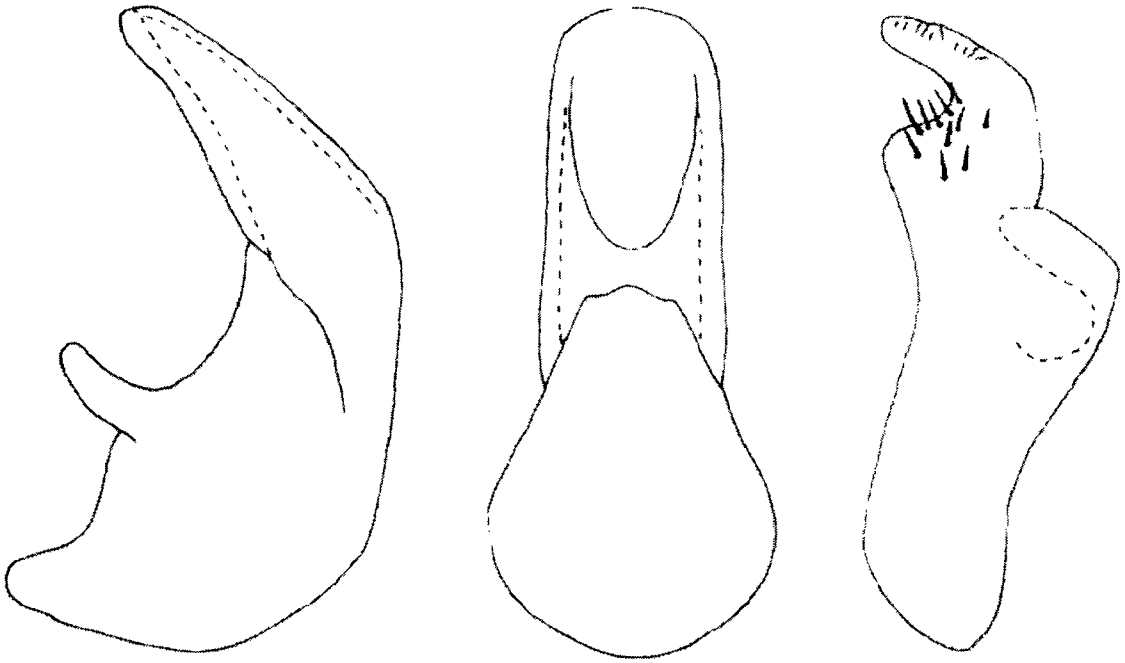


Fig. 32. *Tambila greeni* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

small, slender, atrium well developed. Shaft slightly curved dorso-anteriorly, narrowed caudally with large gonopore on ventral margin, folded plate like area on dorsal margin near base is not prominent.

Female terminalia: Seventh sternite rectangular, hind margin straight with a short median projection, with median concavity.

Material examined: SRI LANKA: 1♀ 'Type', '*Tambila greeni* Dist. type' 'Kandy, Sri Lanka, 9.02', 'Distant Coll.1911-383' (BMNH). 'Type ♂, '*Tambila opulenta* Dist. type' 'bred on *Persia gratissima*, Peradeniya, Sri Lanka, xi.1911' 'Distant Coll. 1911-383' (BMNH).

Measurement: Male 5.20 mm long, head 2.2 mm wide across eyes and 2.40 mm wide across pronotum. Female 6.16mm long, head 2.44mm wide across eyes. 2.72 mm wide across pronotum.

Remarks: Male genitalia of *T. gravelyi* are similar to those of *T. greeni* except for having a plate like area on the dorsal margin near base which is distinguishable in *T. gravelyi*, where as it is not very prominent in *T. greeni*. Both *T. greeni* and *T. opulenta* have similar colouration and are male and female of the same species, and the hence synonymy.

***Tambila variabilis* (Distant) comb. nov.**

(Plate 10b & Fig. 33)

Penthimia variabilis Distant1918b:18.

Dark yellowish-brown to pale yellowish-brown, irregularly mottled, suffused with black. Pronotum brownish yellow with median pale yellow irregular band. Scutellum dull brownish yellow, with dark spot near each basal angle, two small dark spots on apical area. Face pale yellow, basal half mottled with black.Tegmina pale brown, mottled with black. Legs with stout stramineous spinules.

Male genitalia: Pygophore lobes rounded caudally with stout setae ventrally. Subgenital plate obtusely produced on lateral margin near base with apex rounded, two rows of stout setae on lateral margin. Style with well developed preapical lobe, apophysis long curved laterally with median protuberance laterally. Connective short, with arms as long as stem. Aedeagus simple, dorsal apodeme well developed, preatrium reduced, shaft curved caudodorsally with large gonopore on ventral margin.

Measurements: Male 4.6–4.7 mm long, 1.7 mm wide across head, 1.9 mm wide across pronotum.

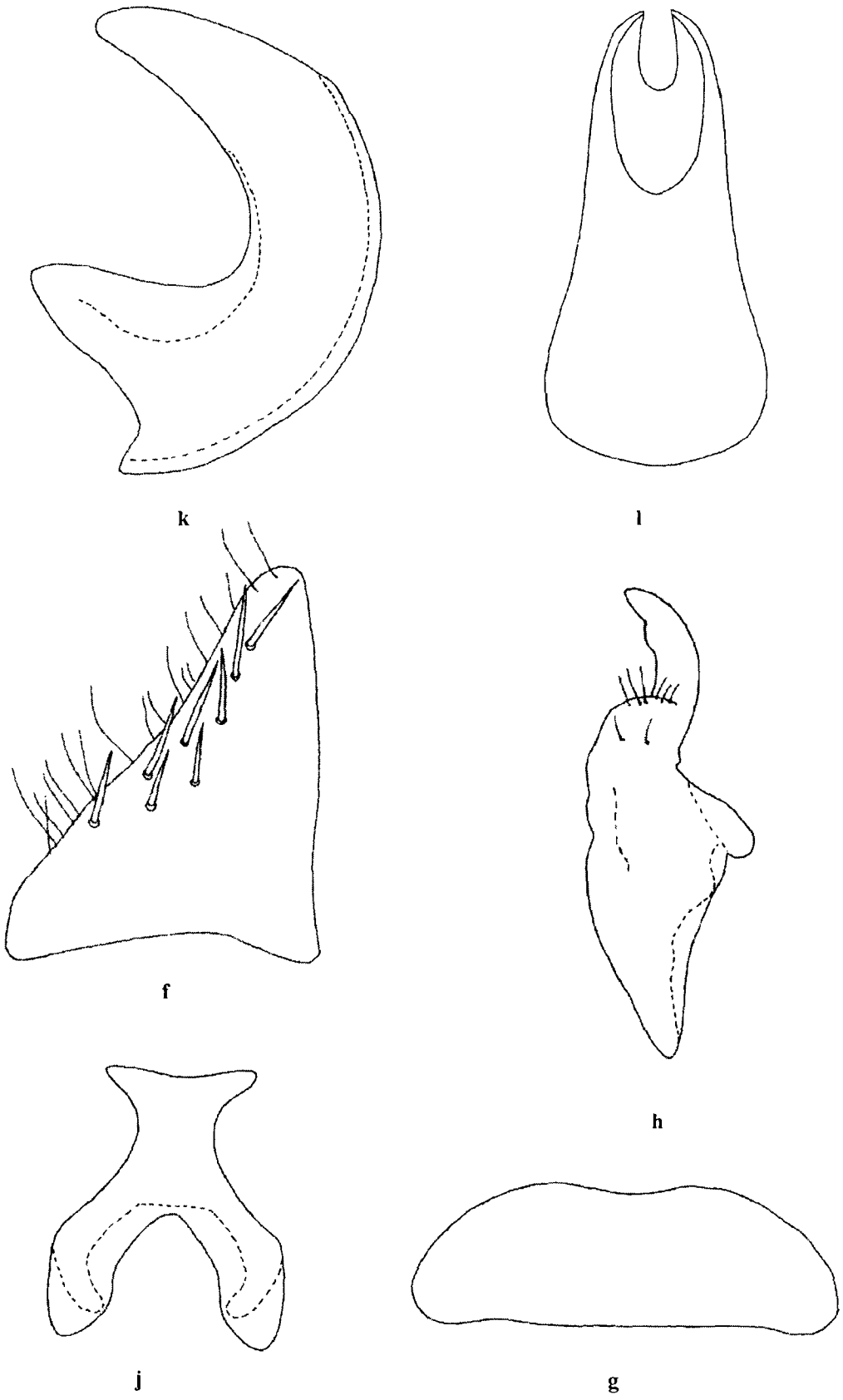
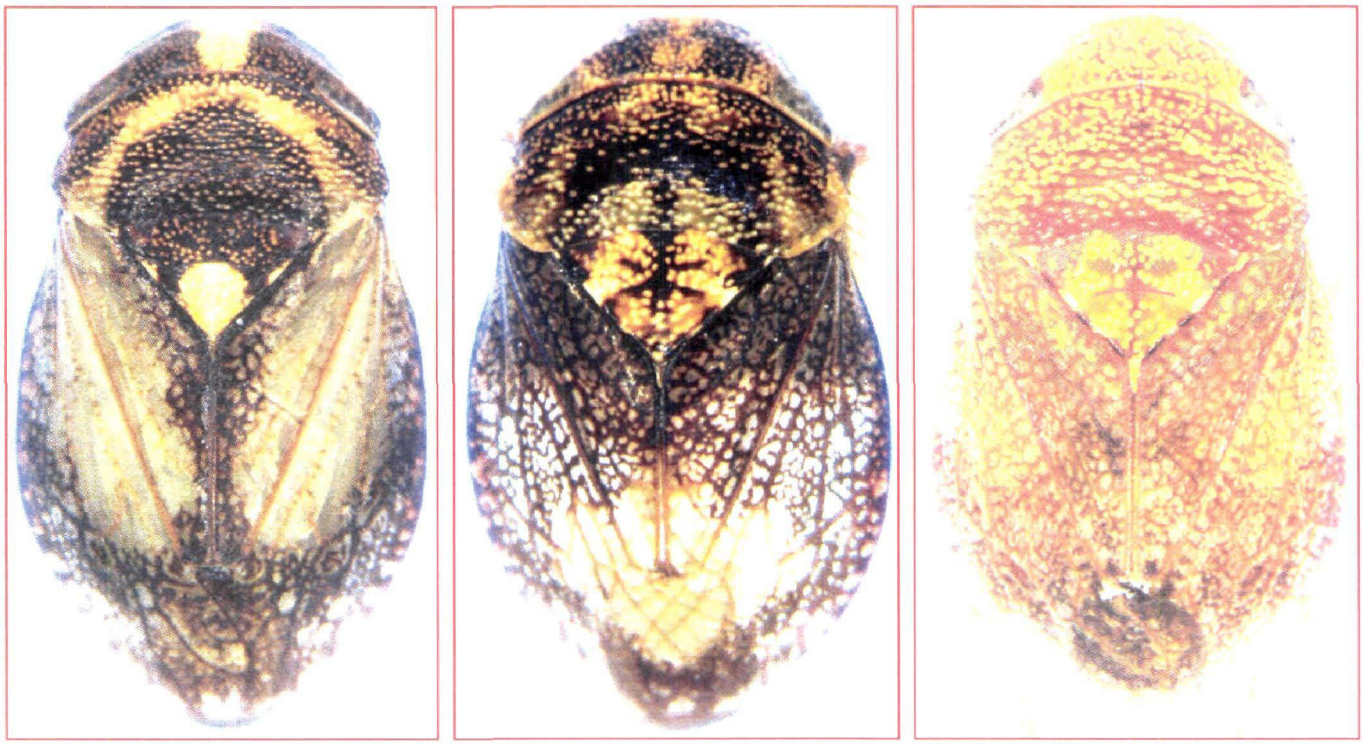
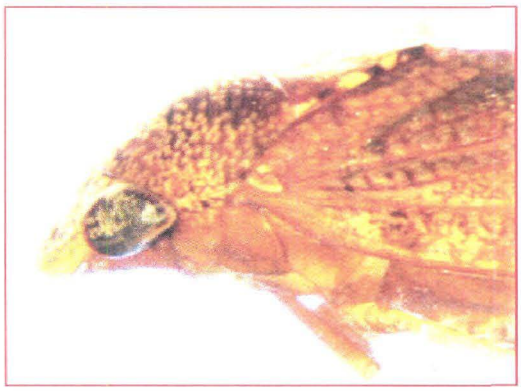


Fig. 33. *Tambila variabilis* (Distant)

Refer legends of Fig. 2 of Chapter III for details of alphabets used



a. *Tambila gravelyi* Distant



a. *Tambila gravelyi* Distant

b. *Tambila variabilis* (Distant)

Plate 10

Material examined: INDIA: Pulney Hills, 2♂, 3 to 6000 feet, May, 1917, T. V. Campbell, *Penthimia variabilis* (Distant) (TNAU).

Remarks: The spatulate head and lateral frontal suture on face almost reaching ocelli place this species in the genus *Tambila* rather than in *Penthimia*. The type series are not found in BMNH. However, two males found in TNAU are from the type locality and agree with the description and have been determined as such by Distant. Basal lobe of aedeagal shaft present in both *T. gravelyi* and *T. opulenta* is absent in this species.

***Tambila vittatifrons* (Distant) comb. nov.**

Penthimia vittatifrons Distant 1918b: 17-18.

Colouration and structure as described by Distant (1918).

Material examined: SRI LANKA: Syntypes 2 ♀, 'Type H. T' '*Penthimia vittatifrons*' Dist. type' Maha Illupalama, Sri Lanka, vi.1912, J. C. F. Fryer' 'Sri Lanka, J. C. F. Fryer 1914-3. Other material: 1♀, 'Peradeniya, Sri Lanka, A.R.13.ii.14' 'Distant Coll.1911-383 (BMNH).

Remarks: The spatulate head and the face with frontal sutures reaching ocelli place this species in *Tambila*. This species can be readily distinguished by its reddish brown colour.

4.1.6. Genus *Uzelina* Melichar

Pale yellowish. Smooth, head in profile spatulate, marginally rimmed with four to five transverse carinae. Vertex medially sulcate at base, broadly rounded, projecting slightly beyond outer line of eyes. Ocelli located on crown, close to eyes than to each other. Lateral frontal suture not reaching ocelli. Eyes notched ventrally. Clypeus flat, raised. Clypellus rectangular. Lorum flat, raised. Antenna located near antero-dorsal corner of eye. Gena broad, lateral margins almost in line with apex of clypellus. Pronotum convex anteriorly, truncate posteriorly. Scutellum broadly triangular with transverse median impression. Forewing with six apical, three ante-apical cells, covering entire abdomen, claval veins joined by a cross vein; hind wing with four apical cells. Hind femoral spinulation 2+2+1, hind tibia with one macroseta between 2-3 much smaller setae on postero-dorsal region, with small setae between macrosetae on antero-dorsal region, meta basitarsus with three platellae.

Male pygophore with caudal margin rounded, with a row of short spines subapically, small hook-like appendage on dorso-mesal angle, surface with stout setae. Valve with caudal margin broadly rounded. Subgenital plate triangular with small hair-like setae on surface. Connective Y-shaped. Style broad at anterior half, apophysis pointed finger-like, curved laterally, curvature of apophysis in line with curvature of preapical lobe. Aedeagus dorso-ventrally flattened, dorsal apodeme plate-like, well developed, preatrium reduced, shaft curved caudo-dorsally, concave on dorsal margin, shaft serrated laterally on apical half; gonopore apical. Hind margin of female seventh sternite slightly concave with median projection. The form of first valvula dorsal sculpturing concatenate, position of dorsal sculpturing marginal; dorsal tooth on shaft of second valvula large, prominent, extended more than apical half

Remarks: This genus is related to *Tambila* in having lateral frontal sutures reaching ocelli but differs in possessing broadly rounded vertex which is projecting slightly beyond outer line of eyes. The genera *Vulturnus* and *Uzelina* are similar with respect to the shape of the male genitalia. In the case of *Vulturnus* lateral frontal sutures reach the ocelli, and entire body has brownish reticulations, but in the case of *Uzelina* the lateral frontal sutures do not reach the ocelli and the body surface is smooth.

There are only two species reported from Indian Subcontinent.

Key to the species of *Uzelina* Melichar of the Indian subcontinent

1 Aedeagus with lateral lamellate processes in the distal part where shaft expands abruptly.....***U. laticeps* Melichar**

- Aedeagus without lamellate processes and shaft widens gradually towards apex (fig. 34 *l*).....***U. thaloriensis* Sharma**

***Uzelina thaloriensis* Sharma**

(Plate 11 & Fig. 34, 35)

Pale yellowish, smooth, head in profile spatulate, marginally rimmed with four to five transverse carinae. Vertex medially sulcate at base with four orange spots. Ocelli red. Face shaded with yellow and black. Clypeus flat. Clypellus rectangular, ridged medially. Lorum flat. Pronotum orange basally, pale yellow with obscure brownish black dots on posterior half. Scutellum with two basal and one small area on each lateral side pale white, rest pale yellowish with brown markings. Tegmina hyaline with

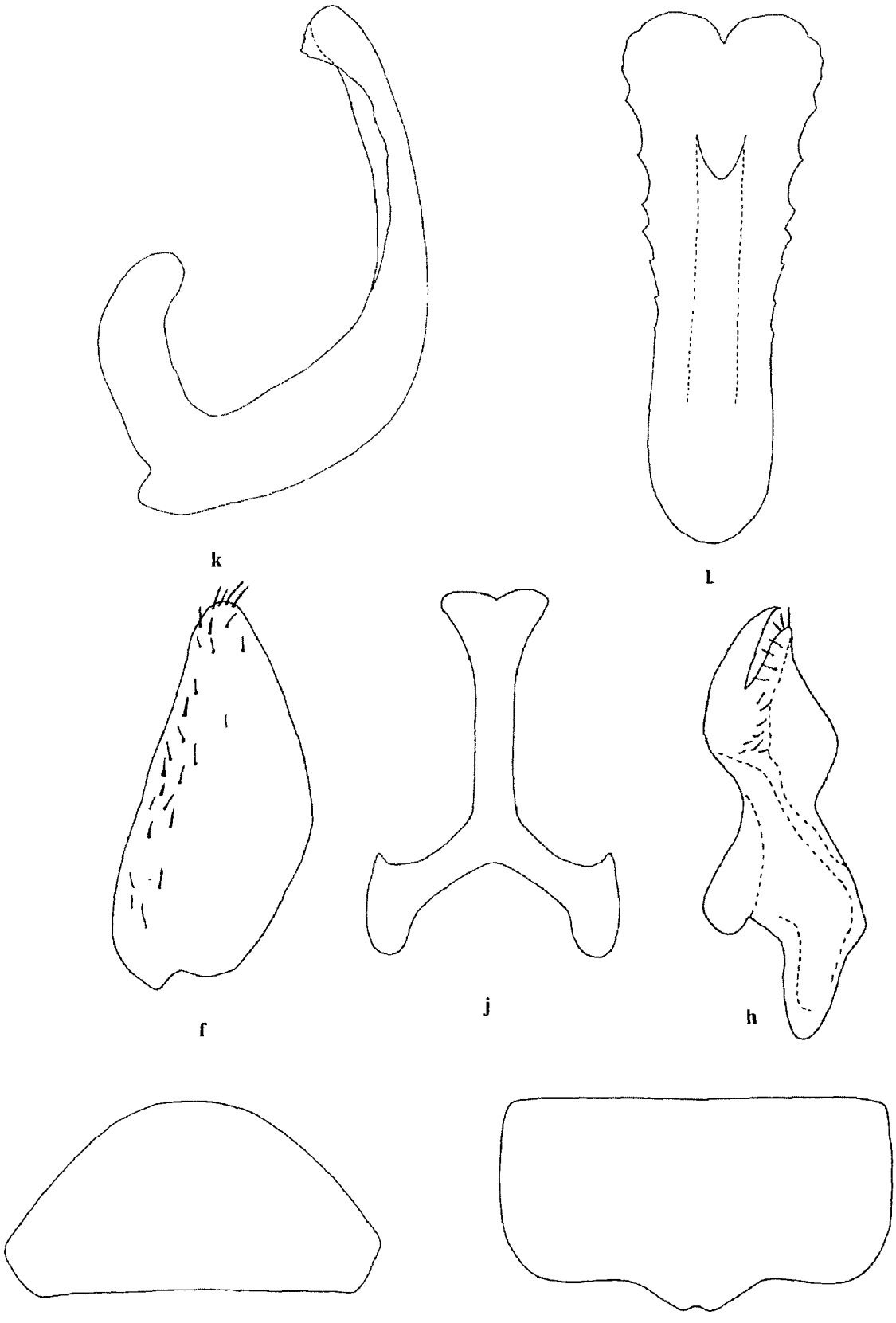


Fig. 34. ***Uzelina thaloriensis*** **Sharma**

Refer legends of Fig. 2, Fig. 3 of Chapter III for details of alphabets used

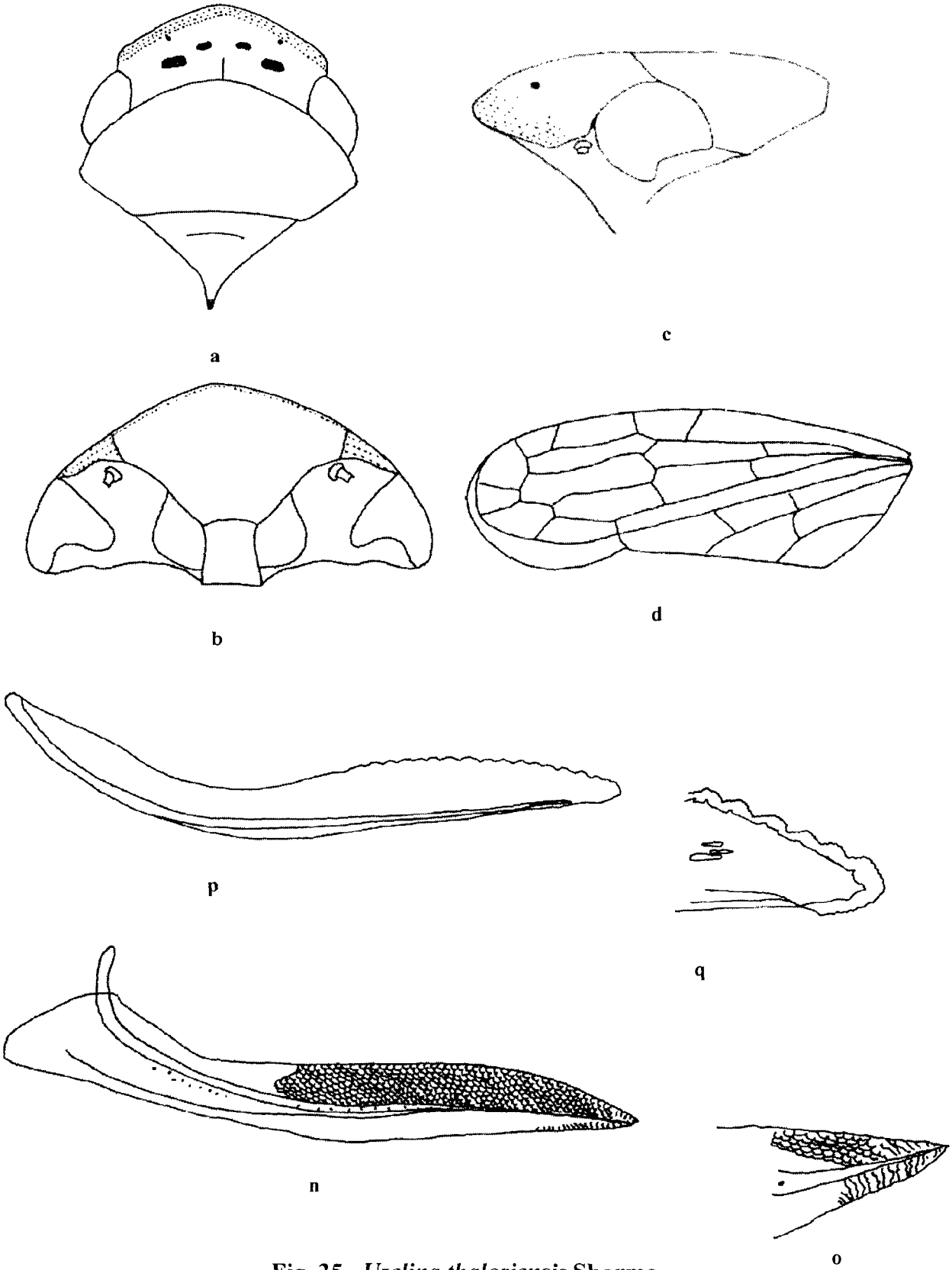
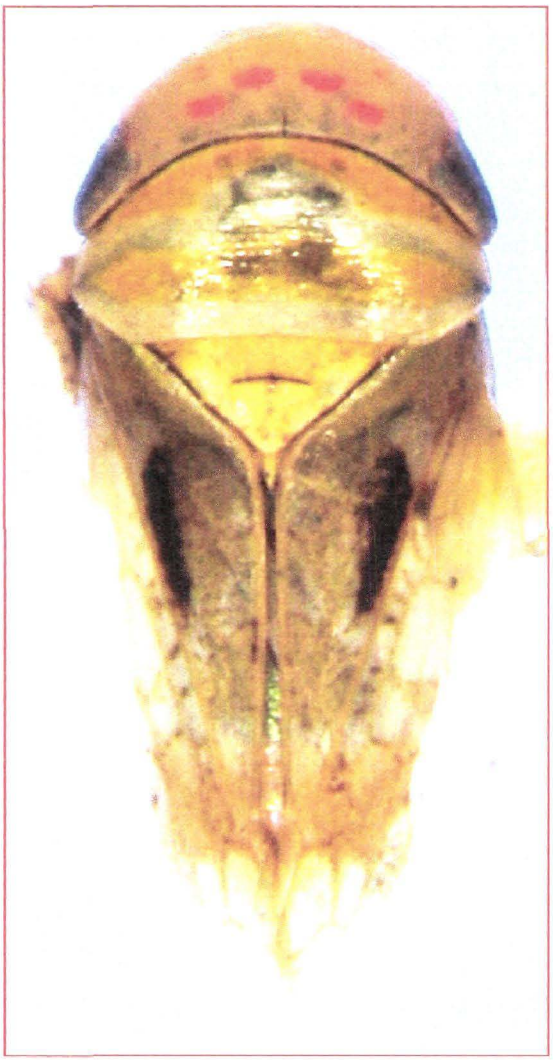


Fig. 35. ***Uzelina thaloriensis*** **Sharma**

Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used



Uzelina thaloriensis **Sharma**

Plate 11

basal and claval marginreddish-brown. Body beneath black, hind legs black with pale yellowish spinules.

Male genitalia: pygophore with caudal margin rounded with a row of short spines subapically, small hook-like appendage on dorso-mesal angle, surface with stout setae. Valve with caudal margin broadly rounded. Subgenital plate triangular with small hair like setae on surface. Connective Y-shaped. Style broad at anterior half, apophysis pointed finger-like, curved laterally, curvature of apophysis in line with curvature of preapical lobe. Aedeagus dorso-ventrally flattened, dorsal apodeme plate like well developed, preatrium reduced, shaft curved caudo-dorsally, concave on dorsal margin, uniform width throughout the length with serrated lateral margins in some specimens or shaft widens gradually towards apex in some specimens; gonopore at apex.

Female terminalia: Hind margin of female seventh sternite slightly concave with median projection, which is excavated medially.

Measurements: Male 3.60 mm long, head 1.40 mm wide across eyes, 1.40 mm wide across pronotum. Female 3.90 mm long, 1.50 mm wide across eyes, 1.55 mm wide across pronotum (Table 7).

Material examined: INDIA: Jammu & Kashmir, Paratypes, 1 ♂, 2 ♀, Thalori, Vijaypur, 11.v.1982, *Ex. Citrus* sp., B. Sharma (UASB).

Remarks: U. thaloriensis externally resembles *U. laticeps* but differs in the structure of aedeagal shaft. The aedeagal shaft in *U. thaloriensis* gradually widens apically whereas in *U. laticeps* it abruptly widens near the apical region.

4.1.7. Genus *Vulturnus* Distant

Head in profile spatulate, bluntly pointed, marginally rimmed with four to five transverse carinae. Ocelli on crown close to eyes than to each other. Lateral frontal sutures reaching ocelli. Clypeus flat or depressed. Clypellus rectangular. Lorum flat. Antenna located near antero-dorsal corner of eye. Gena broad, lateral margins almost in line with apex of clypellus. Pronotum convex anteriorly, truncate posteriorly. Scutellum broad, triangular with transverse median impression. Forewing finely blackly reticulate, with six apical and three ante-apical cells, covering entire abdomen, claval veins joined by a cross vein; hind wing with four apical cells. Hind femoral spinulation 2+2+1, hind tibia with one macrosetae between 1-2 much smaller setae on postero-dorsal region,

Table 7. Measurements (in mm) of males and females of *Uzelina thaloriensis* Melichar

Measurements	Female	Male
	Mean±SD	Mean±SD
LENGTH		
Total length	3.90±0.14	3.6
Wing	2.80±0.00	2.7
Clavus	2.05±0.07	1.8
Vertex	0.50±0.00	0.5
Pronotum	0.75±0.07	0.7
Scutellum	0.60±0.00	0.5
Clypellus	0.28±0.04	0.25
WIDTH		
Wing	1.05±0.07	0.9
Vertex	0.95±0.07	0.9
Pronotum	1.55±0.07	1.4
Head	1.50±0.00	1.4
Clypellus	0.19±0.02	0.18
Lorum	0.18±0.00	0.15
DISTANCE BETWEEN		
Eyes	1.19±0.09	1.08
Antennal pits	0.75±0.00	0.73
Ocelli	0.55±0.07	0.50

No. of specimens used for measurement: One male of *U. thaloriensis.*

with small setae between macrosetae on antero-dorsal region, meta basitarsus with three platellae.

Male pygophore with caudal margin rounded, long hair-like setae distributed in caudal one third. Subgenital plate triangular. Valve with caudal margin broadly rounded. Connective Y-shaped. Style with well developed preapical lobe, apical apophysis pointed, finger-like, curved laterally; curvature of apophysis in line with curvature of preapical lobe. Aedeagus dorso-ventrally flattened, shaft curved caudo-dorsally; gonopore apical. Hind margin of female seventh sternite with median projection having a median excavation. Dorsal sculpturing of first valvula dorsal sculpturing concatenate, position of dorsal sculpturing marginal; dorsal tooth on shaft of second valvula large, prominent, extended more than apical half.

Remarks: The genera *Vulturnus* and *Uzelina* are similar but can be differentiated by the following characters. The lateral frontal sutures reach the ocelli, and entire body has brownish reticulations in *Vulturnus* but in the case of *Uzelina* the lateral frontal sutures do not reach the ocelli and the body surface is smooth.

There are three species reported from Indian subcontinent including a new species from Nepal found during this study.

Key to the species of *Vulturnus* Distant of the Indian subcontinent (Only males)

1 Aedeagal shaft spatulate with finely serrated lateral margins and prominent triangular lobes at apex (fig. 38 *I*)..... ***V. spatulatus* sp. nov.**

- Aedeagal shaft not spatulate, with strongly serrated lateral margins and lacks prominent triangualar lobes at apex (fig. 36 *I*).....***V. ornatus* (Distant)**

***Vulturnus flavocapitatus* (Distant) comb. nov.**

Penthimia flavocapitata Distant 1918b: 20.

Colouration and structure as described by Distant (1918) with following additional characters.

Female terminalia: Hind margin of the female seventh sternite slightly concave with median projection (specimen from Lovedale).

Measurements: Female 4.12 mm long, head 1.60 mm wide across eyes, 1.64 mm wide across pronotum.

Material examined: Type 2♀, '*Penthimia flavocapitata* Dist. Type', 'Nilgiri hills, S. India, T.V. Campbell'. 'S. India, E.A. Butler, 1915-60'. 1♀, 'S. India, Lovedale, T. V. Campbell' (BMNH). 1 specimen, 'S. India, Madras, Kodaikanal, T. V. Campbell'(BMNH).

Remarks: The head being spatulate, lateral frontal sutures reaching ocelli and smaller size of the body, flat fronto-clypeus places this species in the genus *Vulturnus*. This species can be readily recognized by the unmaculated head.

***Vulturnus ornatus* Distant**

(Plate 12a & Fig. 36, 37)

Vulturnus ornatus Distant 1912d: 445; 1918b: 26.

Vulturnus speciosus Distant 1912d: 445; 1918b: 27. **syn. nov.**

Female: Vertex pale yellowish-brown, finely speckled with brownish. Pronotum very pale reddish brown, thickly blackly reticulate, posterior margin, central transverse fascia grayish white. Scutellum yellow, with black reticulations, denser near basal margin and less so on lateral areas. Body beneath (including face), legs black; basal margin of head beneath and between eyes, anterior, intermediate tibiae, tarsi, minute spots to posterior tibiae, bases, apices of posterior tarsi, lateral marginal spot to metasternum, yellow. Forewing yellowish, finely blackly reticulate, clavus with a discal black patch enclosing about four small white spots, apex whitish; a large central, longitudinal, costal white spot, containing two small black spots followed by a larger black spot, a cluster of subapical white spots.

Male: Vertex yellowish, a black submarginal apical line not reaching eyes, with three reddish-brown discal spots, the central one transverse, the other two shorter, oblique. Eyes black. Pronotum yellowish or very pale brownish, thickly blackly reticulate, the posterior margin, a central transverse fascia grayish white. Scutellum black with yellowish tinge, with four grayish white spots, two before apex, two near basal margin. Body beneath (including face), legs black, basal margin of head beneath containing a few minute dark spots, anterior, intermediate tibiae, tarsi yellowish. Tegmina yellowish, finely, thickly, blackly reticulate, a small black patch in clavus with three white spots, some white spots on claval suture, a small white spot on disk of tegmen, thee whitish spots on costal margin, a small cluster of subapical white spots. Vertex slightly longer and a little more narrowed anteriorly than in *V. ornatus*, with a central dark incised line extending from base about halfway to apex.

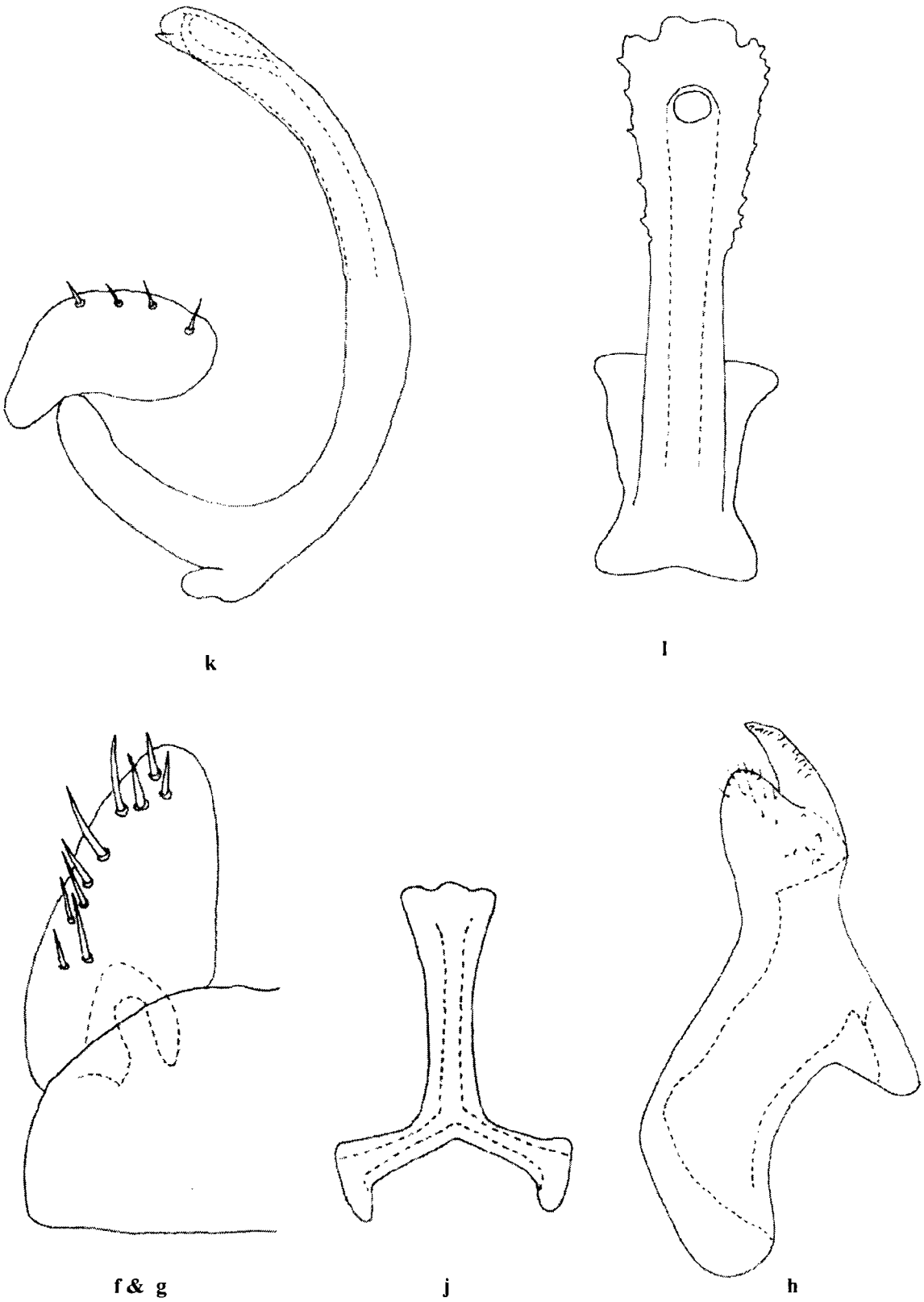


Fig. 36. *Vulturnus ornatus* Distant

Refer legends of Fig. 2 of Chapter III for details of alphabets used

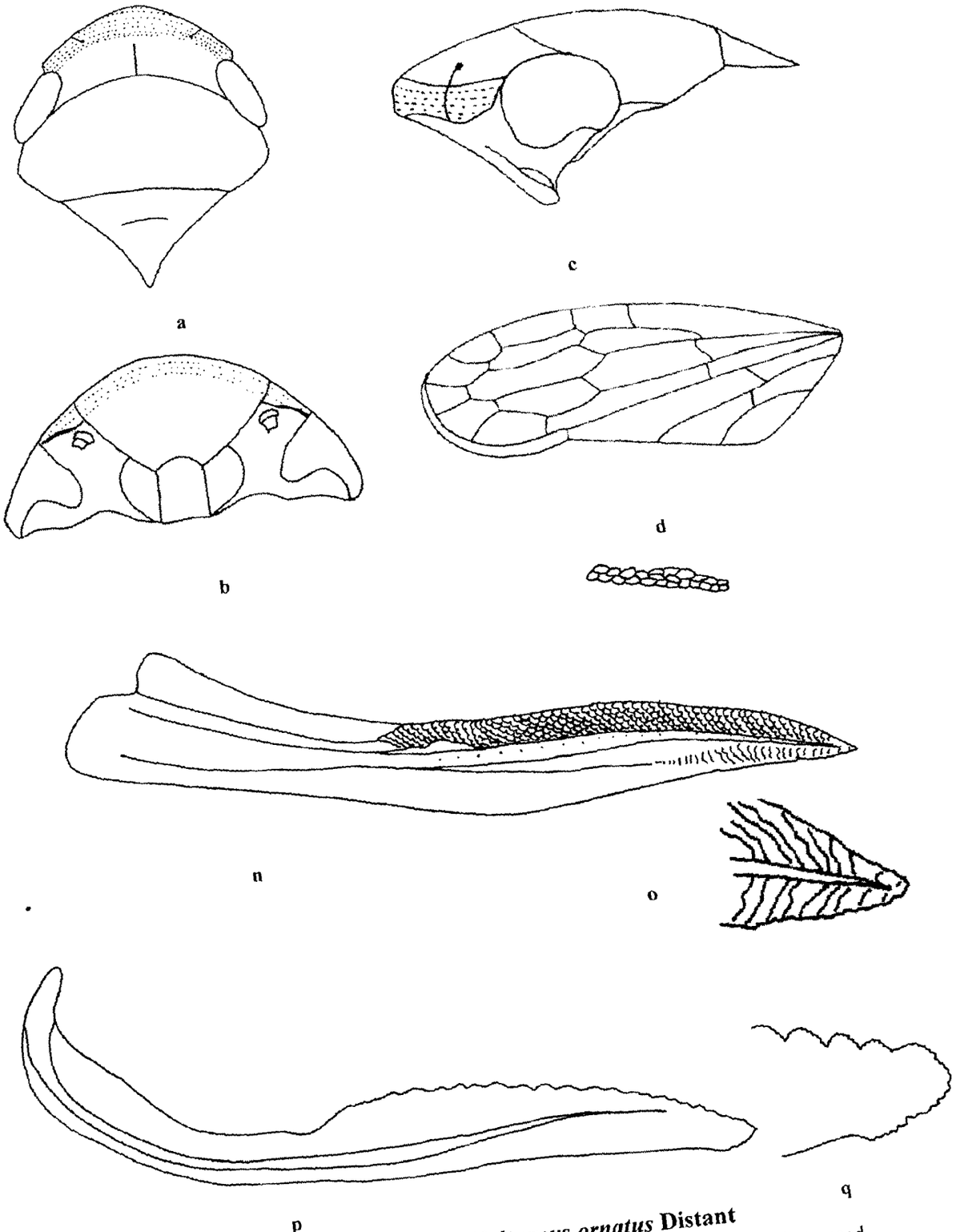


Fig. 37. ***Vulturnus ornatus*** **Distant**

Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used

Male genitalia: Subgenital plate with stout setae on lateral margin. Connective with stem twice longer than arm. Style broad at anterior half, lateral margin sinuate, apophysis long finger-like, pointed, curved laterally; preapical lobe curved downward which is in line with the curvature of apophysis. Acdcagus with well developed dorsal apodeme, preatrium not well developed, shaft curved caudo-dorsally; in caudal view shaft almost straight, parallel sided in basal half laterally, anterior half gradually expanded with serrated lateral margin; gnopore subapical.

Female terminalia: Hind margin of seventh sternite with median projection having median concavity.

Measurement: Male 3.20 mm long, Head 1.24 mm wide across eyes, 1.24 mm wide across pronotum. Female 3.77 mm long, head 1.46mm wide across eyes, 1.43 mm wide across pronotum (Table 8).

Material examined: SRI LANKA: 1♂, 'Type H. T' '*Vulturnus speciosus* Dist. Type' 'Peradeniya, Sri Lanka, 4.06' (BMNH). 1♀ 'Type H.T' '*Vulturnus ornatus* Dist. type' 'Peradeniya, Sri Lanka, 2.1902' (BMNH). *Other material examined*: SRI LANKA (Two specimens mounted on same stage) 1♀ and specimen with abdomen missing, R.R.S.No.1174. St. Coombs, on tea Talawakelle, Sri Lanka. C. B. Redmarking, 16.xi.39. H. S. Pruthi, det.1940, R-7827-28(IARI).

Remarks: V. ornatus and *V. speciosus* are male and female of the same species and hence are considered as synonyms. *V. ornatus* resembles *V. spatulatus*, but differs in having much narrower aedeagal shaft, strongly serrated lateral margins without prominent triangular lobes at apex and also the structure of style.

***Vulturnus spatulatus* sp. nov.**

(Plate 12b & Fig. 38)

Yellowish-brown, finely speckled with brownish. Labium slightly extending beyond forecoxae. Scutellum broad, triangular, basal angles dark brown or black. Forewing with five marginal, three sub marginal cells.

Male genitalia: Pygophore with caudal margin rounded, with long hair-like setae distributed in caudal one third. Subgenital plate triangular, with small hair-like setae on surface. Connective slender, arms shorter than stem. Style broad at anterior half, apical apophysis pointed, finger-like, curved laterally. Aedeagus dorso-ventrally flattened, dorsal apodeme plate-like, well developed, preatrium reduced, shaft curved

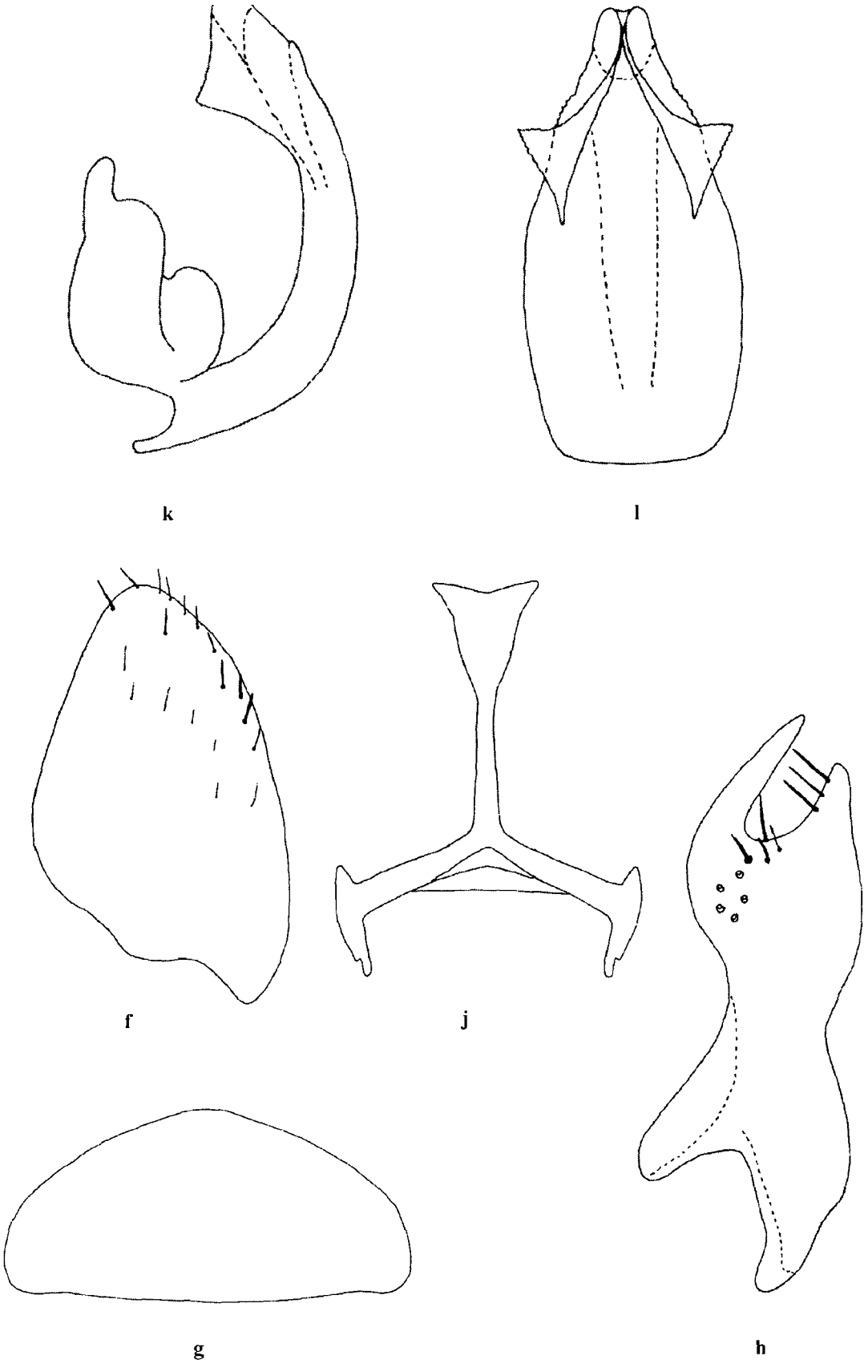
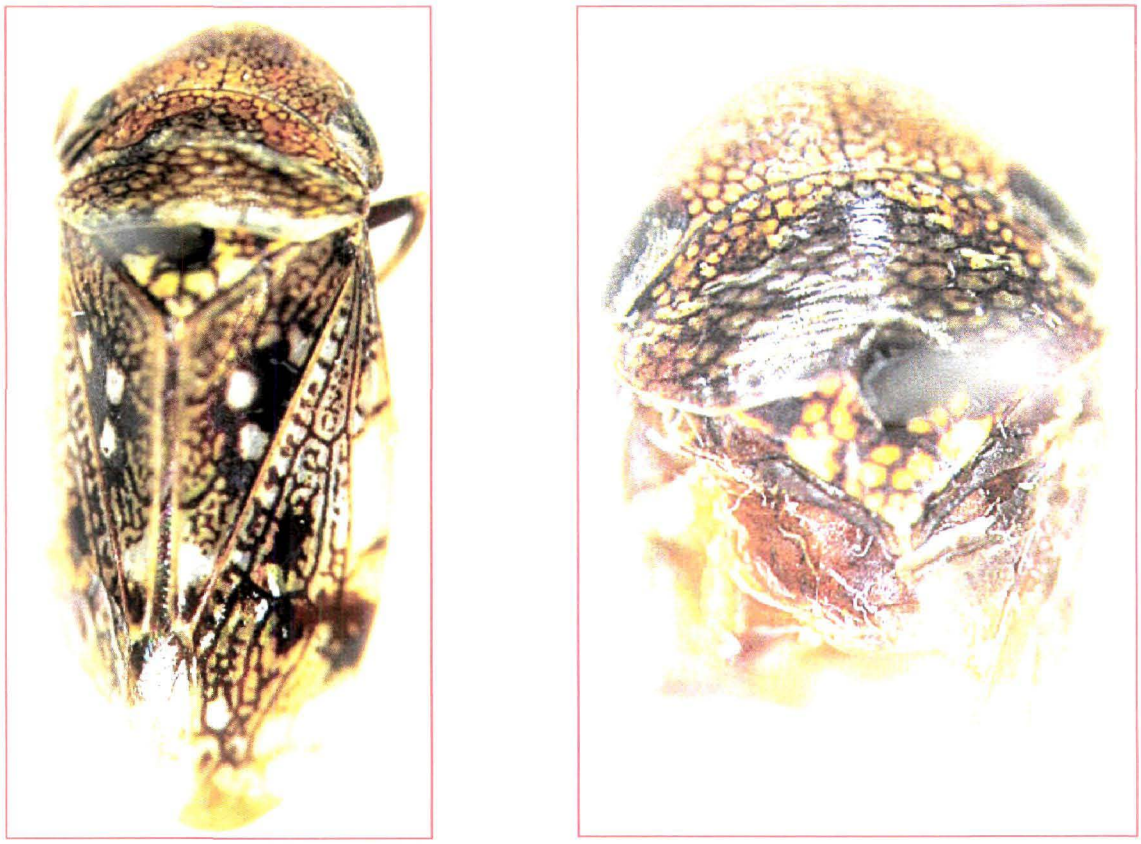
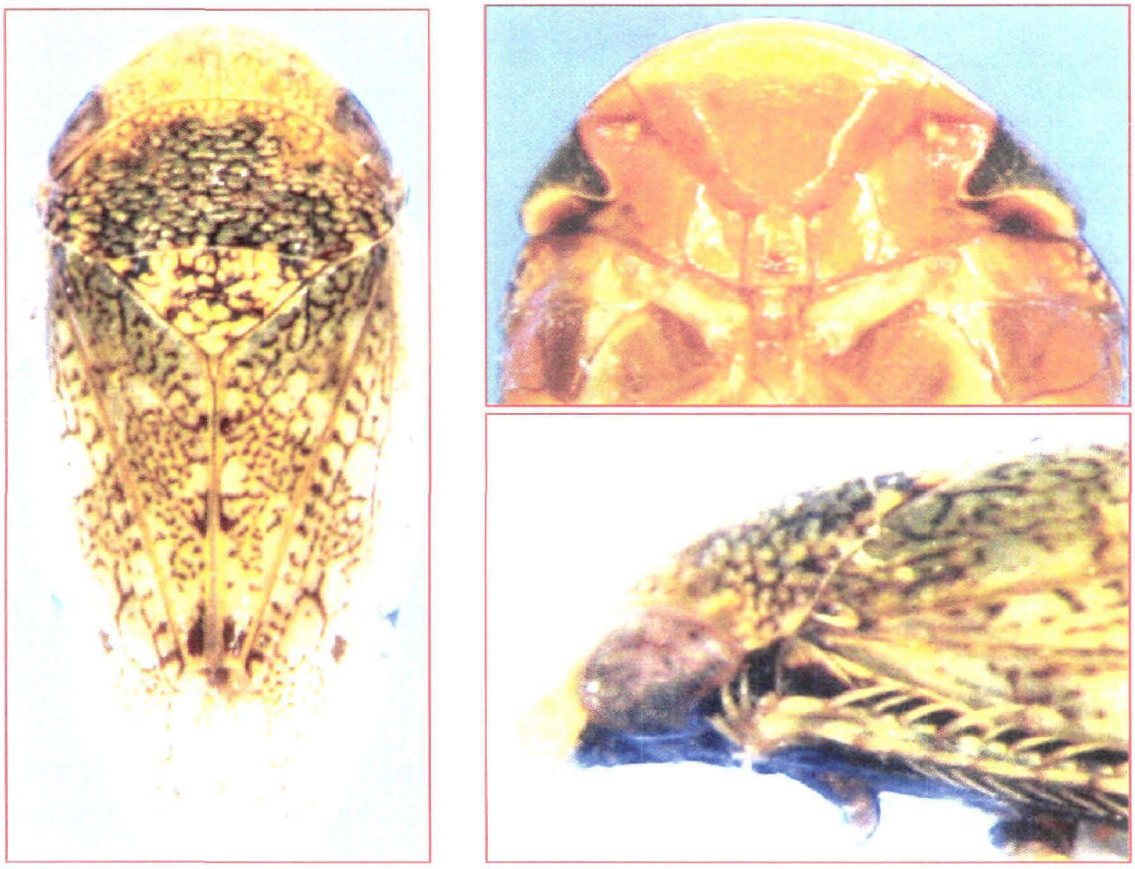


Fig. 38. *Vulturnus spatulatus* sp. nov.

Refer legends of Fig. 2 of Chapter III for details of alphabets used



a. *Vulturnus ornatus* Distant



b. *Vulturnus spatulatus* sp. nov.

Plate 12

Table 8. Measurements (in mm) of males and females of *Vulturnus* Kirkaldy

Measurements	*spatulatus* (♂)	*ornatus* (♀)
	Mean±SD	Mean
LENGTH		
Total length	3.77±0.06	3.77
Wing	2.80±0.00	2.80
Clavus	2.00±0.00	1.80
Vertex	0.40±0.00	0.40
Pronotum	0.70±0.00	0.70
Scutellum	0.60±0.00	0.63
Clypellus	0.26±0.01	
WIDTH		
Wing	1.00±0.00	0.93
Vertex	0.87±0.06	0.90
Pronotum	1.40±0.00	1.43
Head	1.40±0.00	1.46
Clypellus	0.18±0.00	
Lorum	0.18±0.00	
DISTANCE BETWEEN		
Eyes	1.00±0.00	
Antennal pits	0.68±0.00	
Ocelli	0.53±0.00	

No. of specimens used for measurement: One female of *V. ornatus*.

caudo-dorsally, with a triangular lateral flange apically, margins finely serrated; gonopore apical.

Measurements: Male 3.77 mm long, head 1.40 mm wide across eyes, 1.40 mm wide across pronotum (Table 8).

Material examined: NEPAL: Kathmandu, Holotype ♂, Chandragiri, Sundarijal, 6-28.viii.1978, V. K. Thapa: 2♂, Chandragiri, Sundarijal, 6-28.viii.1978, V. K. Thapa (UASB).

Remarks: V. spatulatus externally resembles *V. ornatus* but pronotum is uniformly maculate and the aedeagus is spatulate with lateral triangular lobes with finely serrated margins.

4.1.8. Host plants of Penthimiinae

Among the species of Penthimiinae, *N. acocephaloides* and *P. compacta* are very common and found feeding on a variety of plant species. *N. acocephaloides* was found feeding on *Artocarpus heterophyllus* Lam., *Anacardium occidentale* L., *Clerodendron inerme* (L.), *Santalum album* L., *Mimosa pudica* L., *Ocimum sanctum* L., *Phaseolus vulgaris* L., *Cajanus cajan* L., *Mangifera indica* L., *Dodonea viscosa* (L.) and *Duranta goldiana*. *P. compacta* was found feeding on *Santalum album* L., *Cajanus cajan* L., *Ocimum sanctum* L. and *Phaseolus vulgaris* L., whereas *P. scutellata* was mainly recorded on *Santalum album* L., and *T. gravelyi* on *Artocarpus heterophyllus* Lam., and *Dodonea viscosa* (L.).

4.2. Subfamily Deltocephalinae

Tribe Stenometopiini

Distant (1918) included two species in his genus *Galerius* Distant, namely *G. indicatrix* Distant (type species) and *G. aberrans* Distant. Vilbaste (1965) without studying the male genitalia of these species considered *Galerius* as a junior synonym of *Stirellus*. However, examination of male genitalia of *Galerius* indicated that this synonymy is unjustified as *G. indicatrix* possesses male genitalia that is very different from *Doratulina* Melichar. Therefore, this genus is reinstated as a valid genus. However, *G. aberrans* has male genitalia very similar to those of *Stirellus* and hence it has been transferred here to the genus *Stirellus*.

4.2. Genus *Stirellus* Osborn and Ball

Doratulina Melichar 1903b: 198-199. **syn. nov.**
Viridomarus Distant 1918b: 69. **syn. nov.**

The genus *Viridomarus* Distant (type species: *V. capitatus* Distant) is here treated as a juniour synonym of *Stirellus* as both share very similar male genitalia. Therefore the present study revealed that the tribe is represented by single genus *Stirellus* Osborn and Ball with three subgenera, *Campbellinella* (Distant), *Cymbopogonella* (Viraktamath) and *Stirellus* Osborn and Ball based on the morphological analysis.

Key to subgenera of the genus *Stirellus* Osborn and Ball of the Indian subcontinent

1 Male pygophore with dorsal processes (Fig.39e)...***S. (Campbellinella)* (Distant)**
- Male pygophore without dorsal processes.....2

2 Head five to six times longer than width between eyes and frons anteriorly forming a strong median ridge (Fig.40b, Plate 14).....***S. (Cymbopogonella)* (Viraktamath)**
- Head at most two and half times longer than width between eyes and frons not as above.....***S. (Stirellus)* Osborn & Ball**

4.3.1. Subgenus *Campbellinella* (Distant)

Pale yellow or straw coloured, vertex two times longer than inter-ocular distance, apex subacutely produced, medially sulcate at the base. Ocelli black, located on lateral margin of vertex, close to eyes than to each other. Eyes prominent, long, oblique, projecting over lateral angles of pronotum. Gena broad, outer margin sinuate, not visible in dorsal view. Clypeus fairly raised. Lorum flat, not reaching apex of clypellus. Clypellus slightly extending beyond lateral margin of gena. Ocellus placed at a distance equal to twice its diameter from adjacent eye. Frontal suture reaching ocellus. Pronotum more than twice as wide as long, medially ridged. Scutellum triangular with median transverse impression. Forewing not extending beyond tip of the abdomen in females; in male covering the abdomen, appendix narrow. Hind femoral

spinulation 2 + 1, hind tibia with one macrosetae between 1-4 much smaller setae on postero-dorsal region, antero-dorsal region with medium sized macrosetae, meta basitarsus with four platellae.

Male pygophore long, broad at anterior half, surface convex, narrowing posteriorly towards apex, dorsal margin slightly curved upward at apex, with an appendage on postero dorsal margin. Valve triangular, subgenital plates broad, rounded laterally with few stout marginal setae. Connective Y-shaped, arms slightly shorter than stem. Style long, slender with moderately developed preapical lobe, apical apophysis long, broad, slightly curved laterally, truncate at apex, apex of the apophysis sclerotised pointed with lateral projections. Aedeagus shaft, straight, tightly recurved, apex slightly bent, acute. Hind margin of the seventh sternite concave medially, with lateral projections. Form of first valvula dorsal sculpturing granulose, position of dorsal sculpturing sub-marginal; dorsal tooth on shaft of second valvula almost reduced.

Remarks: Subgenus *Campbellinella* closely resembles subgenus *Stirellus* but can be distinguished by the dorsal process of the male pygophore which is absent in *Stirellus*. *Stirellus (Campbellinella) illustrata* is the only species in this subgenus.

***Stirellus (Campbellinella) illustrata* (Distant)**

(Plate 13 & Fig. 39)

External structure and body colouration as described by Distant (1918) with following additions.

Pale yellowish, forewing often with illdefined dark brown longitudinal stripe. Vertex 2.5 times longer than inter-ocular distance, apex acutely produced in front of eyes. Forewing with four apical, three subapical cells.

Male genitalia: Dorsal process of the pygophore slightly curved near apex and bluntly pointed. Other structures as in generic description.

Female terminalia: Hind margin of the seventh sternite concave medially, with lateral projections.

Measurements: Male 5.30 mm long, 1.01 mm wide across eyes, 1.13 mm wide across pronotum. Female 5.70 mm long, head 1.05 mm wide across eyes, 1.20 mm wide across pronotum (Table 9). *Genitalia measurements*: (Table 11).

Material examined: INDIA: Karnataka, 3♀, 1♂, Mandya, 24.i.2007, *ex.* Sugarcane, Shobharani, M; 1♀, Mandya, 25.i.2007, *ex.* Sugarcane, Shobharani, M; Raichur, 16.xi.1980, C. A. Viraktamath; 1♀, 1♂, Siddleghatta, 9.vii.1976, B. Mallik;

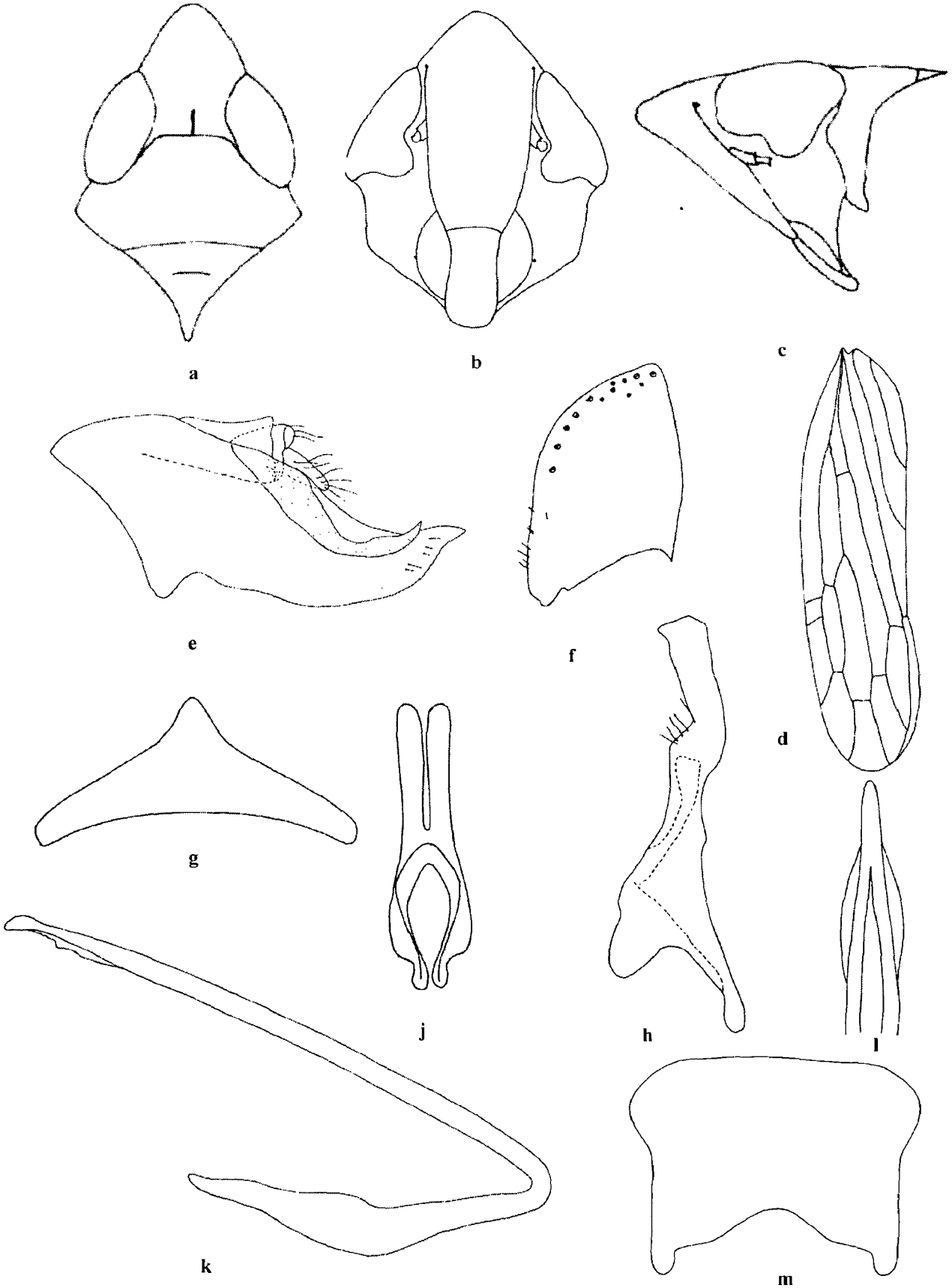
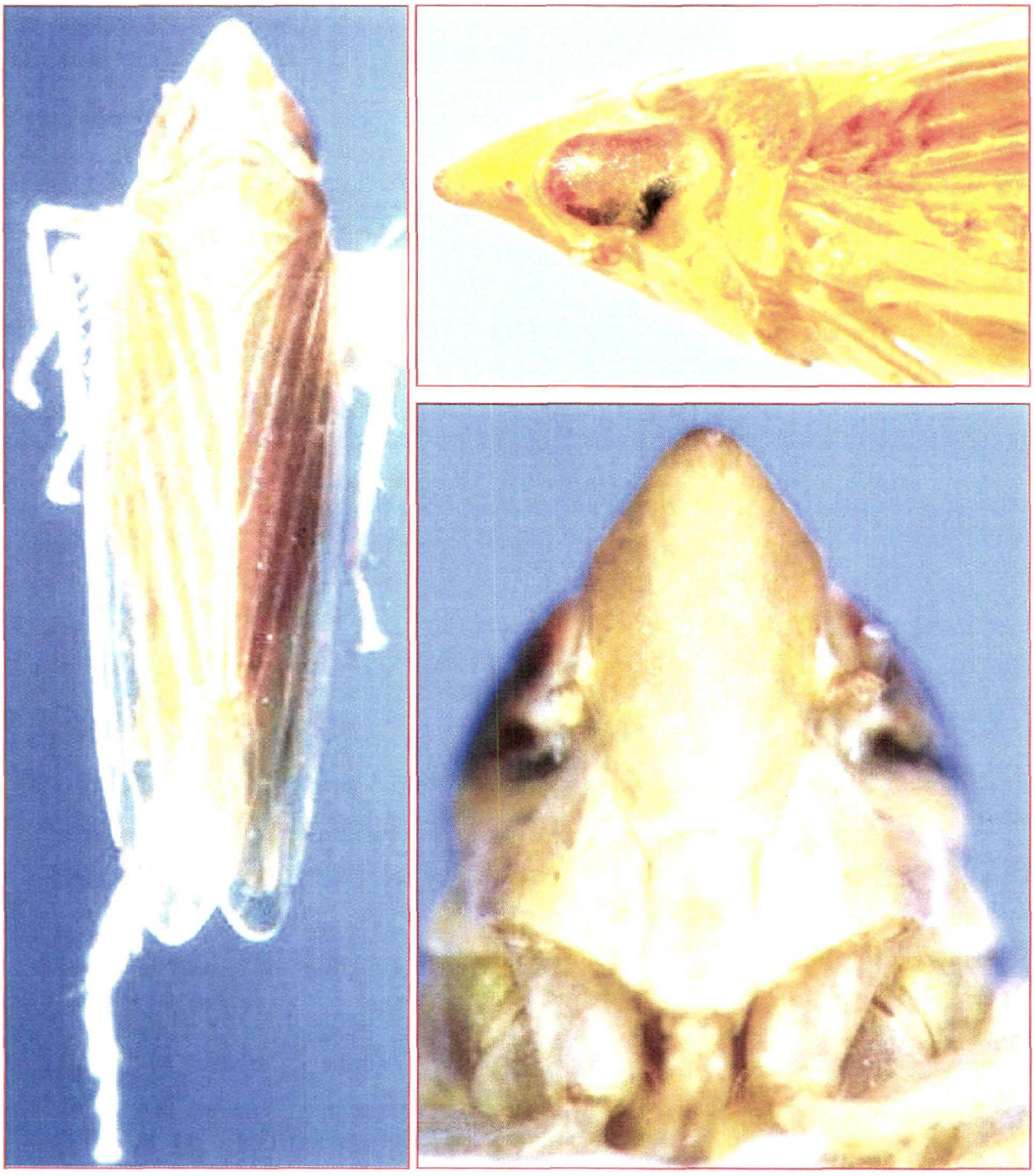


Fig. 39 *Stirellus (Campbellinella) illustrata* (Distant)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus (Campbellinella) illustrata (Distant)

Plate 13

Table 9. Measurements (in mm) of males and females of *S.* (*Campbellinella*) *illustrata* Distant

Measurements	Male	Female
	Mean±SD	Mean
LENGTH		
Total length	5.30±0.22	5.70
Total length *	5.36±0.02	-
Wing	4.14±0.24	4.60
Clavus	2.74±0.09	3.00
Vertex	0.73±0.03	0.75
Pronotum	0.51±0.02	0.53
Scutellum	0.48±0.06	0.58
Clypeus	0.97±0.04	1.00
Clypellus	0.41±0.01	0.43
WIDTH		
Wing	0.71±0.03	0.75
Vertex	0.28±0.00	0.30
Pronotum	1.13±0.04	1.20
Head	1.01±0.02	1.05
Clypellus	0.21±0.01	0.23
Lorum	0.15±0.01	0.15
DISTANCE BETWEEN		
Eyes	0.48±0.01	0.50
Antennal pits	0.43±0.00	0.47
Ant. E to ant. V	0.35±0.03	0.33

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex.
No. of specimens used for measurement: One female of *S. illustrata.*

1♂, 20 Km N of Yelburga, 14.ii.1977, K. D. Ghorpade; Gujarat: 2♂, Navasari, 16.i.1981, C. A. Viraktamath.

Remarks: This is the only species under the subgenus *Campbellinella*. This species has an appendage on postero-dorsal margin of the pygophore and also has different type of female seventh sternum compared to other species of Stenometopiini in the Indian subcontinent.

4.3.2. Subgenus *Cymbopogonella* Viraktamath

Vertex five to six times as long as its inter-ocular distance, apically pointed, with median longitudinal carina, lateral margins of vertex also carinate in distal 0.75. Face with a mid ventral carina. Clypeus longer than wide, slightly constricted at middle. Gena visible dorsally. Forewing with four apical, three subapical cells. Hind femoral spinulation 2 + 1, hind tibia with one macrosetae between 1-4 much smaller setae on postero-dorsal region, antero-dorsal region with medium sized macrosetae, meta basitarsus with five platellae.

Male pygophore elongate ventrally excavated about middle, with a stout tubercle. Valve, subgenital plate triangular, uniserially spinose. Connective Y-shaped. Style with moderately developed preapical lobe, apical apophysis long finger-like, laterally with corrugated surface. Aedeagus strongly recurved at basal half, gonopore subapical on dorsal margin. Female with hind margin of seventh sternite slightly concave. Form of first valvula dorsal sculpturing granulose, position of dorsal sculpturing sub-marginal; dorsal tooth on shaft of second valvula almost reduced.

Remarks: This subgenus differs from *Stirellus* in having long apically pointed, medially carinated vertex. Some species of *Stirellus* (*eg. Stirellus capitatus* and *S. projectus*) also have elongated head but lack dorsal or ventral carinae or both and the gena is not visible dorsally, in addition the head in these cases is at most three times as long as inter-ocular distance.

***Stirellus (Cymbopogonella) longivertex* (Viraktamath)**

(Plate 14 & Fig. 40)

Straw coloured, elongate species. Other characters as in generic description.

Male genitalia: Pygophore elongate ventrally excavated about the middle, with one stout tubercle at apical one-third near ventral margin. Subgenital plate gradually tapering towards apex, uniserially spinose. Connective with arms of almost equal

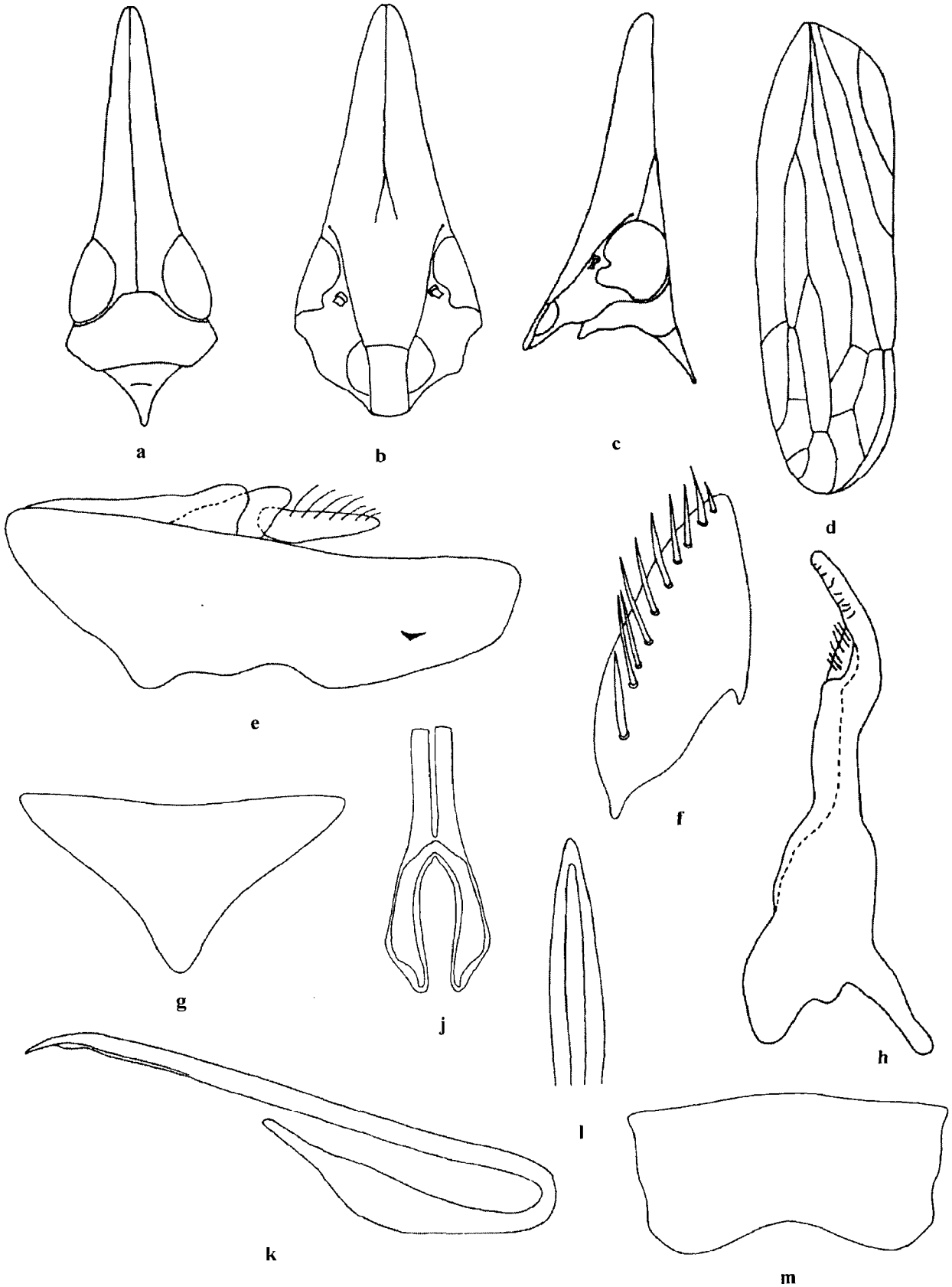
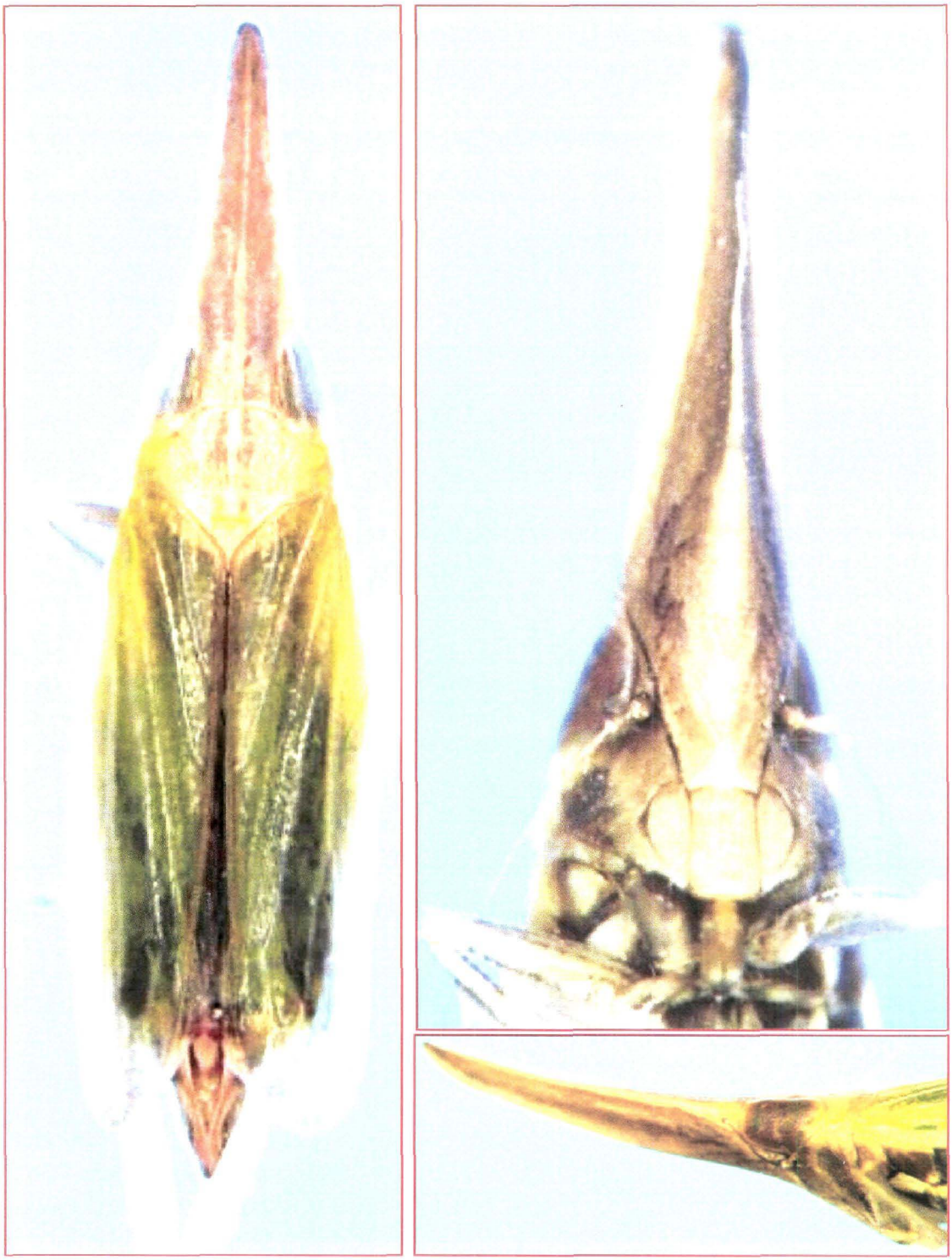


Fig. 40 *Stirellus (Cymbopogonella) longivertex* (Viraktamath)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus (Cymbopogonella) longivertex (Viraktamath)

Plate 14

Table 10. Measurements (in mm) of males and females of *S.* (*Cymbopogonella*) *longivertex* Viraktamath

Measurements	Male	Female
	Mean±SD	Mean±SD
LENGTH		
Total length	4.90±0.1	6.86
Total length *	-	5.90
Wing	3.03±0.06	3.30
Clavus	2.20±0.00	2.40
Vertex	1.68±0.12	2.30
Pronotum	0.39±0.01	4.00
Scutellum	0.37±0.01	0.40
Clypeus	1.95±0.09	2.60
Clypellus	0.38±0.01	0.40
WIDTH		
Wing	0.60±0.03	0.80
Vertex	0.27±0.01	3.00
Pronotum	0.90±0.00	1.00
Head	0.82±0.03	0.90
Clypellus	0.19±0.01	0.20
Lorum	0.13±0.00	0.15
DISTANCE BETWEEN		
Eyes	0.43±0.00	0.60
Antennal pits	0.36±0.01	0.50
Ant. E to ant. V	1.36±0.09	1.80

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex.
No. of specimens used for measurement: One female of *S. longivertex*.

Table 11. Measurements (in mm) of male and female genitalia of the *Stirellus* (*Cymbopogonella) longivertex* (Viraktamath) and *Stirellus* (*Campbellinella) illustrate* (Distant)

Measurements	*S. (C.) logivertex*	*C. illustrata*	Measurements	*S. (C.) logivertex*	*C. illustrata*
LENGTH			**LENGTH**		
Valve	0.037	0.035	Seventh sternum	0.055	0.068
Subgenital plate	0.064	0.088	1st gonapophysis	0.286	0.366
Pygophore	0.105	0.165	Dorsal sculpturing 1st gonapophysis	0.187	0.295
I segment of the anal tube	0.033	0.066	2nd gonapophysis	0.264	0.358
II segment of the anal tube	0.011	0.017	Dorsal tooth 2nd gonapophysis	0.143	0.204
III segment of the anal tube	0.022	0.024	Gonoplac	0.215	0.329
Connective	0.061	0.088	Anterior half of gonoplac	0.121	0.215
Style	0.065	0.099	Pygophore	0.201	0.220
Apophysis of style	0.008	0.028	**WIDTH**		
Aedeagal shaft	0.103	0.144	7th sternum	0.121	0.121
WIDTH			1st gonaophysis	0.032	0.030
Valve	0.066	0.105	2 nd gonapophysi	0.023	0.021
Subgenital plate	0.026	0.053	Gonoplac	0.035	0.042
Pygofer	0.029	0.075	Pygophore	0.051	0.074
Connective	0.010	0.015			
Style (anterior part)	0.017	0.031			
Style (Posterior part)	0.007	0.014			
Atrium	0.026	0.050			
Distance from base to shaft	0.033	0.033			

length of stem. Style with apical apophysis curved laterally with corrugated surface. Aedeagus shaft with recurved part of shaft rather straight but near apex slightly curved and acutely pointed.

Female terminalia: Hind margin of the seventh sternite slightly concave

Measurements: Male 4.90 mm long, head 0.82 mm wide across eyes, 0.9 mm wide across pronotum. Female 6.86 mm long, head 0.90 mm wide across eyes, 1.00 mm wide across pronotum (Table 10). *Genitalia measurements*: (Table 11).

Material examined: INDIA: Karnataka, 1♀, 4♂, Chintamani, 16.x.2006, Shobharani, M. (UASB).

Remarks: This species can be readily recognized by its long anteriorly projected head which is more than five to six times as long as inter-ocular distance and the gena slightly visible in dorsal view.

4.3.3. Subgenus *Stirellus* Osborn and Ball

In life green, iridescent green or pale yellowish green, vertex of variable shape, size; sulcate medially at base. Eyes prominent, long, oblique, projecting over lateral angles of pronotum. Clypeus fairly raised. Lorum flat, not reaching apex of clypellus. Clypellus slightly extending beyond lateral margin of gena. Ocelli placed close to eyes than to each other. Frontal suture reaching ocellus. Antenna long. Pronotum more than twice as wide as long, anterior margin convex to truncate, posterior margin almost truncate or slightly concave. Scutellum triangular with median transverse impression. Forewing with four to five apical cells, three subapical cells; forewing not extending beyond tip of abdomen in females, appendix very narrow, hind wing with four apical cells. Hind femoral spinulation 2 + 1, hind tibia with one macrosetae between 1-4 much smaller setae on postero-dorsal region, antero-dorsal region with small setae between macrosetae, meta basitarsus with four to five platellae.

Male pygophore simple, without processes. Valve triangular. Subgenital plate triangular, uniserially or rarely biserially spinose. Style elongate with well developed preapical lobe, apophysis long finger-like, slightly curved laterally. Connective Y-shaped, stem deeply bilobed. Aedeagus simple, shaft tubular recurved dorsad and cephalad, apex pointed, shaft either straight or sinuate, gonopore terminal. Hind margin of female seventh sternite slightly concave or truncate. The form of first valvula dorsal sculpturing granulose, position of dorsal sculpturing sub-marginal; dorsal tooth on shaft of second valvula almost reduced.

Remarks: Subgenus *Stirellus* differs from *Campbellinella* in the following characters. Subgenus *Campbellinella* has strong curved appendage on postero-dorsal margin of pygophore which is absent in *Stirellus*. The female seventh sternite of the subgenus *Stirellus* is either slightly concave or truncate, but in the subgenus *Campbellinella* it has semicircular excavation in the middle with lateral lobe like extensions. Subgenus *Stirellus* differs from *Cymbopogonella* in having shorter head that lacks median ridge.

A total of 20 species including nine new species under the subgenus *Stirellus* were reported from Indian subcontinent.

Key to species of the subgenus *Stirellus* of the genus *Stirellus* Osborn and Ball

1 Vertex more than 2.5 times longer than inter-ocular distance 2

- Vertex two times or less than two times longer than inter-ocular distance.....4

2 Vertex three times longer than inter-ocular distance, clypeus with black oblique stripes on lateral margin and basal half pale yellowish (Plate 20).....***S. ribeiroi* (Pruthi)**

- Vertex 2.5 times longer than inter-ocular distance, clypeus not as above.....3

3 Head long and slender, laterally moderately emarginated, gradually narrowing to about half its length and then more slenderly produced***S. projectus**** **(Distant)**

- Vertex gradually narrowing to an acute apex, slightly deflected in anterior region, lateral margins thick and forming a distinct border between vertex and the face (Fig.41a-c, Plate 15).....***S. capitatus* (Distant)**

4 Vertex slightly longer than inter-ocular distance.....7

- Vertex 1.5 to 2 times longer than inter-ocular distance.....5

5 Vertex less than or equal to 1.75 times as long as inter-ocular distance.....6

- Vertex two times longer than inter-ocular distance.....26

6 Vertex 1.75 times longer than inter-ocular distance, with two prominent black spots on anterior margin, which are connected beneath on upper margin of face (Fig.45a-c, Plate 19).....***S. notatus* (Distant)**

- Vertex 1.5 times longer than inter-ocular distance, markings on the vertex not as above.....18

7 Macropterous.....8
- Brachypterous (Plate 17).....*S. jacosa* **(Melichar)**

8 Vertex with two black circular spots between eyes, face not black.....9
- Vertex without circular spots, may be with black patches around eyes (some times face may be black).....10

9 Aedeagal shaft straight (Fig.42 k)..... ***S. indra* (Distant)**
- Aedeagal shaft sinuate (Fig.60 k)..... ***Stirellus* sp. 9**

10 Face black, more dark brown towards apex and with two large prominent grayish white spots near middle and cheeks reddish-brown with an oblique grayish white fascia.....*S. albifrons** **(Distant)**
- Face and cheeks not as above.....11

11 Head, pronotum, scutellum and body beneath yellowish..*S. aberrans** **(Distant)**
- Head, pronotum, scutellum and body beneath not yellowish.....12

12 Disc of the pronotum with two closely placed quadrangular impression which are clearly visible.....*S. colombensis** **(Melichar)**
- Disc of the pronotum not as above.....13

13 Vertex crossed before eyes by a orange fascia which is medially interrupted (Plate 22).....*S. rubrolineata* **(Distant)**
- Vertex without orange fascia.....14

14 Apical apophysis of the style thumb-like and straight (Fig.56 h&i)***Stirellus* sp. 5**
- Apical apophysis of the style finger-like and curved laterally (Fig 58h, 59h)..15

15 Vertex broadly rounded to face.....16
- Vertex subacutely produced.....17

16 Vertex broadly rounded at anterior margin (Fig.47 a-c, Plate 21).....***S. rotundus*** **(Pruthi)**

- Vertex with anterior margin broadly angulate (Fig. 51a-b,Plate 25).....***S. tolla*** **(Pruthi)**

17 Pygophore slightly tapering caudad (fig. 59c), arms of connective widely separated (fig.59j).....***Stirellus*** **sp. 8**

- Pygophore gradually declivous caudally (fig.49e), arms of connective closely placed (49j).....***S. solitaris*** **(Melichar)**

18 Vertex with markings.....19

- Vertex without markings.....20

19 Vertex with orange transverse fasciae between eyes (Fig.44a, Plate 18).....***S. laetus*** **(Melichar)**

- Vertex mostly dark brown except an apical triangular markings and base.....***S. asiatica**** **(Ishihara)**

20 Face with upper half of the frons dark brown with a median pale streak, lower half of the frons, clypeus and genae brown.....***S. dindorensis**** **(Pruthi)**

- Face entirely pale yellowish.....21

21 Adeagal shaft sinuate (fig. 45 k).....***Stirellus*** **sp. 3**

- Aedeagal shaft straight (fig. 53 k).....22

22 Disc of the vertex finely longitudinally rugose.....***Stirellus*** **sp. 4**

- Disc of the vertex not rugose.....23

23 Head including eyes broader than pronotum (fig. 57a, Plate 31).....24

- Head including eyes not broader than pronotum.....25

24 Pygophore acutely pointed, slightly recurved dorsally at apex.....***S. thattaensis**** **Mahmood, Sultana and Waheed**

- Pygophore bluntly pointed, not recurved at apex.....***Stirellus*** **sp. 6**

25 Style is very broad anteriorly and slender posteriorly with well developed preapical lobe.....*Stirellus* **sp. 7**

- Style not as above.....*S. vertica** **(Pruthi)**

26 Vertex with two longitudinal fasciae, pronotum with three and scutellum with single central longitudinal fascia orange (Fig.50a, Plate 24).....*S. speciosum* **(Distant)**

- Vertex, pronotum and scutellum without longitudinal fasciae.....27

27 Hind margin of the female seventh sternite deeply emarginated in the middle.....*S. viridicans* ***(Distant)**

- Hind margin of the female seventh sternite concave medially.....28

28 Head, pronotum and scutellum black.....*S. atrata** **(Distant)**

- Head, pronotum and scutellum pale yellowish green.....29

29 Scutellum with obscure dark spots near base.....*S. pusanus* ***(Distant)**

- Scutellum without any spots.....30

30 Vertex of the head triangularly subacutely produced, lateral margins of which are darker in hue.....*S. lahorensis** **(Distant)**

- Vertex acutely pointed.....31

31 Male style with preapical lobe well developed.....32

- Male style with preapical lobe not well developed .....*S. khewrensis** **(Pruthi)**

32 Pygophore with tubercle.....33

- Pygophore without tubercle.....*S. jhokensis** **Ahmed and Aziz**

33 Arms of the connective with short lateral extensions (fig. 52j).....*Stirellus* **sp.1**

- Arms of the connective without lateral extensions (fig. 53j).....34

34 Apical apophysis of the style pointed at apex.....35

- Apical apophysis of the style bluntly pointed at apex.....*Stirellus* **sp. 2**

35 Aedeagal shaft short, tightly recurved.....
.....***S. peshawarensis** Mahmood, Sultana and Waheed**

- Aedeagal shaft long, loosely recurved .....***S. viridulus* *(Pruthi)**

(Species with asterisk were not studied but are included in the key to make it more comprehensive)

***Stirellus (Stirellus) capitatus* (Pruthi) comb. nov.**

Viridomarus capitatus Distant 1918:70.

Bella apicalis Pruthi, 1930: 45. **syn. nov.**

(Plate 15 & Fig. 41)

Colour variable from black to pale yellow or straw coloured, surface finely rugulose. Body bell-shaped. Vertex twice as long as inter-ocular distance, gradually narrowing to acute apex, slightly deflected in the anterior region, deflected apex with obscure black spot, lateral margins thick forming a distinct border between vertex and face. Face black, longer than broad, medially convex, sloping on the sides. Clypeus 3.5 times longer than clypellus. Labium extending beyond the fore coxae. Pronotum about 2.5 times as broad as long, anterior margin slightly produced between eyes, almost truncate, posterior margin straight. Body beneath black with pale yellowish segmental lines. Forewing with five small apical, three sub apical cells. Legs black to brown with tinge of yellow, hind femoral spines pale yellowish with base black.

Male genitalia: Pygophore broad in anterior half, gradually narrowing in posterior half, ventral margin slightly sinuate medially, 10 to 12 stout setae near dorsal margin, one stout tubercle at ventro-lateral margin near caudal margin. Subgenital plate with convex lateral margin, uniserially spinose, with bluntly rounded apex. Connective with arms longer than stem. Style with well developed preapical lobe, apophysis finger-like, directed laterally with corrugated surface. Dorsal margin of bulbous portion of aedeagus convex in lateral view, shaft sinuate with acute apex.

Female terminalia: Hind margin of seventh sternite slightly concave medially.

Measurements: Male 3.08 mm long, head 0.87 mm wide across eyes, 0.84 mm wide across pronotum. Female 4.92 mm long, head 0.89 mm wide across eyes, 0.88 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 16).

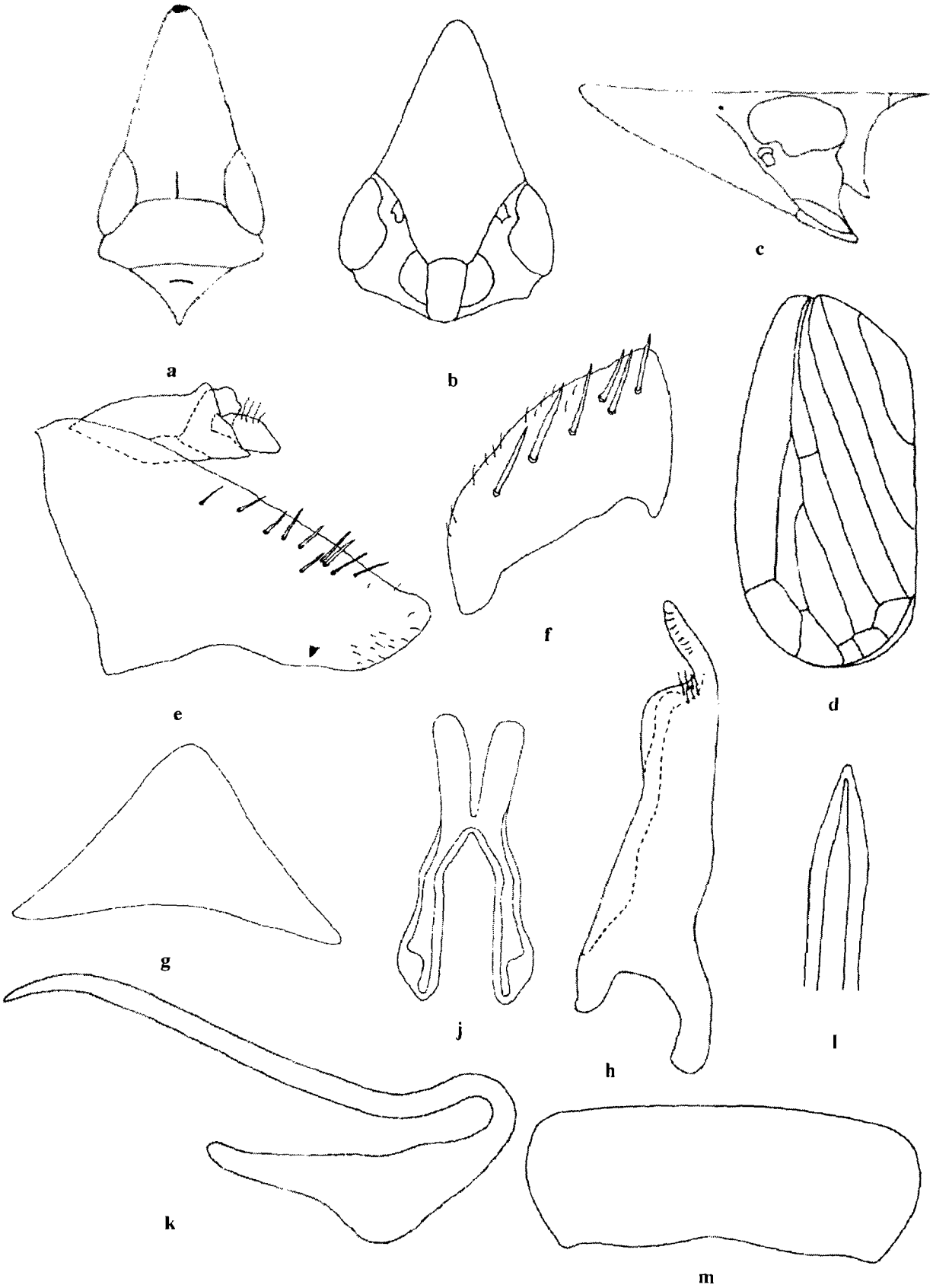


Fig. 41 *Stirellus capitatus* (Distant)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

Stirellus capitatus (**Pruthi**)

Plate 15

Material examined: INDIA: Karnataka, 2♂, Anekal, 10.viii.1975, C. A. Viraktamath; 7♂, 2♀, Ag. Coll. Bangalore, 27.iv.1974, C. A. Viraktamath; 1♀, Ag. Coll. Bangalore, GKVK, 5.vii. 1977, M.V; 3♂, Bannerghatta, 26.i.1975, C.A. Viraktamath; 5♂, Bannerghatta, 10.viii.1975, C.A. Viraktamath; Mysore State, Ag. Coll. Dharwar, 2♂, 1.xi.1969, C.A. Viraktamath; 13♂, 1♀, 25.vii.1972, C.A. Viraktamath; 42♂, 9♀, Dharwar, 24.ii.1973, C.A. Viraktamath; 5♂, 1♀, 22.iv.1974, C.A. Viraktamath; 6♂, 5♀, 31.x.1974, C.A. Viraktamath; Andhra Pradesh: 31♂, 43♀, Nagarjuna Univ. nr. Guntur, 13.xii.2006, Shobharani, M; Gujarat, 1♂, Waghai, 18.i.1981. C. A. Viraktamath; Jammu & Kashmir; 2♂, 2♀, Jammu, 17. vi. 1985, on long grass, Maninder, M (UASB).

Remarks: This species can easily be distinguished from other species of *Stirellus* by the bell-shaped body.

***Stirellus (Stirellus) indra* (Distant) comb. nov.**

Typhlocyba indra Distant, 1908: 415

(Plate 16 & Fig. 42)

Pale yellowish green, vertex slightly longer than inter-ocular distance with anterior margin subangulate. Two black circular spots on the disk. Clypeus 1.75 times longer than clypellus, convex in the middle, deflected in lateral regions. Clypellus broad at base, slightly constricted near middle. Gena with two circular black spots just below antennae base. Pronotum shorter than vertex, anterior margin convex, posterior margin almost truncate. Body beneath pale yellow, with black indistinct broad median longitudinal line. Forewing with five apical, three subapical cells. Spines on hind tibia yellowish, with black base.

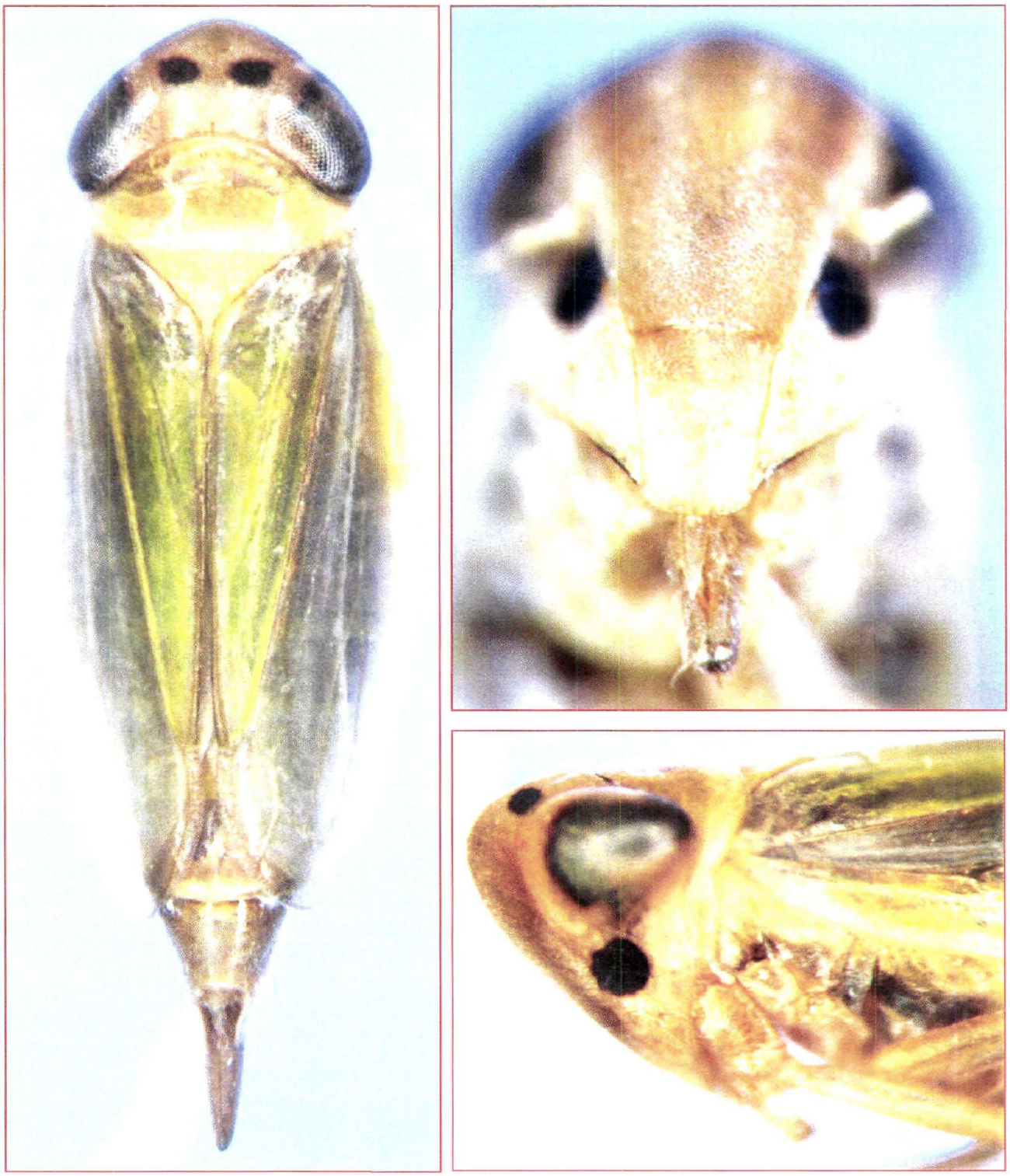
Male genitalia: Pygophore long with dorsal margin almost straight, caudal lobe rounded, eight to nine stout setae on dorsal surface, one stout tubercle near ventral margin at caudal one third. Subgenital plate with setae uniseriate. Connective with arms longer than stem. Style with well developed preapical lobe, apical apophysis long finger- like curved laterally. Aedeagus with basal bulbous region convexly rounded, shaft tightly recurved, slightly curved near apex, apex pointed with lateral flanges.

Female terminalia: Hind margin of seventh sternite slightly concave.

Measurements: Male 2.92 mm long, head 0.86 mm wide across eyes, 0.83 mm wide across pronotum. Female 3.45 mm long, head 0.91 mm wide across eyes, 0.90 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 16).

Fig. 42 *Stirellus indra* (Distant)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus indra (Distant)

Plate 16

Material examined: INDIA: Karnataka, 1♀, Bangalore, 16.x.1982, H. V. A. Murthy; 3♀, Bangalore, GKVK, 21.xi.2002, M. K. Sindhu; 1♀, Bangalore, GKVK, 25.xii.2002, M. K. Sindhu; 1♀, Bandipur, Mysore, 19.i.1985, S. Viraktamath; 2♂, 1♀, Bannerghatta, 26.i.1975, C. A. Viraktamath; 2♂, Chintamani, 16.x.2006, Shobharani, M; 1♀, Ganeshagudi, 30.x.1984, S. Viraktamath; 1♀, Jog falls, 18.xi.1976, K. D. Ghorpade; 1♂, 35 W Jog falls, 18.xi.1976, C. A. Viraktamath; 1♂, Kemmanugundi, 1♂, 1430m, 9.iv.1975, C. A. Viraktamath; 1♂, Mudigere, 7.iv.1975, C. A. Viraktamath;1♀, Mudigere, 28.v.2005, Shobharani, M; 1♂, Nandi hills, 30.xi.1974, C. A. Viraktamath; 1♀, Nandi hills, 17.vii.1979, S. Viraktamath; 1♀, 20 -45 Km N of Raichur, 4.ii.1985, S. Viraktamath; 1♂, Ramandurg, 16.xi.1974, Ghorpade; Meghalaya: 10♂, 9♀, Nangpoh, 762 m, 4.xi.1981, C. A. Viraktamath; Mizoram: 2♀, Aizwal, 18.xi.1981, C. S. Wesley; Delhi: 1♂, IARI, 13.iv.1975, C. A. Viraktamath; Kerala: 1♀, Thekkady, 27.iii.1977, B. Mallik; 2♀, Walayar, 305 m, 26.x.1975, C. A. Viraktamath; Maharashtra: 1♀, Mahabaleshwar, 1381 m, 20.xi.1977, C. A. Viraktamath; Orissa: 2♀, Sakhigopai, 24.x.1993, P.C. Dash; Tamil Nadu: 1♂, 1♀, Burliar, 860 m, 22.x.1975, S. Viraktamath; 1♀, Burliar, 5.xi.1977, C. A. Viraktamath; 1♀, 8 Km S of Yercaud, 1050 m, 21.ix.1978, C. A. Viraktamath; 1♂, Doddabetta, 4.vi.1971, Shashidhar; West Bengal: 1♂, 5♀, Calcutta, 17.iv.1975, C. A. Viraktamath; 1♂, Calcutta, 11.xi.1981, C. A. Viraktamath; 1♀, Kalyani, 4.vi. 2005, C. A. Viraktamath; 1♀, Sukna, 1.xi.1981, S. Viraktamath (UASB).

Remarks: S. indra externally resembles *S. jacosa* with respect to the shape of the head, markings on the disk of vertex and near the base of antenna. However, it differs from *S. jacosa* in lacking longitudinal dark brown markings on the abdominal tergites and it is macropterous.

***Stirellus (Stirellus) jacosa* (Melichar) comb. nov.**

Doratulina jacosa Melichar, 1903: 199.

(Plate 17 & Fig. 43)

Pale yellowish, brachypterous species. Head triangularly produced, with vertex as long as breadth between inter-ocular distance, two black circular spots on the disk. Clypeus 1.75 times longer than clypellus. Gena with two black circular spots just below antennal base on either side. Labium slightly extending beyond mid-coxae. Pronotum shorter than vertex, anterior margin convex, posterior margin almost truncate. Fore wing short, only covering abdomen at base, posterior margin almost truncate with

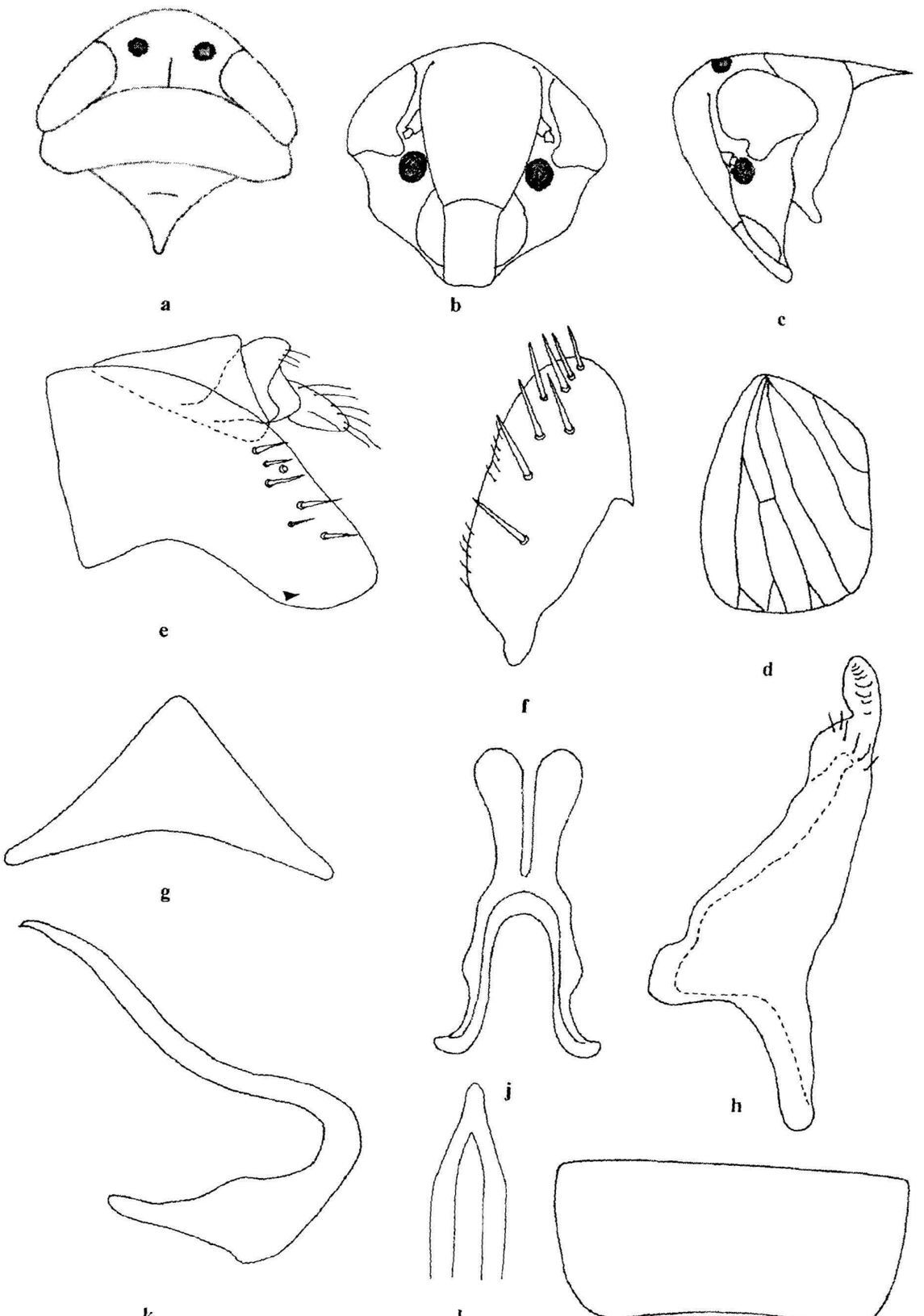
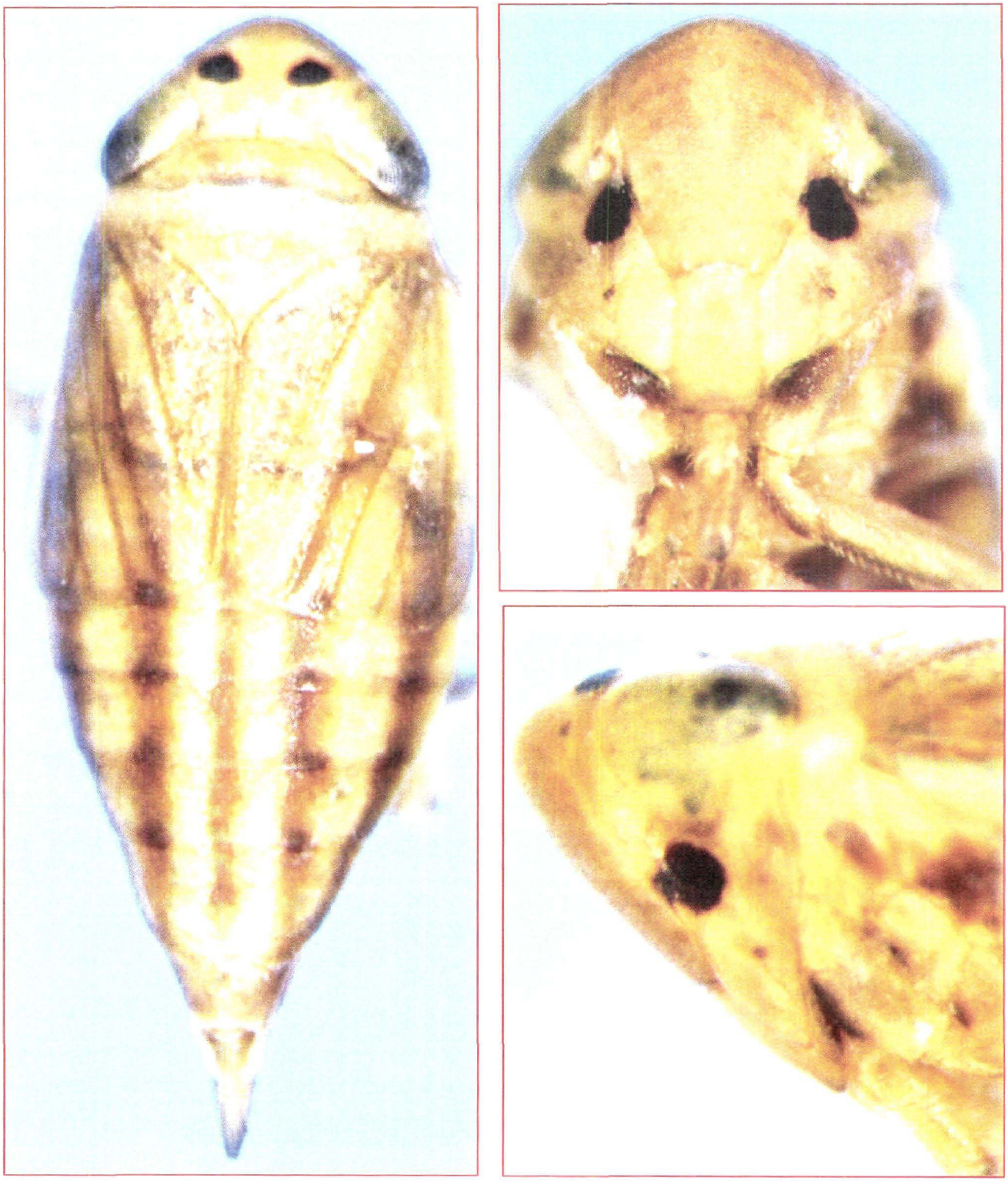


Fig. 43 *Stirellus jacosa* (Melichar)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus jacosa (Melichar)

Plate 17

rounded corner angles. Abdomen conical with five pale brown longitudinal stripes. Hind tibial spines light brown.

Male genitalia: Pygophore broad, truncate at anterior margin, caudal margin rounded, dorsal margin gradually declivous, with 6 to 7 stout submarginal setae, with stout tubercle ventrally near caudal margin. Subgenital plate rounded caudally, biserially spinose. Connective with arms longer than stem, with lateral extensions. Style long with well developed preapical lobe, apophysis thumb-like, slightly curved laterally with corrugated surface. Aedeagal shaft sinuate.

Female terminalia: Hind margin of seventh sternite almost straight.

Measurements: Male 1.72 mm long, head 0.89 mm wide across eyes, 0.89 mm wide across pronotum. Female 3.40 mm long, head 0.96 mm wide across eyes, 0.98 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 16).

Material examined: INDIA: Karnataka, 3♀, Anekal, 10.viii.1975, C.A. Viraktamath; 2♂, 2♀, Bannerghatta park, 12.ix.1976, B. Mallik; 3♂, 4♀, Jog falls, 8.v.1976, C. A. Viraktamath; 7♂, 8♀, Jog falls (534m), 17.xi.1976, B. Mallik; 2♀, Jog falls (534m), 19.xi.1976, C. A. Viraktamath; 13♂, 11♀, Kemmanugundi, 10.iv.1975, C. A. Viraktamath; 7♀, Mudigere (970m), 21.v.1976, B. Mallik; 2♂, 1♀, Mudigere, 7.iv.1975, C. A. Viraktamath; 1♀, Mudigere, 28.v.2005, Shobharani, M; 1♀, Kottigehara 15-20 Km W of Mudigere, 27.i.1983, S. Viraktamath; 7♂, 2♀, Yellapur, 23.ix.1973, C. A. Viraktamath; Kerala: 2♂, 2♀, 10 Km E Calicut, 17.x.1976, B. Mallik; Tamil Nadu: 9♂, 21♀, Coonoor, 11.viii.1979, S. Viraktamath (UASB).

Remarks: This species can readily be recognized by its brachypterous form, black spots on head and a spot beneath each antenna and longitudinal brown stripes on abdominal terga. It resembles *S. indra* with respect to head shape and markings on disk and near the base of antenna.

***Stirellus (Stirellus) laetus* (Melichar) comb. nov.**

Deltocephalus laetus Melichar, 1908: 483.

(Plate 18 & Fig. 44)

Pale yellowish green, vertex triangularly produced with median transverse orange fascia between eyes, posterior margin of head concave. Clypeus two times longer than clypellus with dark brown striae on lateral margin. Labium reaching mid coxae. Anterior margin of pronotum convex with orange fascia, posterior margin truncate. Scutellum orange with Pale yellowish spot just below median transverse

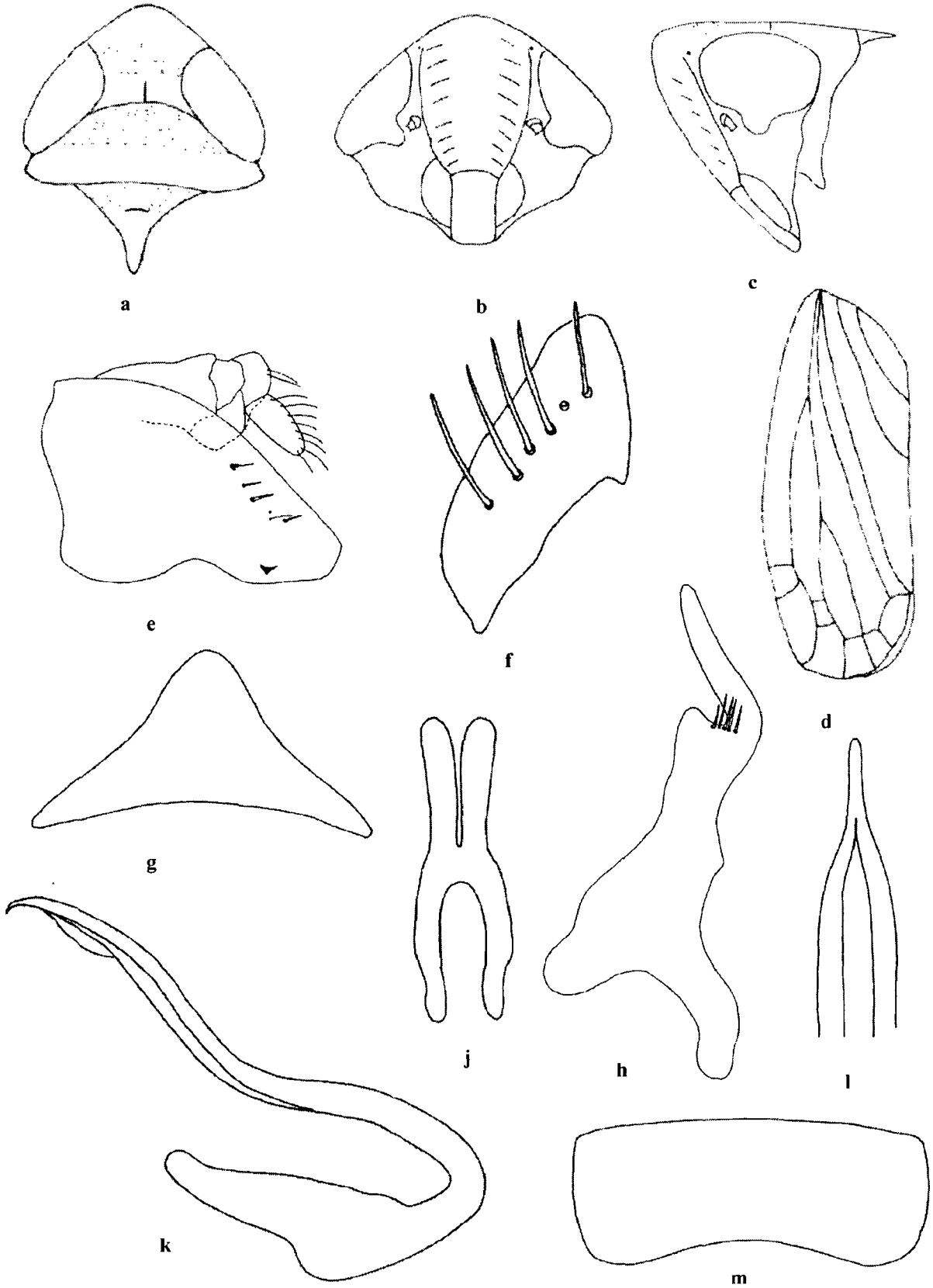
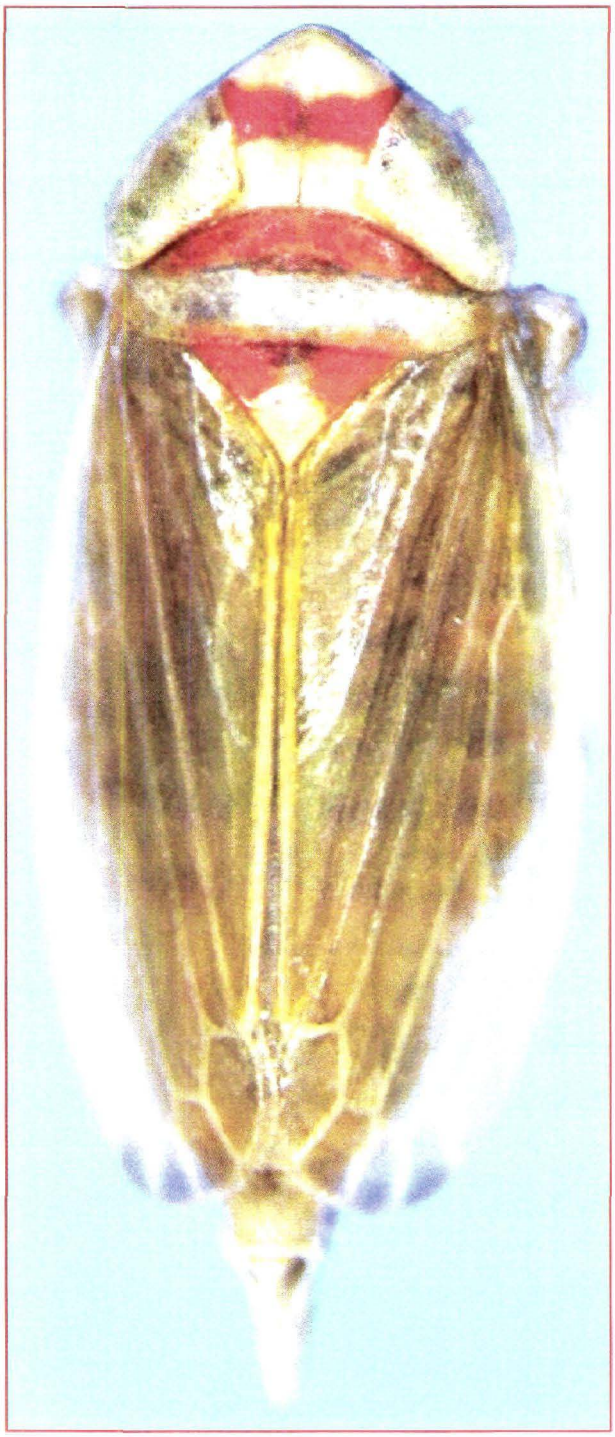
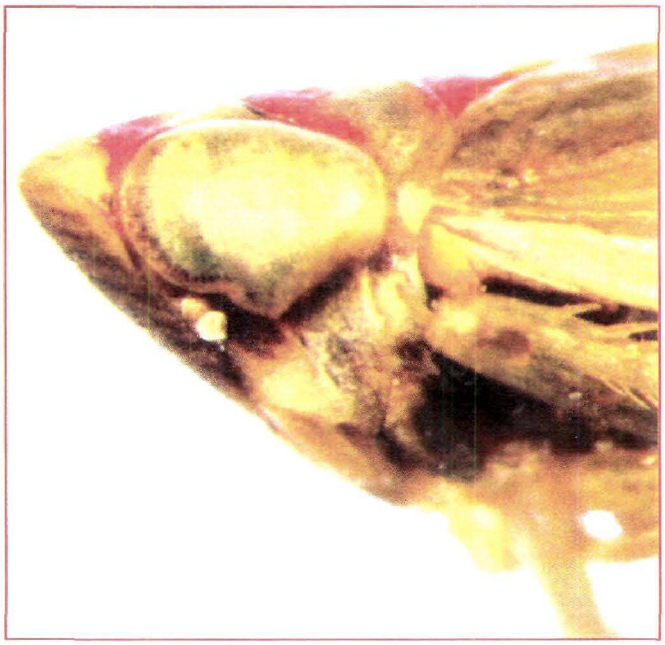


Fig. 44 *Stirellus laetus* (Melichar)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used





Stirellus laetus (Melichar)

Plate 18

impression. Forewing with five apical, three subapical cells. Body beneath black with thin pale coloured segmental lines, in some cases pale yellow with reddish tinge.

Male genitalia: Pygophore short, broad at anterior half, strongly declivous caudally, ventral margin slightly notched medially, five to six stout setae on dorsal region, one stout tubercle on ventral region about one third distance from caudal margin,. Subgenital plate with setae uniseriate. Style broad at anterior margin, preapical lobe well developed, apophysis long, finger-like, heavily pigmented. Aedeagal shaft sinuate.

Female terminalia: Hind margin of the female seventh sternite slightly concave.

Measurements: Male 2.50 mm long, head 0.80 mm wide across eyes, 0.78 mm wide across pronotum. Female 2.80 mm long, head 0.80 mm wide across eyes, 0.78 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 16).

Material examined: INDIA: Karnataka, 6♂, 7♀, Mudigere, 22. v. 1776, C.A. Viraktamath; 1♂, Mudigere, 28.v.2005, Shobharani, M; 1♀, Kottigehara, 15-20 Km W of Mudigere, 27.i.1983, S. Viraktamath (UASB).

Remarks: S. laetus resembles *Stirellus* sp. 9 with respect to male genitalia and external characters, but lacks black spots beneath the antennal bases that are present in *Stirellus* sp. 9.

***Stirellus (Stirellus) notatus* (Distant) comb. nov.**

Allectus notatus Distant, 1918: 76.

(Plate 19 & Fig. 45)

Pale yellowish green, vertex of head 1.75 times longer than inter-ocular distance, vertex anteriorly conical, longly produced, almost as long as pronotum and scutellum combined; vertex with two prominent black spots on anterior margin which are connected beneath on upper margin of face. Clypeus two times longer than clypellus. Labium reaching mid coxae. Pronotum with anterior margin convex, posterior margin truncate. Scutellum small. Body beneath black with pale yellowish segmental lines. Forewing with five irregularly shaped small apical cells, three subapical cells.

Male genitalia: Pygophore long almost of same width throughout entire length, caudal margin rounded, ventral margin almost straight with slight median notch, both anterior and caudal margins darkly pigmented, four to five stout setae on dorsal region. Subgenital plate broad at anterior half, slightly narrowing at posterior region,

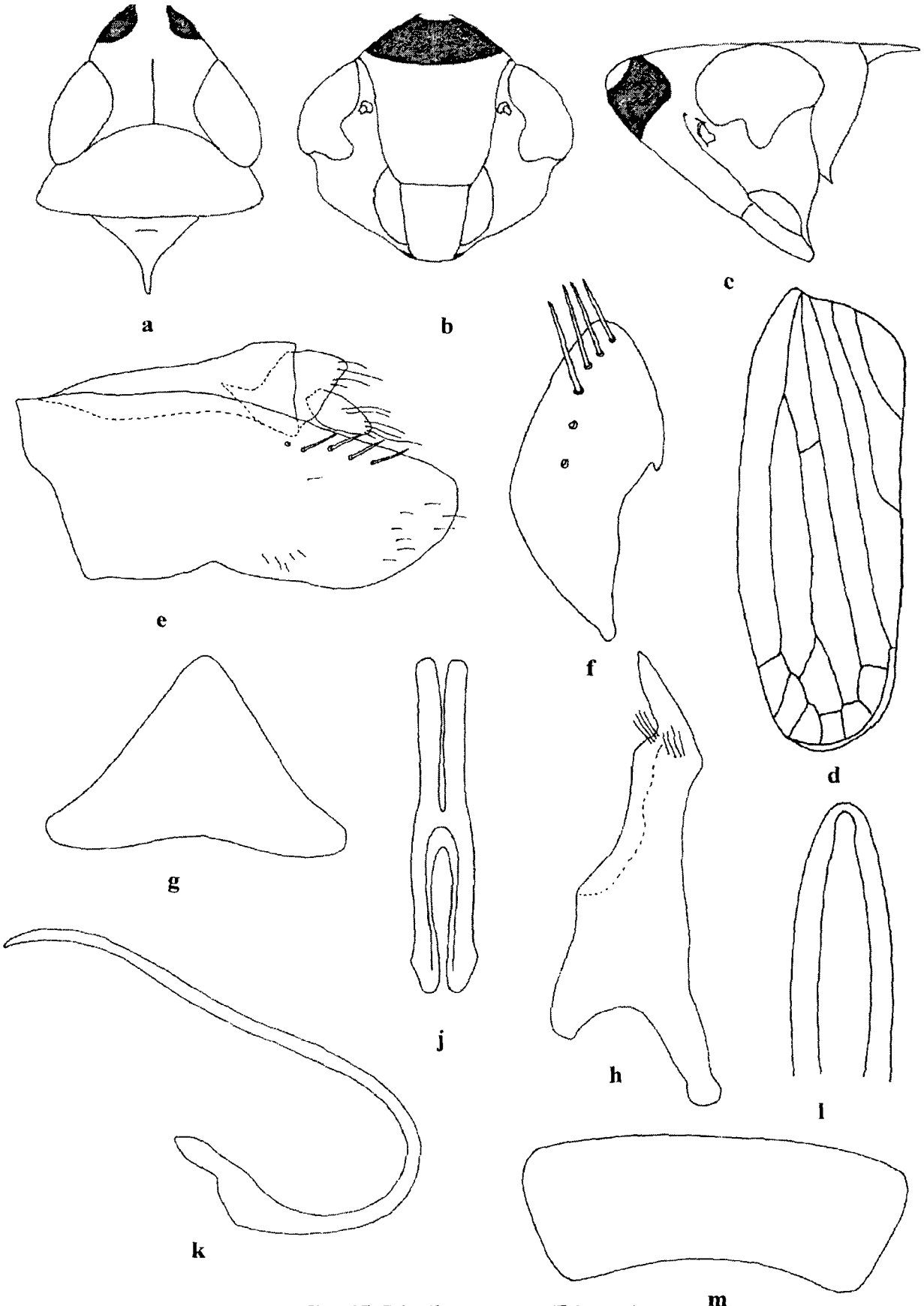


Fig. 45 *Stirellus notatus* (Distant)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

Stirellus notatus (Distant)

Plate 19

uniserially spinose. Connective with arms almost equal to length of stem. Style with sinuate outer margin, preapical lobe well developed, apophysis long finger-like, pointed. Aedeagus with basal bulbous region narrow, shaft broadly recurved, slightly bisinuate.

Female terminalia: Hind margin of the female seventh sternite uniformly shallowly concave.

Measurements: Male 4.02 mm long, head 0.99 mm wide across eyes, 1.03 mm wide across pronotum. Female 5.70 mm long, head 1.02 mm wide across eyes, 1.06 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 16).

Material examined: INDIA: Tamil Nadu, 33 ♂, 30 ♀, Ootacamund, 4.vi.1977, C.A. Viraktamath (UASB).

Remarks: This species can be differentiated from other species by the two prominent black spots (connected beneath on upper margin of face) on head and the anterior and caudal margins of the pygophore have black coloured border.

***Stirellus (Stirellus) ribeiroi* (Pruthi) comb. nov.**

Sunda ribeiroi Pruthi, 1936: 112.

(Plate 20 & Fig. 46)

Pale yellowish green, vertex three times longer than inter-ocular distance with acute apex, lateral margins carinated, tip rugulose. Clypeus longer than broad, anteriorly rugulose, slightly bent at apex, anterior half of clypeus with black oblique stripes on lateral margin, basal half straw coloured, clypeus 3 times longer than clypellus. Clypellus flat, almost in line with lateral margin of gena. Labium extending beyond mid coxae. Pronotum medially ridged. Body beneath black with pale coloured segmental lines. Legs pale yellowish with black tinge, bases of hind tibial spines black. Sternites black with paler hind margin. Forewing with five apical, three subapical cells.

Male genitalia: Pygophore elongate, excavated medially on ventral margin, caudal margin truncate, stout tubercle ventrally near caudal margin. Subgenital plate caudally rounded, with lateral margin insinuated, uniserially spinose. Connective with arms longer than stem. Style slender very long with well developed preapical lobe, apophysis long finger-like, curved laterally with rounded tip; apophysis of style heavily pigmented with corrugated surface. Aedeagus with dorsal margin of basal bulbous region straight, shaft broadly recurved, apex of shaft curved ventrally with lateral subapical flange.

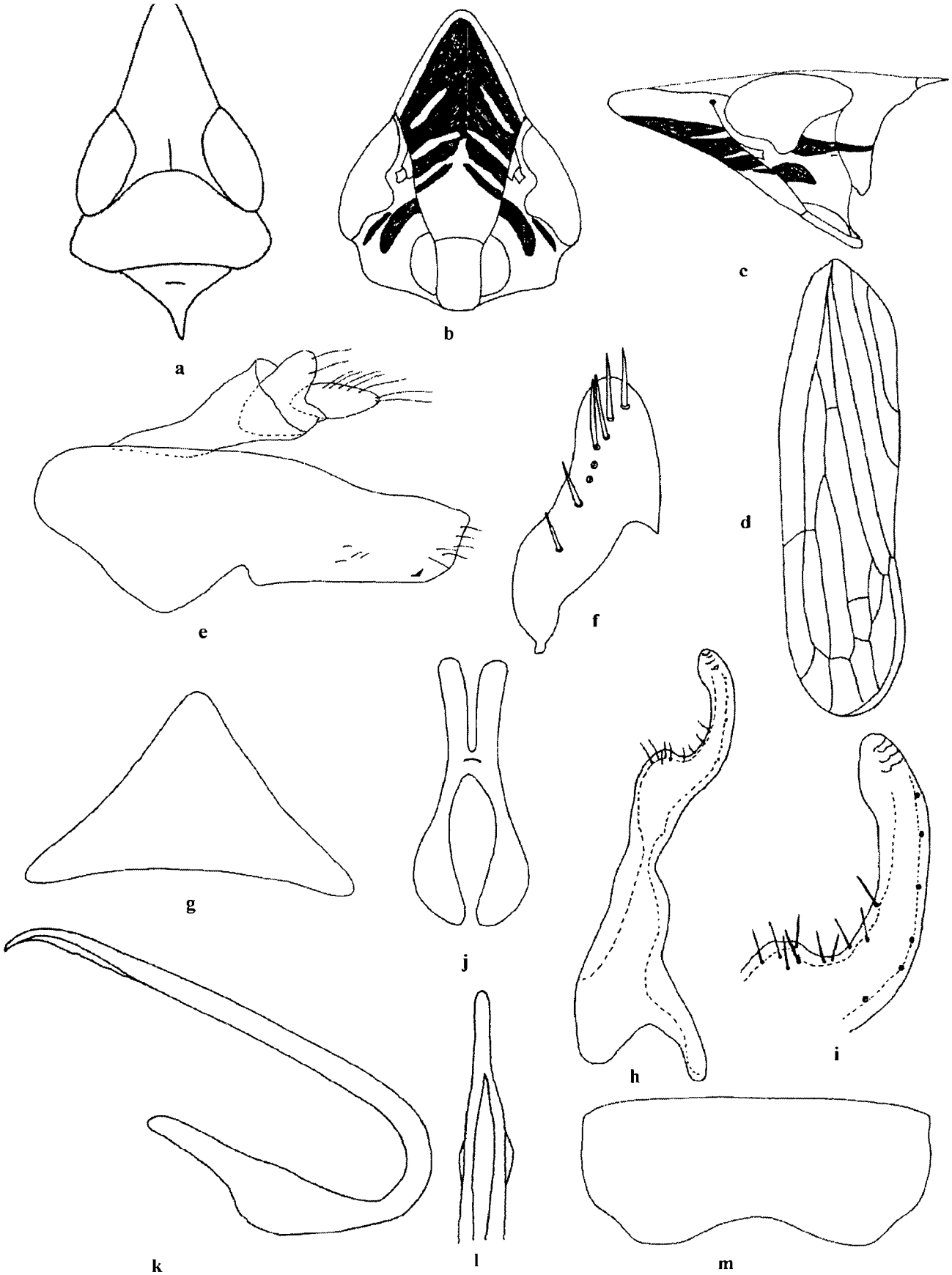
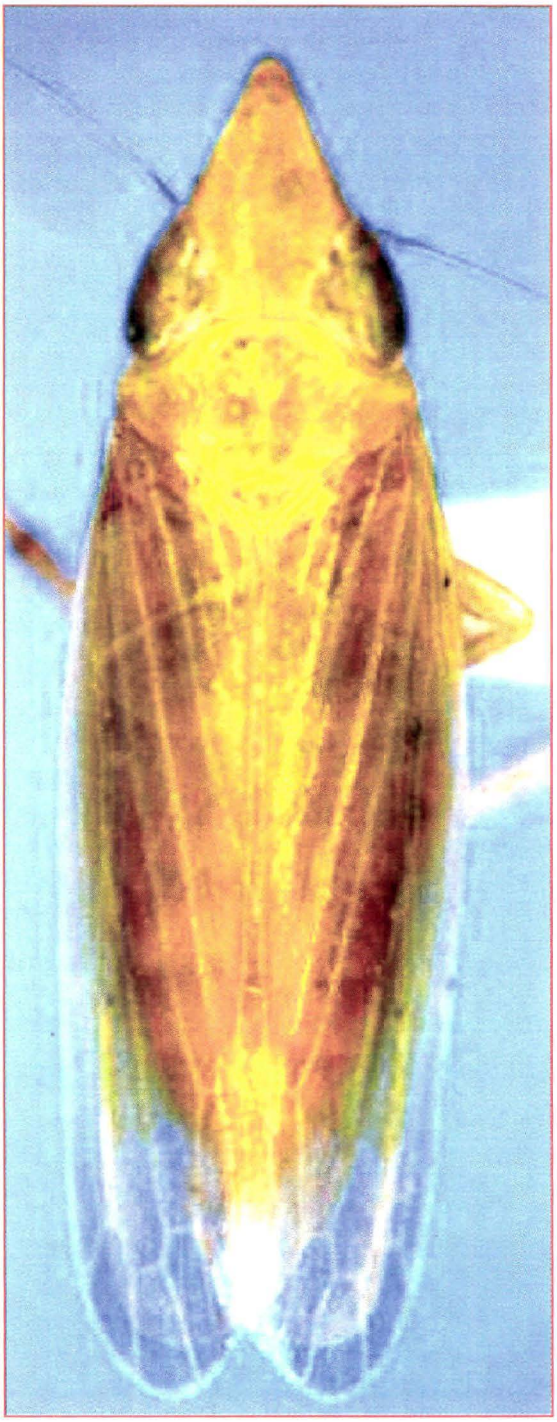
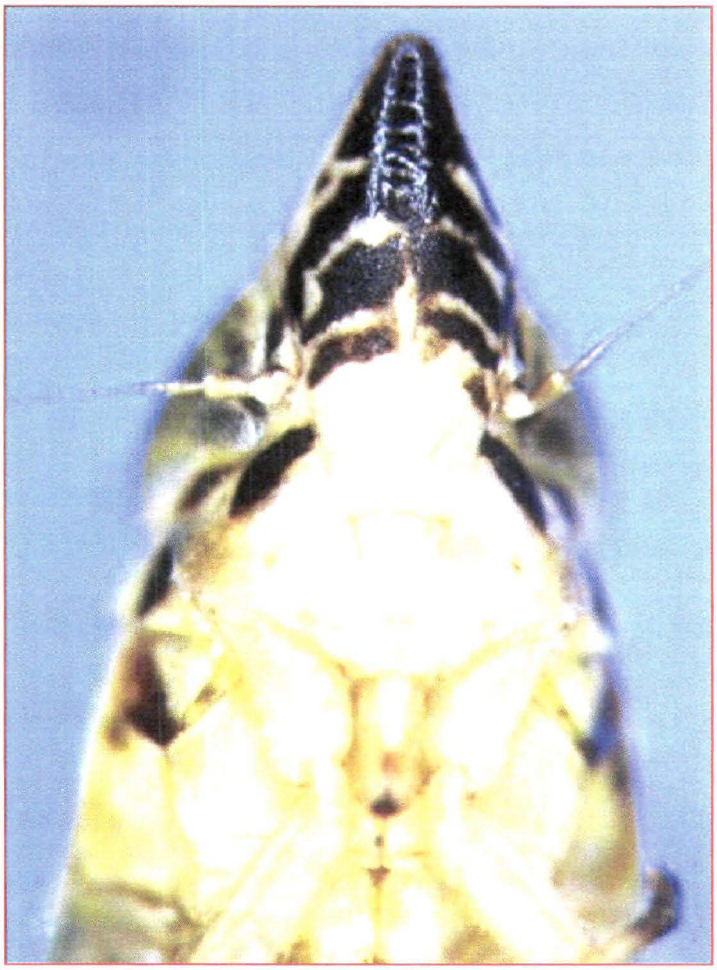


Fig. 46 *Stirellus ribeiroi* (Pruthi)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used





Stirellus ribeiroi (Pruthi)

Plate 20

Female terminalia: Hind margin of seventh sternite concave medially.

Measurements: Male 4.64 mm long, head 0.95 mm wide across eyes, 1.03 mm wide across pronotum. Female 6.20 mm long, head 0.98 mm wide across eyes, 1.09 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 16).

Materials examined: INDIA: Karnataka, 13 ♂, 5 ♀, Bangalore, GKVK, 6.x.2005, Shobharani, M; 6 ♂, 2 ♀, Bangalore, GKVK, 15.x.2005, Shobharani, M; 2♂, 1♀, Bangalore, GKVK, 15.xi.2005, Shobharani, M; Gujarat: 9 ♂, 6 ♀, Navasari, 16.i.1981, C. A. Viraktamath; Punjab: 1♂, Kaile, 15.i.1985, A.S. Sohi (UASB).

Remarks: Subgenital plates with insinuated outer margin and the distinctive colouration separates this species from all other species of *Stirellus* in the subcontinent.

***Stirellus (Stirellus) rotundus* (Pruthi) comb. nov.**

Arya rotundus Pruthi, 1930: 40.

(Plate 21 & Fig. 47)

Pale yellowish green, vertex slightly longer than inter-ocular distance, broadly rounded at anterior margin, medially sulcate, with two oblique, dark linear impression near base. Clypeus twice longer than clypellus, with brown striae on lateral margins. Scutellum as long as broad. Labium reaching mid coxae. Body beneath pale yellowish. Fore wing with five apical, three subapical cells.

Male genitalia: Pygophore elongate, with small setae at caudal half on dorsal margin, one stout tubercle ventrally near caudal margin. Subgenital plate caudally rounded, uniserially spinose laterally. Connective with arms longer than stem. Style long with well developed preapical lobe, apophysis long finger-like, curved laterally, with corrugated surface. Aedeagus with dorsal margin of basal bulbous region straight, shaft recurved, apex of shaft pointed.

Female terminalia: Hind margin of the seventh sternite slightly concave.

Measurements: Female 5.30 mm long, head 1.16 mm wide across eyes, 1.16 mm wide across pronotum (Table 11). *Genitalia measurements*: (Table 16).

Materials examined: INDIA: West Bengal, 2♀, Kalyani, 4.vi.2005, C. A. Viraktamath (UASB).

Remarks: This species resembles *S. rubrolineatus* (Distant), but differs in having broadly rounded (subconically produced in *S. rubrolineatus*) vertex and lacking the orange fasciae on head which are well developed in *S. rubrolineatus.*

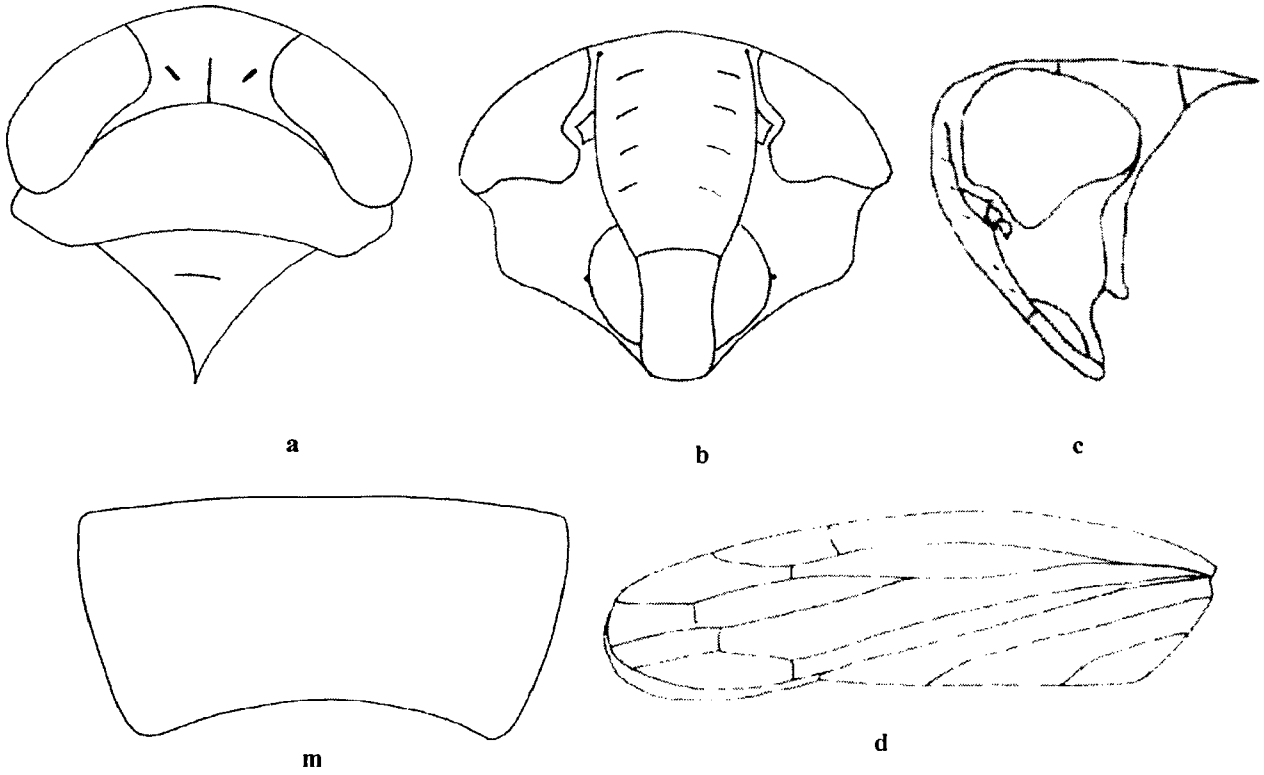


Fig. 47 *Stirellus rotundus* (Pruthi)

Refer legends of Fig. 1, Fig. 3 of Chapter III for details of alphabets used

Stirellus rotundus (**Pruthi**)

Plate 21

***Stirellus (Stirellus) rubrolineatus* (Distant) comb. nov.**

Arya rubrolineata Distant, 1908: 338.

(Plate 22 & Fig. 48)

Pale yellowish green. Vertex 1.25 times longer than inter-ocular distance, anterior margin subconically rounded, with orange fascia which is interrupted medially, two oblique dark spots near base on either side on median line. Clypeus 1.75 times longer than clypellus, with black transverse striations laterally. Labium slightly extending beyond the fore coxae. Forewing with five apical, three subapical cells. Body beneath pale yellowish with black markings medially, lateral margin with black longitudinal stripe.

Male genitalia: Pygophore elongate, dorsal margin slightly concave at midlength, caudal lobe rather rounded, slightly excavated near to base ventrally, one stout tubercle on ventro-mesal margin at midlength. Subgenital plate uniserially spinose, with rounded caudal lobe. Connective with arms almost as long as stem. Style with well developed preapical lobe, lateral margin sinuate, apophysis finger like, slightly curved laterally with corrugated surface. Aedeagus with basal bulbous region convex at middle on dorsal margin, shaft rather strongly recurved, then straight but curved ventrally near apex.

Female terminalia: Hind margin of female seventh sternite slightly concave.

Measurements: Male 4.14 mm long, head 1.10 mm wide across eyes, 1.13 mm wide across pronotum. Female 4.88 mm long, head 1.20 mm wide across eyes, 1.23 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 17).

Material examined: INDIA: Karnataka, 1♂, Bannerghatta, 26.i.1975, C. A. Viraktamath. 5♂, 3♀, Calcutta, 11.xi.1981, C. A. Viraktamath; Meghalaya: 1♂, Shillong, 1961m, 6.x.1981, C.A. Viraktamath; West Bengal: 4♂, Calcutta, 17.iv.1975, C. A. Viraktamath (UASB).

Remarks: This species can be readily recognized by its distinctive colouration. The vertex is subconically produced with orange fascia that is medially interrupted and two oblique dark spots near the base on either side of the median line.

***Stirellus (Stirellus) solitaris* (Melichar) comb. nov.**

Aconura solitaris Melichar, 1903: 188.

(Plate 23 & Fig. 49)

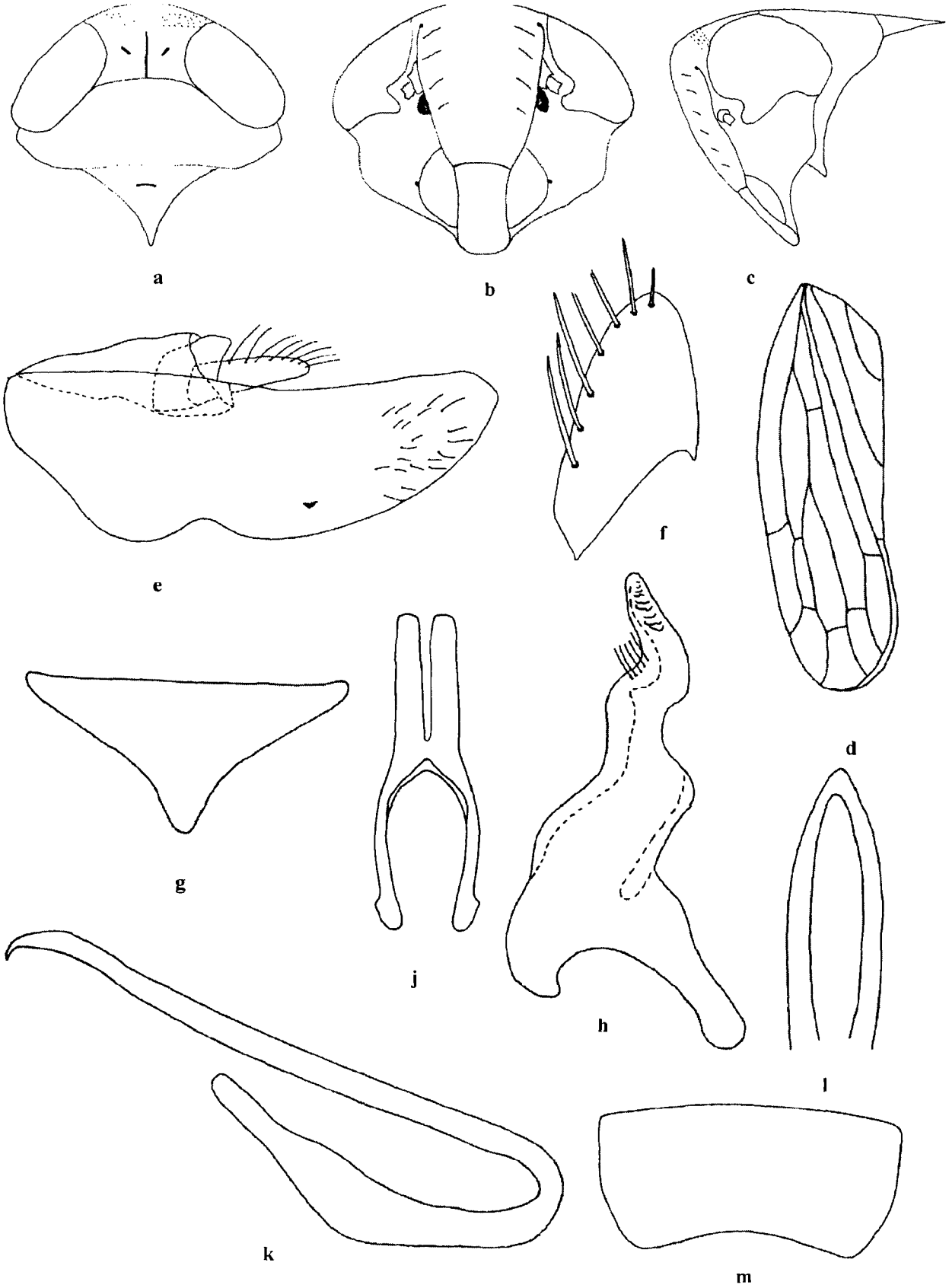
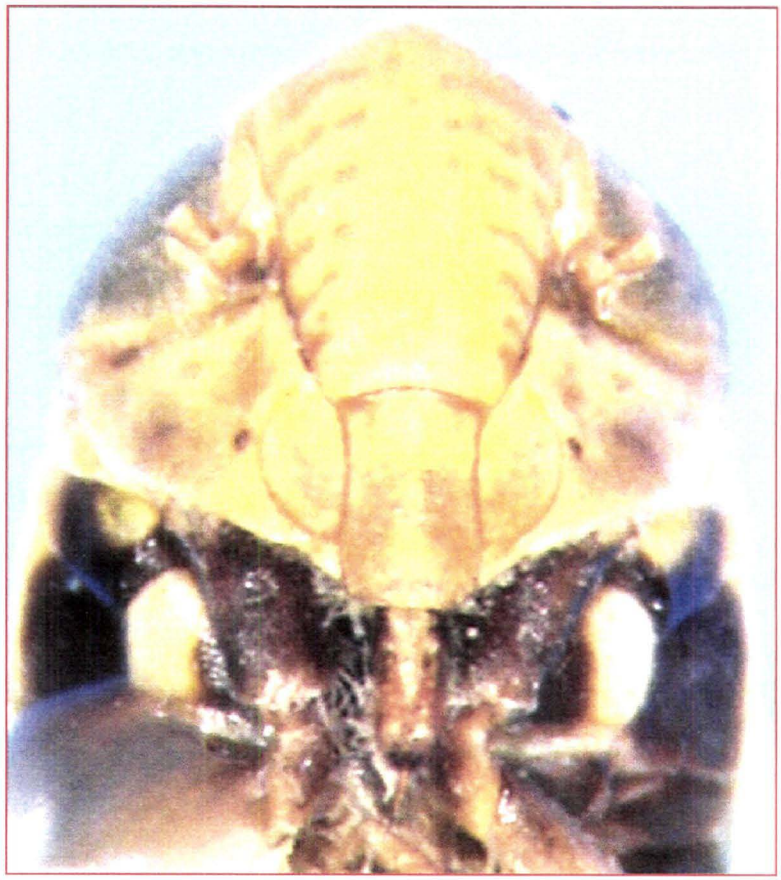


Fig. 48 *Stirellus rubrolineatus* (Distant)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

Stirellus rubrolineatus (Distant)

Plate 22



Stirellus solitaris **(Distant)**

Plate 23

Pale yellowish green, vertex 1.25 times as long as inter-ocular distance, with two brownish longitudinal impressions near base, subacutely produced anteriorly. Clypeus twice longer than clypellus, with brownish transverse striae on lateral margin. Labium slightly extending beyond fore coxae. Body beneath black with pale segmental lines. Pronotun medially ridged. Forewing with four apical, three subapical cells.

Male genitalia: Pygophore gradually declivous caudally, caudal lobe bluntly rounded with one stout tubercle at 0.25 distance from caudal margin, ventral margin excavated near base. Subgenital plate with setae uniseriate. Style with well developed preapical lobe, apophysis finger-like. Aedeagus with basal bulbous region straight, shaft rather strongly recurved, then straight but curved ventrally near apex.

Female terminalia: Hind margin of the seventh sternite concave.

Measurements: Male 3.58 mm long, head 0.98 mm wide across eyes, 0.98 mm wide across pronotum. Female 4.34 mm long, head 1.09 mm wide across eyes, 1.10 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 17).

Materials examined: INDIA: Karnataka, 2♀, Bangalore, 25.vii.1972, C.A. Viraktamath; 6♂, 8♀, Bangalore, 27.vii.1972, C.A. Viraktamath; 1♂, Raichur, 25.x.1983, on grasses, S. Viraktamath (UASB).

Remarks: S. solitaris externally resembles *S. tolla* (Pruthi), but differs from it in having more acutely pointed head.

***Stirellus (Stirellus) speciosum* (Distant) comb. nov.**

Nandidrug speciosum Distant, 1918: 75.

(Plate 24 & Fig. 50)

Pale yellowish green, vertex two times longer than the inter-ocular distance, subacutely produced anteriorly, vertex with two longitudinal fasciae, pronotum with five, scutellum with three longitudinal orange fascia. Clypeus twice longer than clypellus. Labium slightly extending beyond the fore coxae. Body beneath pale yellowish, abdomen pale brownish. Fore wing with five apical, three subapical cells.

Male genitalia: Pygophore gradually narrowed posteriorly, caudal margin truncate, with seven to eight stout setae on dorsal region, one stout tubercle at ventro-mesal margin about one third from apex, slightly excavated ventrally at about the middle. Subgenitial plate triangular, with rounded caudal angle, spines uniseriate. Connective with lateral extensions. Style broad at anterior half, apophysis finger-like, curved laterally with rounded apex, surface corrugated. Aedeagus with basal bulbous

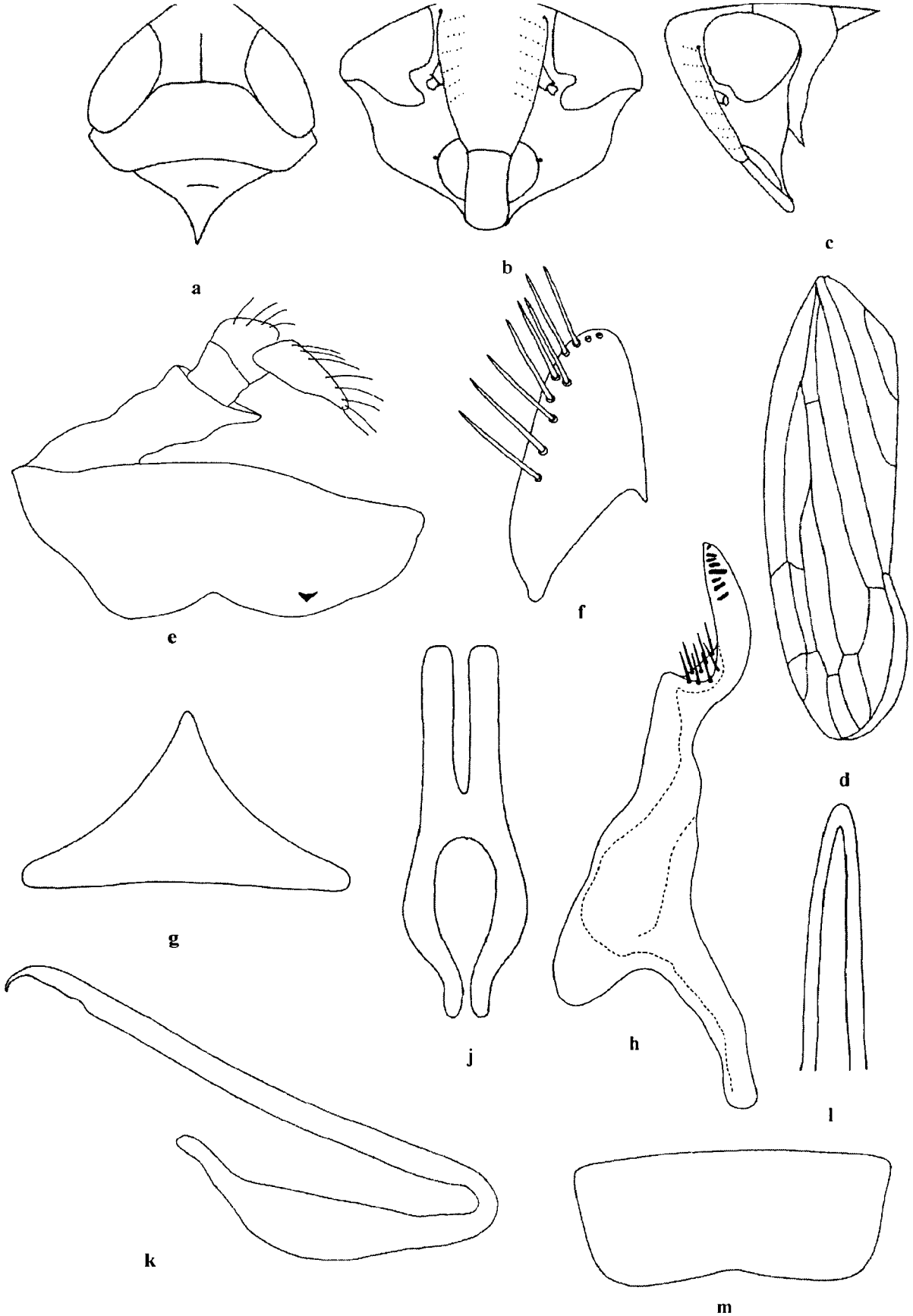


Fig. 49 *Stirellus solitaris* (Melichar)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

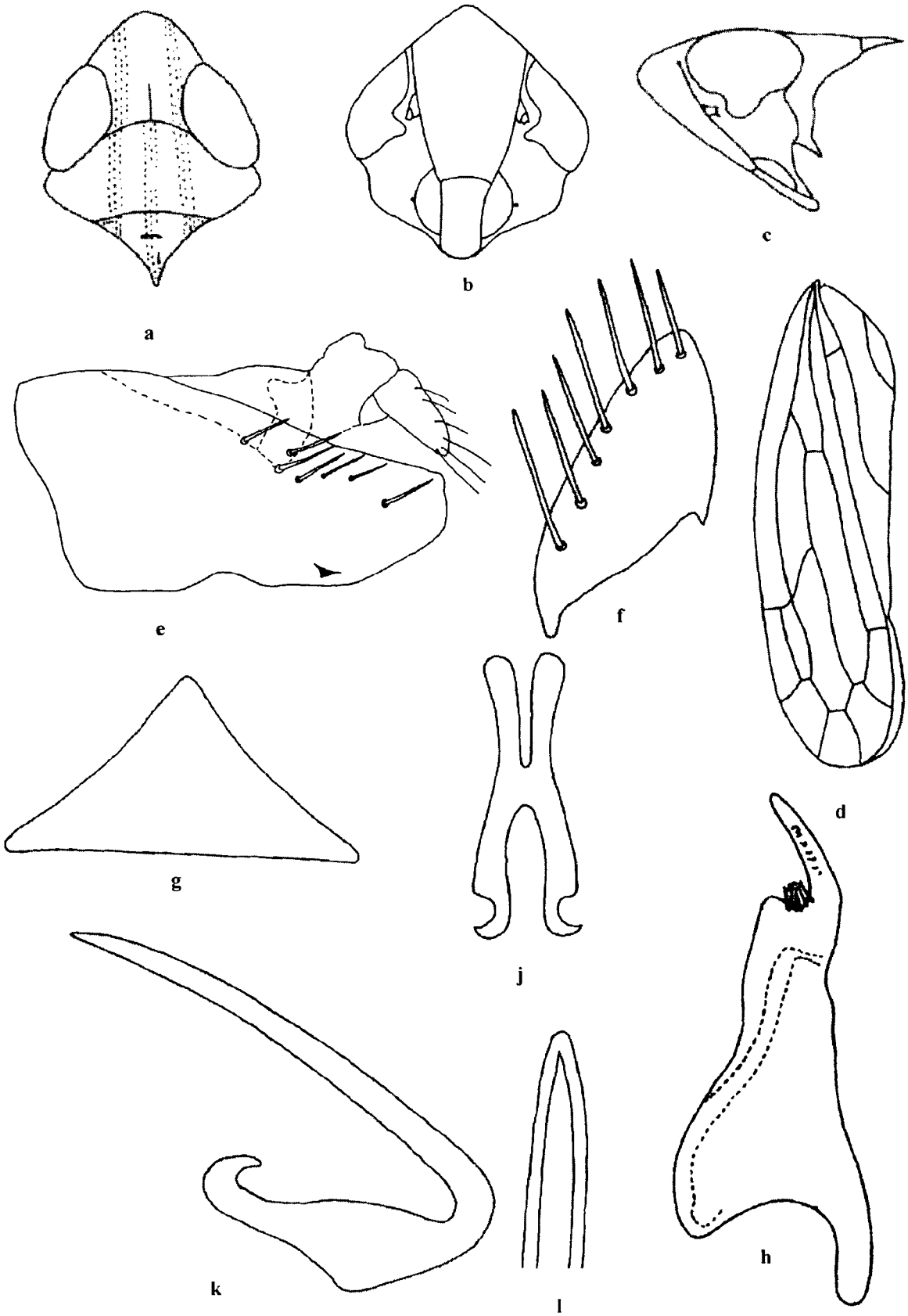


Fig. 50 *Stirellus speciosum* (Distant)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

Stirellus speciosum (Distant)

Plate 24

Table 12. Measurements (in mm) of males of the genus *Stirellus* Osborn and Ball

Measurements	*capitatus*	*indra*	*jacosa*	*laetus*	*notatus*	*ribeiroi*	*rubrolineata*	*speciosum*	*solitaris*
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
LENGTH									
Total length	3.04±0.18	2.92±0.26	1.72±0.08	2.50±0.21	4.02±0.23	4.64±0.21	4.14±0.18	3.65±0.19	3.58±0.10
Wing	1.80±0.07	2.26±0.23	1.14±0.09	1.82±0.25	2.94±0.09	3.60±0.10	3.34±0.11	2.78±0.17	2.88±0.10
Clavus	1.36±0.05	1.66±0.11	1.08±0.04	1.38±0.11	1.72±0.44	2.36±0.13	2.14±0.15	1.85±0.06	1.80±0.08
Vertex	0.91±0.15	0.35±0.03	0.34±0.02	0.38±0.02	0.59±0.02	0.81±0.03	0.42±0.04	0.44±0.04	0.42±0.01
Pronotum	0.33±0.07	0.35±0.03	0.29±0.02	0.29±0.02	0.45±0.01	0.46±0.06	0.41±0.02	0.39±0.02	0.35±0.00
Scutellum	0.34±0.09	0.32±0.02	0.32±0.02	0.31±0.04	0.36±0.04	0.41±0.01	0.44±0.04	0.39±0.04	0.38±0.02
Clypeus	1.01±0.15	0.62±0.03	0.61±0.05	0.55±0.00	0.81±0.03	0.96±0.04	0.64±0.05	0.66±0.03	0.70±0.02
Clypellus	0.30±0.11	0.34±0.02	0.33±0.02	0.29±0.01	0.38±0.03	0.35±0.00	0.38±0.03	0.29±0.01	0.36±0.02
WIDTH									
Wing	0.60±0.07	0.58±0.02	0.63±0.04	0.55±0.04	0.66±0.01	0.64±0.00	0.75±0.00	0.60±0.04	0.63±0.04
Vertex	0.43±0.16	0.29±0.04	0.32±0.03	0.25±0.00	0.34±0.02	0.31±0.01	0.34±0.04	0.31±0.01	0.33±0.01
Pronotum	0.84±0.15	0.83±0.03	0.89±0.05	0.78±0.02	1.03±0.03	1.03±0.04	1.13±0.05	0.86±0.04	0.98±0.02
Head	0.87±0.15	0.86±0.04	0.89±0.05	0.80±0.03	0.99±0.02	0.95±0.02	1.10±0.05	0.84±0.03	0.98±0.02
Clypellus	0.15±0.08	0.18±0.02	0.61±0.05	0.15±0.00	0.25±0.00	0.18±0.00	0.64±0.05	0.16±0.01	0.70±0.02
Lorum	0.13±0.00	0.11±0.01	0.13±0.01	0.13±0.01	0.13±0.02	0.14±0.01	0.14±0.01	0.13±0.00	0.13±0.00
DISTANCE BETWEEN									
E to E	0.55±0.00	0.44±0.02	0.47±0.03	0.38±0.01	0.55±0.01	0.45±0.01	0.51±0.03	0.44±0.03	0.47±0.02
Antennal pits	0.43±0.07	0.40±0.03	0.42±0.03	0.36±0.01	0.50±0.01	0.34±0.00	0.47±0.03	0.35±0.02	0.37±0.02
Ant. E to ant. V	0.63±0.22	0.12±0.01	0.13±0.01	0.13±0.01	0.25±0.04	0.46±0.02	0.12±0.01	0.18±0.02	0.13±0.00

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex

Table 13. Measurements (in mm) of females of the genus *Stirellus* Osborn and Ball

Measurements	***capitatus***	***indra***	***jacosa***	***laetus***	***notatus***	***ribeiroi***	***rotundus***	***rubrolineata***	***speciosum***	***solitaris***
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean	Mean±SD
LENGTH										
Total length	3.36±0.05	3.00±0.00	1.82±0.08	2.42±0.15	3.96±0.13	5.60±0.56	4.10±0.00	4.70±0.32	3.50	4.08±0.11
Total length *	4.92±0.25	3.45±0.31	3.40±0.12	2.80±0.19	5.70±0.44	6.20±0.62	5.30±0.00	4.88±0.31	4.00	4.34±0.11
Wing	2.12±0.11	2.40±0.39	1.20±0.07	1.76±0.09	2.96±0.09	4.10±0.41	3.40±0.00	3.95±0.47	2.70	3.30±0.02
Clavus	1.68±0.11	1.78±0.17	1.18±0.08	1.36±0.09	1.40±0.02	2.70±0.27	2.20±0.00	2.63±0.22	1.90	2.16±0.03
Vertex	0.98±0.41	0.35±0.00	0.35±0.02	0.36±0.02	0.63±0.04	1.07±0.03	0.68±0.02	0.46±0.04	0.50	0.44±0.02
Pronotum	0.33±0.01	0.36±0.05	0.31±0.01	0.28±0.00	0.46±0.01	0.49±0.01	0.43±0.00	0.46±0.03	0.40	0.40±0.02
Scutellum	0.39±0.01	0.34±0.01	0.35±0.02	0.29±0.01	0.37±0.05	0.46±0.01	0.49±0.02	0.50±0.02	0.30	0.43±0.02
Clypeus	1.07±0.05	0.67±0.06	0.62±0.04	0.59±0.02	0.81±0.05	1.19±0.03	0.70±0.00	0.68±0.05	0.70	0.77±0.03
Clypellus	0.31±0.02	0.21±0.03	0.32±0.03	0.29±0.02	0.38±0.02	0.38±0.01	0.40±0.00	0.41±0.04	0.30	0.40±0.02
WIDTH										
Wing	0.65±0.03	0.59±0.03	0.62±0.02	0.54±0.02	0.70±0.06	0.72±0.02	0.69±0.02	0.71±0.07	0.70	0.70±0.02
Vertex	0.50±0.04	0.28±0.02	0.34±0.02	0.24±0.01	0.35±0.02	0.35±0.01	0.30±0.07	0.36±0.01	0.30	0.36±0.02
Pronotum	0.88±0.04	0.90±0.02	0.98±0.05	0.78±0.03	1.06±0.02	1.09±0.03	1.16±0.05	1.23±0.01	0.80	1.10±0.02
Head	0.89±0.03	0.91±0.04	0.96±0.05	0.80±0.03	1.02±0.03	0.98±0.02	1.16±0.05	1.20±0.06	0.80	1.09±0.01
Clypellus	0.17±0.01	0.21±0.03	0.18±0.01	0.59±0.02	0.26±0.01	0.20±0.00	0.20±0.00	0.68±0.05	0.20	0.21±0.01
Lorum	0.13±0.00	0.13±0.00	0.14±0.01	0.13±0.00	0.12±0.01	0.15±0.00	0.15±0.00	0.16±0.01	0.10	0.15±0.00
DISTANCE BETWEEN										
Eyes	0.52±0.04	0.45±0.03	0.49±0.01	0.38±0.02	0.59±0.01	0.51±0.01	0.51±0.02	0.54±0.01	0.45	0.54±0.01
Antennal pits	0.40±0.00	0.41±0.03	0.45±0.01	0.34±0.02	0.51±0.01	0.37±0.01	0.45±0.00	0.49±0.01	0.40	0.44±0.01
Ant. E to ant. V	0.71±0.05	0.11±0.01	0.13±0.01	0.14±0.01	0.29±0.01	0.66±0.02	0.05±0.00	0.12±0.02	0.20	0.14±0.01

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex
No. of specimens used for measurement: One female of *S. speciosum*.

region sinuate dorsally, shaft tightly recurved, and then straight. As shown in the Figure 56, shaft straight.

Female terminalia: Hind margin of the female seventh sternite truncate.

Measurements: Male 3.65 mm long, head 0.84 mm wide across eyes, 0.86 mm wide across pronotum. Female 4.0 mm long, head 0.80 mm wide across eyes, 0.80 mm wide across pronotum (Table 12 & 13). *Genitalia measurements*: (Table 17).

Materials examined: INDIA: Karnataka, 1♀, Bangalore, 18.xi.1974, C. A. Viraktamath; 1♂,1♀, Bangalore, 30.iv.1976, B. Mallik; 6 Km N of Vijayapura, 9.vi.1977, Viraktamath, C. A; Kerala: 1♂, Burliar, 5.vii.1977, Viraktamath, C. A; 1♂, 7 Km E of Trichur, 8.i.1986, Viraktamath, C. A.; Delhi: 1♀, 24.iv.1975, C. A. Viraktamath; Tamil Nadu: 1♂, Yercaud, 1370 m, 5.iv, 1976, B. Mallik (UASB).

Remarks: The colouration of this species is very distinctive. The vertex is triangularly produced with two longitudinal fasciae; the pronotum has three and scutellum one central longitudinal orange fasciae. The aedeagal shaft is shorter compared to that in other species of *Stirellus* from the subcontinent and is almost straight.

***Stirellus (Stirellus) tolla* (Pruthi) comb. nov.**

Aconura tolla Pruthi, 1930: 39.

(Plate 25 & Fig. 51)

Pale yellowish green. Vertex slightly longer than breadth between eyes, anteriorly broadly angular. Clypeus 1.75 times longer than clypellus. Clypellus little broader at apex. Labium just reaching mid coxae. Fore wing with five apical, three subapical cells. Body beneath black, with pale yellowish tinge. Legs pale yellowish, base of hind femoral spines light brown.

Male genitalia: Pygophore slightly tapering caudad, ventrally notched near middle, a stout tubercle near caudal margin on ventral side. Subgenital plate with setae uniseriate. Style with well developed preapical lobe, apophysis thick, finger-like with crenulated surface. Aedeagal shaft straight, hooked apically.

Female terminalia: Hind margin of the seventh sternite slightly concave.

Measurements: Male 3.53 mm long, head 1.02 mm wide across eyes, 1.02 mm wide across pronotum, Female 4.40 mm long, head 1.10 mm wide across eyes, 1.10 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 17).

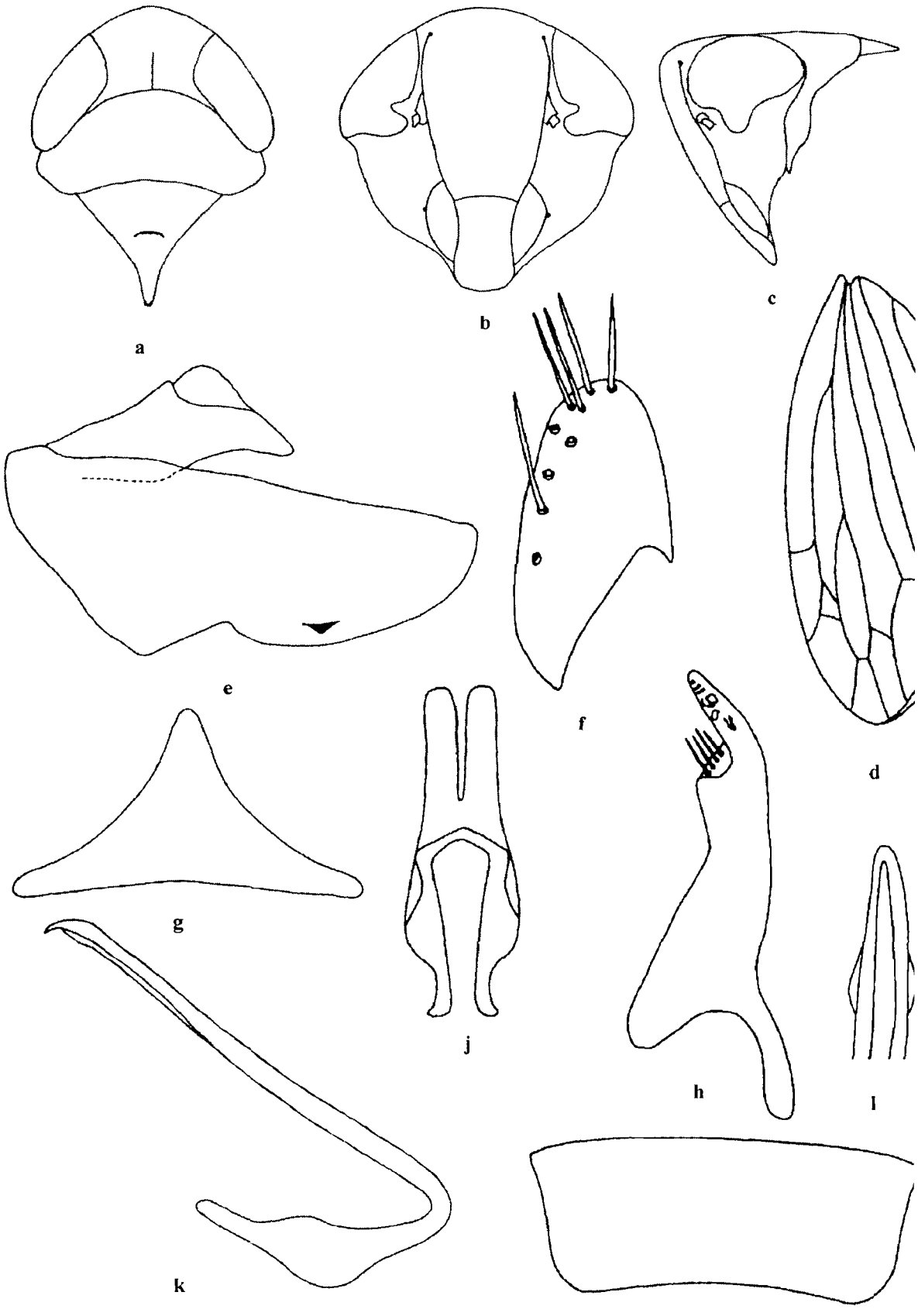
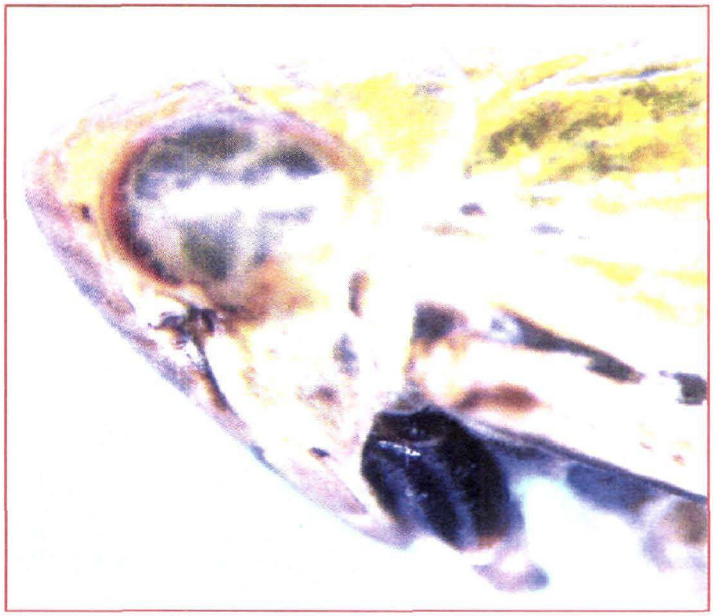


Fig. 51 *Stirellus tolla* (Pruthi)

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus tolla (Pruthi)

Plate 25

Materials examined: INDIA: Karnataka, 1♂, 2♀, Mysore St., Ag. Coll. Dharwar, 27.vii 1972. Viraktamath, C.A. (UASB).

Remarks: *S. tolla* resembles *S. solitaris* externally but has broadly rounded apex of head.

***Stirellus (Stirellus)* sp. 1**

(Plate 26 & Fig. 52)

Light green. Vertex acutely produced anteriorly, twice as long as inter-ocular distance. Clypeus 2.75 times longer than clypellus. Labium slightly extending beyond fore coxae. Pronotum medially ridged, anterior margin slightly produced between eyes, almost truncate, posterior margin concave. Forewing with five apical, four subapical cells.

Male genitalia: Pygophore broad basally, in distal half dorsal margin oblique, ventral margin concavely excavated at midlength, caudal margin rather truncate, tubercle located 0.33 distance from caudal margin. Subgenital plate triangular with caudal angle conically rounded, setae uniseriate. Style with well developed preapical lobe, apical apophysis finger-like curved laterally, lateral margins serrated. Connective with arms as long as stem. Aedeagus with basal bulbous region with straight dorsal margin, shaft recurved, with apex narrowed and pointed.

Female terminalia: Hind margin of the female seventh sternite concave.

Measurements: Male 4.36 mm long, head 1.02 mm wide across eyes, 1.06 mm wide across pronotum. Female 5.42 mm long, head 1.14 mm wide across eyes, 1.22 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 17).

Material examined: INDIA: Andhra Pradesh, 31♂, 45♀, Nagarjuna Uni. Nr. Guntur, 13.xii.2006, Shobharani, M (UASB).

Remarks: This species resembles *S. viridulus* (Pruthi) comb. nov. in colouration but has head narrower than pronotum. *S. pusanus* (Distant) comb. nov. also has head narrower than pronotum but *Stirellus* sp. 1 differs from *S. pusanus* in lacking the dark spots at base of scutellum.

***Stirellus (Stirellus)* sp. 2**

(Plate 27 & Fig. 53)

Straw coloures, with reddish tinge. Vertex twice as long as inter-ocular distance, triangularly produced, acutely pointed anteriorly. Clypeus 2.25 times longer than

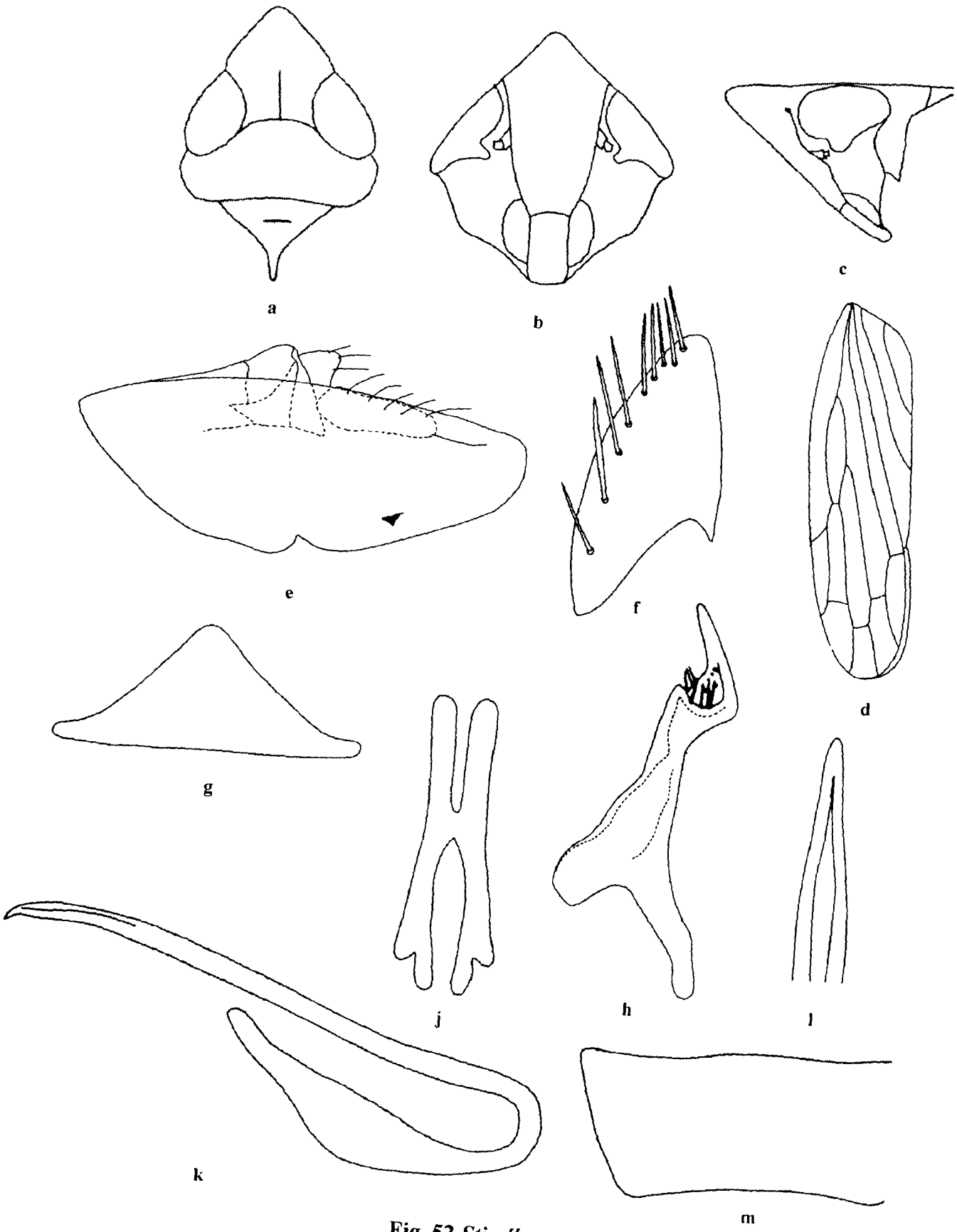


Fig. 52 *Stirellus* sp. 1

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

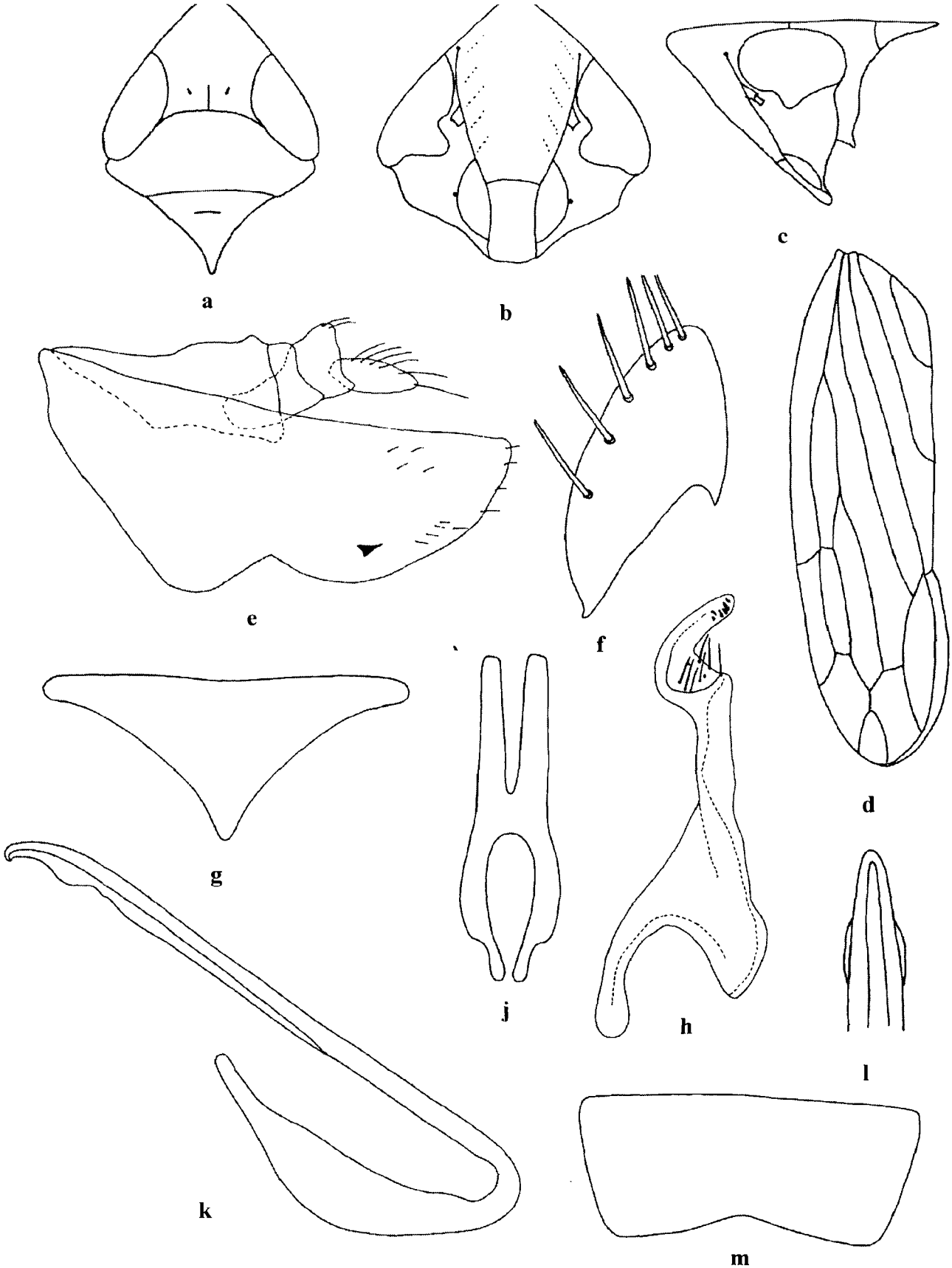
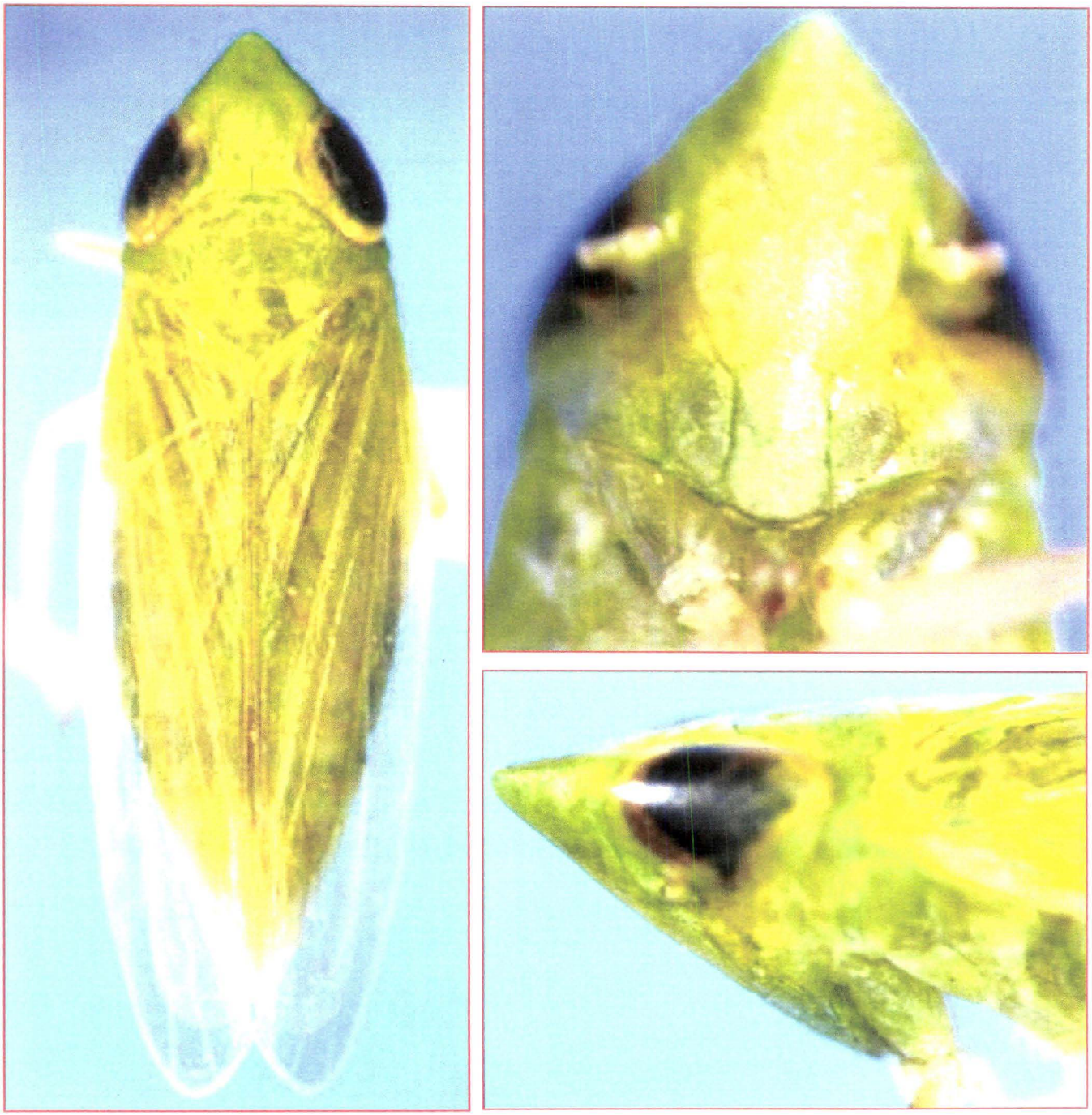


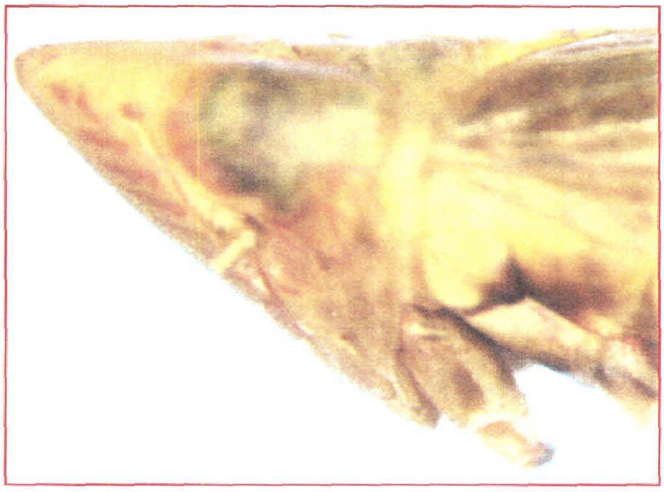
Fig. 53 *Stirellus* sp. 2

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus sp.1

Plate 26



Stirellus **sp. 2**

Plate 27

clypellus, pointed at anterior end, faint stripes laterally. Labium reaching mid-coxae. Pronotum medially ridged. Forewing with five apical, three sub apical cells.

Male genitalia: Pygophore long, dorsal margin almost straight, ventral margin notched at middle, caudal margin broadly rounded stout tubercle on ventro-mesal region at about one third distance from apex. Subgenital plate with setae uniseriate, with rounded lateral margin. Style with well developed preapical lobe, apical apophysis finger-like curved laterally with corrugated surface. Aedeagus with shaft straight but hooked apically.

Female terminalia: Hind margin of the female seventh sternite slightly concave medially.

Measurements: Male 3.90 mm long, head 0.91 mm wide across eyes, 0.94 mm wide across pronotum. Female 4.73 mm long, head 1.03 mm wide across eyes, 1.05 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 17).

Material examined: INDIA: Karnataka, Holotype ♂, Bandipur, Mysore, 19.i.1985, S. Viraktamath: 9♂, 13♀, Bandipur, Mysore, 19.i.1985, S. Viraktamath (UASB).

Remarks: Stirellus sp.2 resembles *S. viridulus*. In both the species the vertex is twice as long as inter-ocular distance and acutely produced. The pygophore of *Stirellus* sp.2 has the dorsal margin almost straight whereas in *S. viridulus* it is declivous.

***Stirellus (Stirellus)* sp. 3**

(Plate 28 & Fig. 54)

Staw coloured or pale yellowish green. Vertex 1.5 times as long as inter-ocular distance, triangularly produced anteriorly. Clypeus 1.75 times longer than clypellus. Clypellus rectangular. Labium slightly extending mid-coxae. Pronotum anteriorly convex, posteriorly truncate. Forewing with five small apical, three long subapical cells. Body beneath black with pale colour lateral margin. Female seventh sternite with black area posteriorly. Base of hind tibial spines black.

Male genitalia: Pygophore broad anteriorly, gradually tapering caudally, caudal margin truncate, ventral margin with a slight concavity near base, stout tubercle at ventro-mesal region at about one third distance from apex. Subgenital plate with rounded apex, setae uniseriate. Connective with arms slightly longer than stem. Style with well developed preapical lobe, apophysis long finger like curved laterally, with pigmented, corrugated surface. Aedeagal shaft sinuate, with lateral flanges near apex.

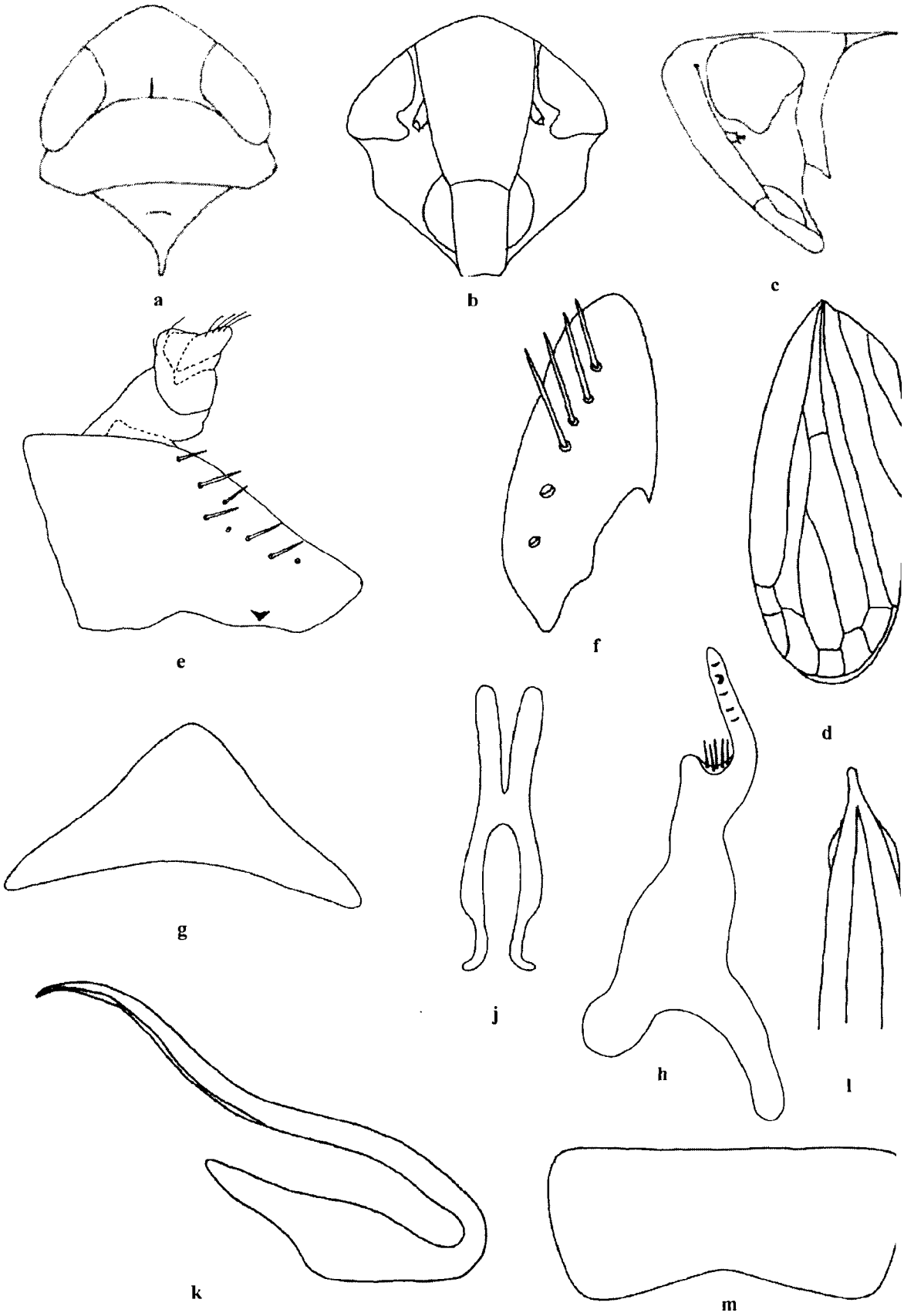
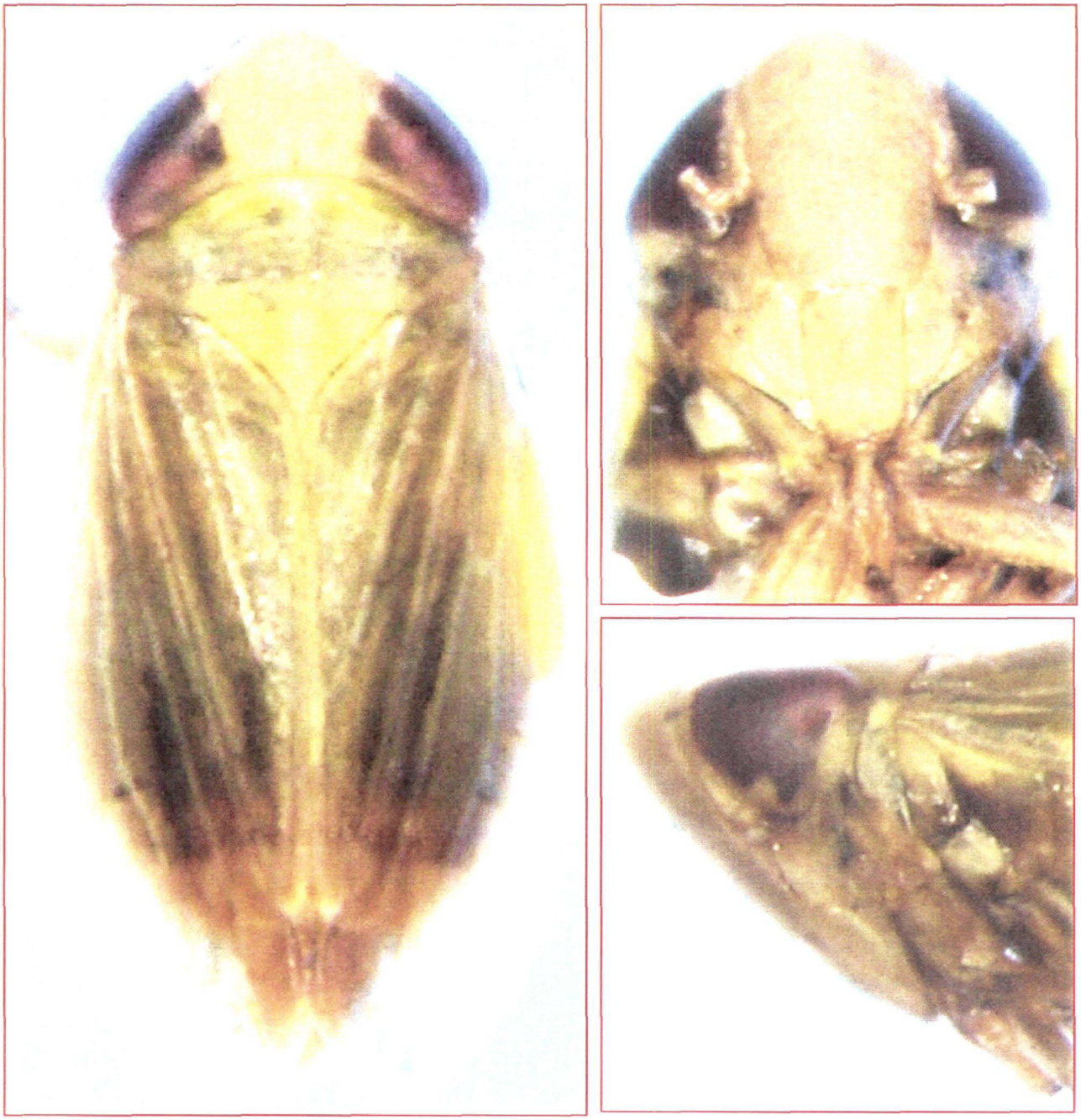


Fig. 54 *Stirellus* sp. 3

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus **sp. 3**

Plate 28

Female terminalia: Hind margin of seventh sternite concave with black pigmented region on posterior margin.

Measurements: Male 2.56 mm long, head 0.88 mm wide across eyes, 0.88 mm wide across pronotum. Female 3.34 mm long, head 0.94 mm wide across eyes, 0.95 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 17).

Material examined: INDIA: Karnataka, Holotype ♂, Bangalore, 16.iv.1976, C. A. Viraktamath; 1♀, nr Anekal, 10.viii.1975, K. D. Ghorpade; 2♂, Bangalore 3.x.1967, H. M. Harris; 1♂, 1♀, Bangalore, GKVK, 28.vii.1971, C. A. Viraktamath; 5♂, 4♀, Bangalore, 16.iv.1976, C. A. Viraktamath; 1♂, 1♀, Bangalore, 29.vii.1977, K. D. Ghorpade; 4♂, 4♀, Bangalore, 16.x.1982, H. V. A .Murthy; 1♂, 1♀, Bangalore, 3.xii.1991, P. C. Dash; 1♂, Bangalore GKVK, 15.xi.2005, Shobharani, M; 6♂, 8♀, Chintamani, 16.x.2006, Shobharani, M; ♂, 2♀, Dharwad, 4.xi. 1967, on grass, C. A. Viraktamath; 1♂, 1♀, Dharwad, 6.xi.1969, on grasses, C. A. Viraktamath; 6♂, 1♀, Ag. College, Dharwar, 25.vii.1972, C. A. Viraktamath; 4♂, 9 Km SE Magadi, 16.vii.1977, C.A.Viraktamath; Andhra Pradesh: 24♂, 30♀, Bapatla, on grass, 12.xii.2006, Shobhrani, M.; 13♂, 10♀, Bapatla, on grass, 14.xii.2006, Shobhrani, M; Kerala: 1♀, Thekkady, 884m, 26.iii.1977, C.A. Viraktamath; Orissa: 1♂, Bhuvaneshwar, 13.vi.1993, P. C. Dash; Tamil Nadu: 1♂, 2♀, Oothu, 29.x.1975, C.A. Viraktamath (UASB).

Remarks: *Stirellus* sp. 3 resembles *S. solitaris* externally, but differs with respect to size and detailed male genitalia characters. *Stirellus* sp. 3 is small compared to *S. solitaris* and aedeagal shaft of *Stirellus* sp. 3 is sinuate whereas in case of *S. solitaris* aedeagal shaft is straight.

***Stirellus (Stirellus)* sp. 4**

(Plate 29 & Fig. 55)

Light yellowish green. Vertex triangularly produced, about one and half times longer than the inter-ocular distance, anterior margin subacutely produced, disc finely longitudinally rugose. Clypeus 1.75 times longer than clypellus, with light brown striae laterally. Clypellus slightly broadening at apex. Labium reaches mid coxae. Pronotum truncate at posterior margin, transversely rugose. Forewing with five marginal, three submarginal cells. Body beneath black except genital capsule which is paler, in some specimens body beneath pale yellowish with blackish tinge. Base of hind tibial spines black.

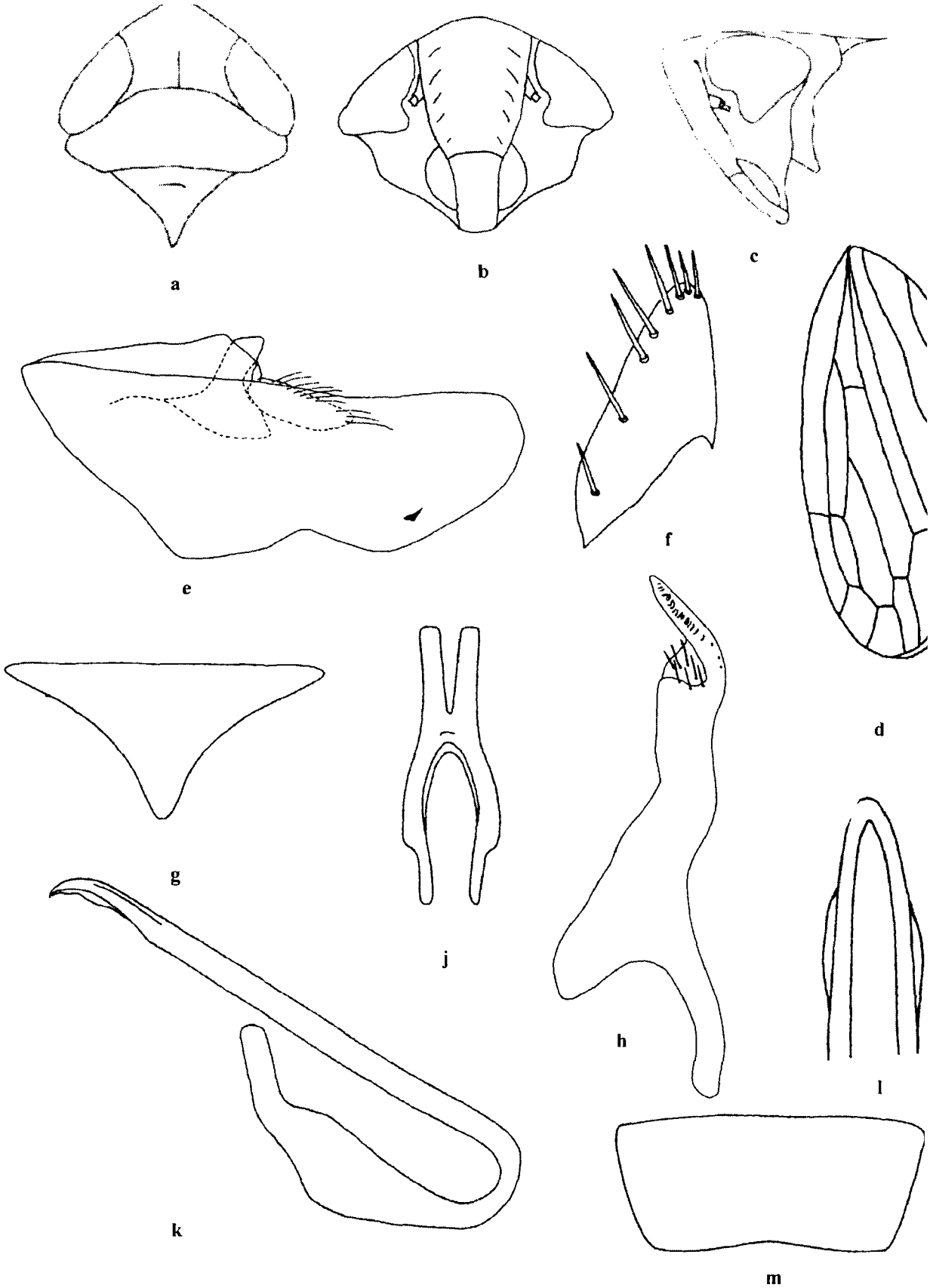


Fig. 55 *Stirellus* sp. 4

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

Stirellus **sp. 4**

Plate 29

Male genitalia: Pygophore long declivous at dorsal region, broad, rounded at the caudal region with one stout tubercle at one third distance from caudal end, ventral margin notched medially. Subgenital plate triangular, uniserially spinose on lateral margin. Style long preapical lobe well developed, apical apophysis finger-like with transverse crenulations on its surface. Aedeagus as shown in the Figure 61, shaft straight with lateral flange sub-apically.

Female terminalia: Hind margin of the seventh sternite slightly concave.

Measurements: Male 2.86 mm long, head 0.96 mm wide across eyes, 0.95 mm wide across pronotum. Female 3.54 mm long, head 1.00 mm wide across eyes, 1.00 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 18).

Materials examined: INDIA: Karnataka, Holotype ♂, Bangalore 3.x.1967, H. M. Harris; 1♂, Bangalore 3.x.1967, H. M. Harris; 6♂, 2♀, Bangalore, 25.ii.1975, C. A. Viraktamath; 16♂, 17♀, Chikkaballapur, 27.ix.2005: 6♂, 4♀, Chikkaballapur, 1.x.2005, Shobharani, M; 4♂, 4♀, Chikkaballapur, 19.xii.2005, Shobharani, M; 9♂, 7♀, Chikkaballapur, 8.viii. 2006. Shobharani, M; 4♂, 19 km NE Ilkalgad, 19.xii.1974, K.D. Ghorpade; 1♂, 4♀, Jog falls, 18.xi.1976, K.D. Ghorpade; 1♂, Jog falls, 534 m, 24.xi.1982, H. V. A. Murthy; 1♀, Mudigere, 7.iv.1975, C. A. Viraktamath (UASB). 2♀, Mudigere, 8.iv.1975, C.A.Viraktamath; 2♀, Mudigere, 7.iv.1975, C. A.Viraktamath

Remarks: This species can be easily distinguished from other species of *Stirellus* by the finely rugose disc of vertex.

***Stirellus (Stirellus)* sp. 5**

(Plate 30 & Fig. 56)

Stramineous or pale green colour, vertex about 1.25 times as long as inter-ocular distance, anterior margin of vertex acutely angled and produced. Clypeus twice long as clypellus, with dark brown striations on lateral margin. Labium reaching mid-coxae. Pronotum with posterior margin truncate, medially ridged. Forewing with five apical, three subapical cells. Body beneath black with pale colour segmental lines, abdomen very long.

Male genitalia: Pygophore declivous caudally, ventrally sinuated at middle, a stout tubercle near ventral margin at one third distance from caudal margin. Subgenital plate with setae uniseriate. Style prelobe well developed, apical apophysis thumb-like, highly pigmented. Aedeagus with shaft straight

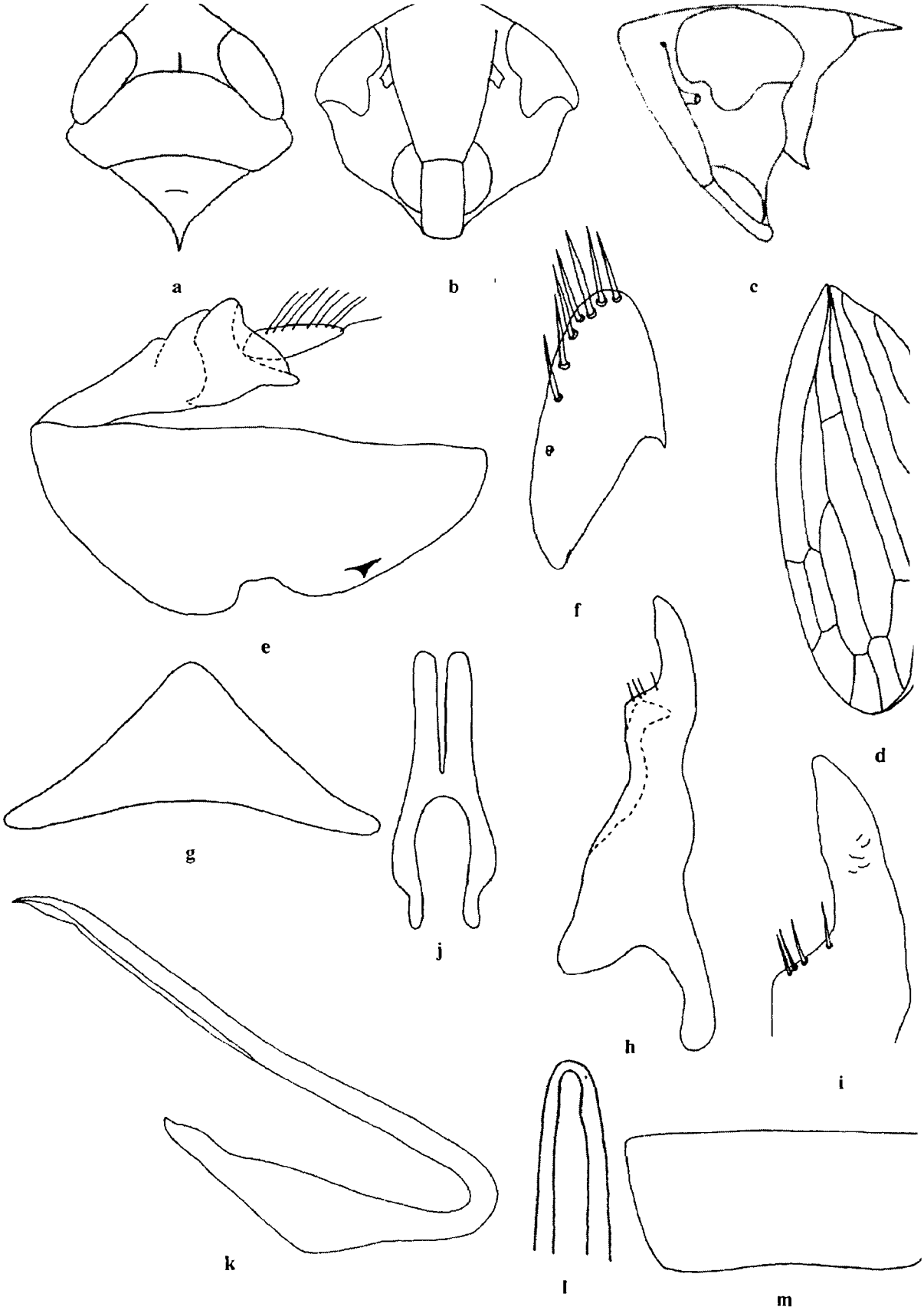
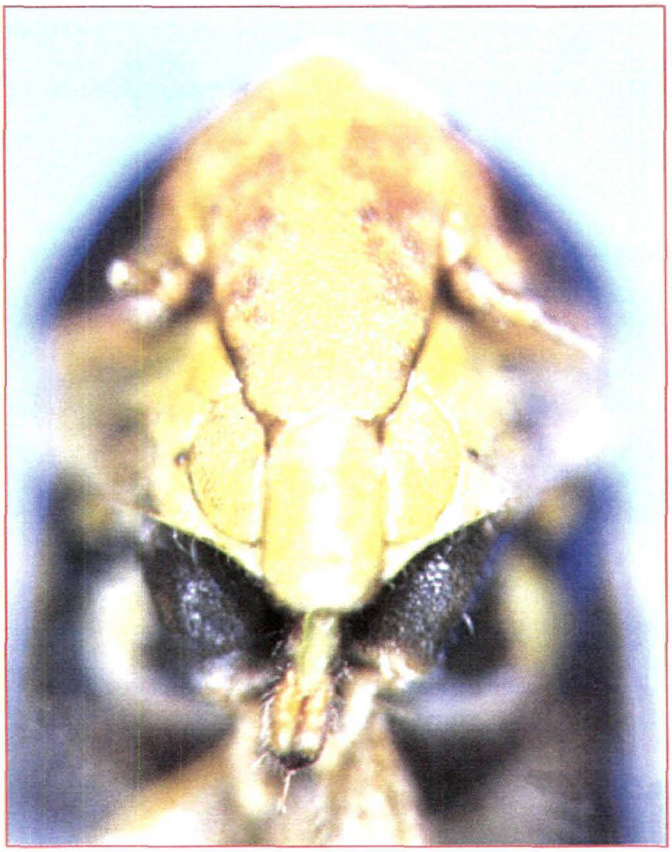
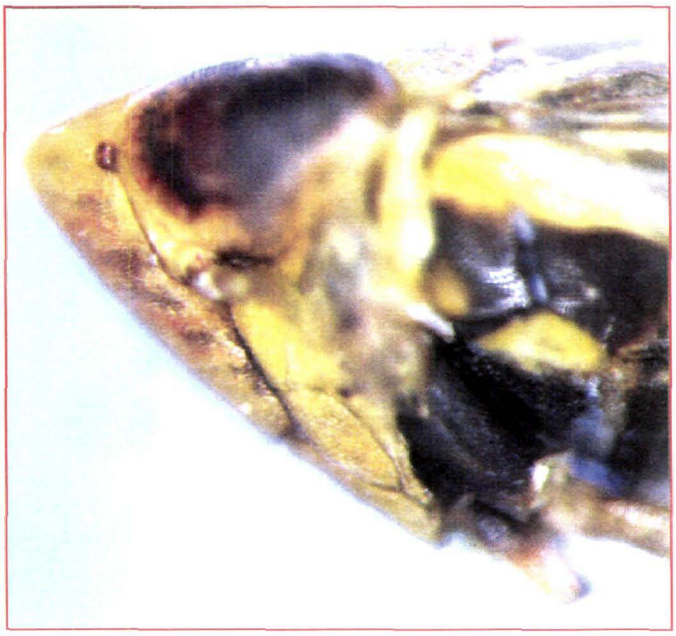


Fig. 56 *Stirellus* sp. 5

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used





Stirellus **sp. 5**

Plate 30

Female terminalia: Hind margin of the female seventh sternite slightly concave.

Measurements: Male 3.60 mm long, head 0.95 mm wide across eyes, 0.98 mm wide across pronotum. Female 4.92 mm long, head 1.09 mm wide across eyes, 1.10 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 18).

Materials examined: INDIA: Andhra Pradesh, Holotype ♂, Lam farm nr. Guntur, 13. xii. 2006, Shobharani, M; 3♀, Lam farm nr. Guntur, 13. xii. 2006, Shobharani, M; 1♀, Bapatla on grass, 14.xii.2006, Shobharani, M. (UASB).

Remarks: Stirellus sp. 5 resembles *Stirellus* sp.8 but can be differentiated based on the shape of apical apophysis of the style. In *Stirellus* sp. 5 apical apophysis of the style is straight, thumb-like, whereas in *Stirellus* sp.8 it is slender, curved laterally.

***Stirellus (Stirellus)* sp. 6**

(Plate 31 & Fig. 57)

Straw coloured or pale yellowish. Vertex 1.5 times as long as inter-ocular distance, acutely produced anteriorly. Head including eyes broader than pronotun. Ocelli black close to eyes. Clypeus, clypellus tumid, clypeus about twice as long as clypellus. Labium slightly extending fore coxae. Pronotum convex at anterior margin, truncate at posterior margin. Forewing with five apical, three subapical cells.

Male genitalia: Pygophore broad anteriorly, gradually declivous posteriorly, caudal lobe bluntly pointed, ventral margin with excavation almost at middle. Valve with caudal margin rounded. Subgenital plate broad with rounded outer margin, setae biseriate. Style long with well developed preapical lobe, apical apophysis long finger-like, highly pigmented with rounded apex. Connective with lateral extensions. Aedeagus short, stout, shaft broader compared to other species, slightly sinuate, pointed at apex.

Female terminalia: Hind margin of the seventh sternite truncate.

Measurements: Male 3.4 mm long, head 0.92 mm wide across eyes, 0.83 mm wide across pronotum. Female 4.45 mm long, head 1.00 mm wide across eyes, 0.91 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 18).

Material examined:, INDIA: Delhi, Holotype ♂, IARI, 7.vii.1992, C. A. Viraktamath; 2♂, 1♀, IARI, 7.vii.1992, C. A. Viraktamath; 5♀, IARI, 23.iv.1975, C. A. Viraktamath; 1♂, 2♀, Delhi, 1968, H.M. Harris (UASB).

Remarks: Stirellus sp. 6 can be distinguished from other species of *Stirellus* by the head being broader than the pronotum and it also lacks the tubercle on the

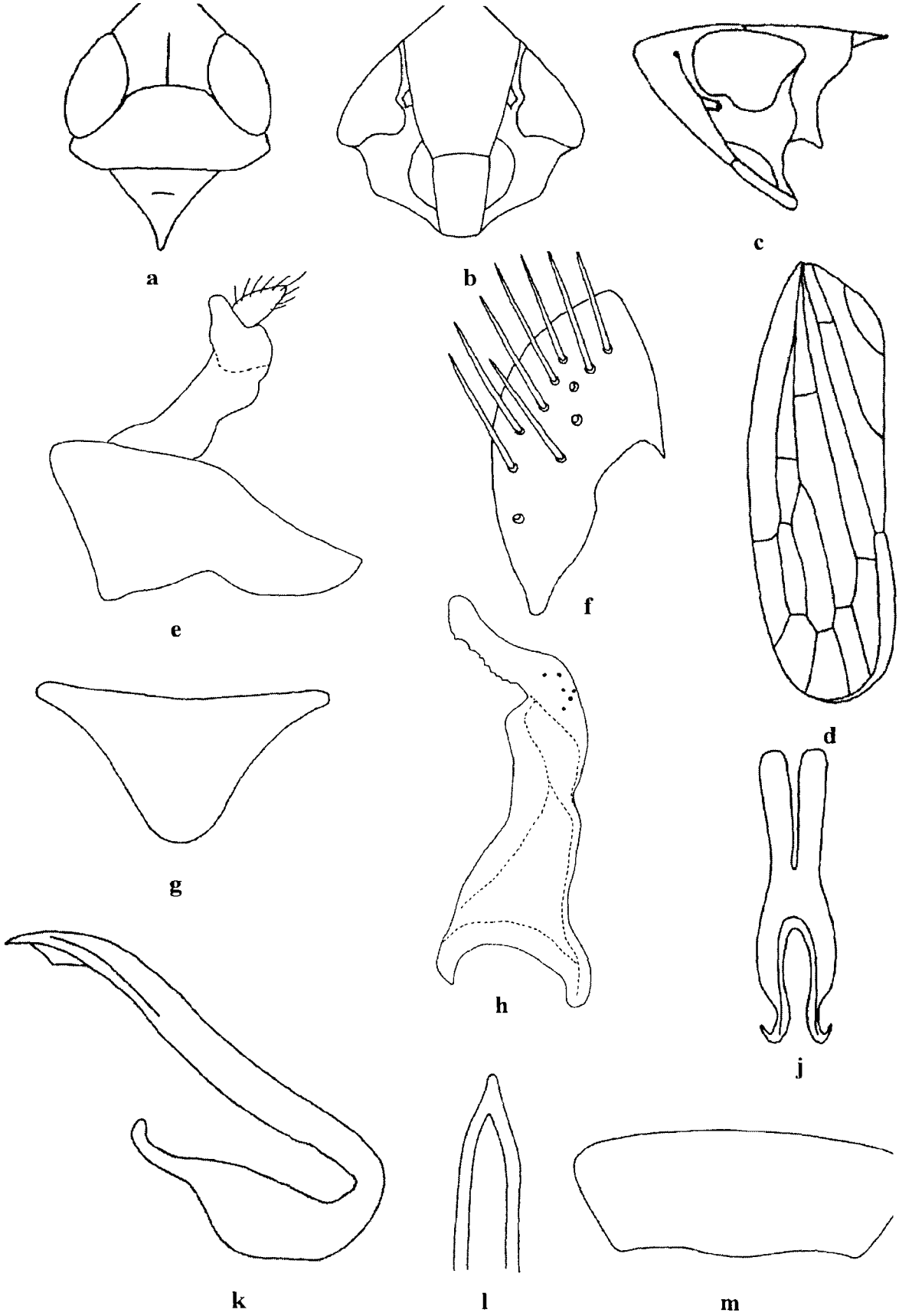
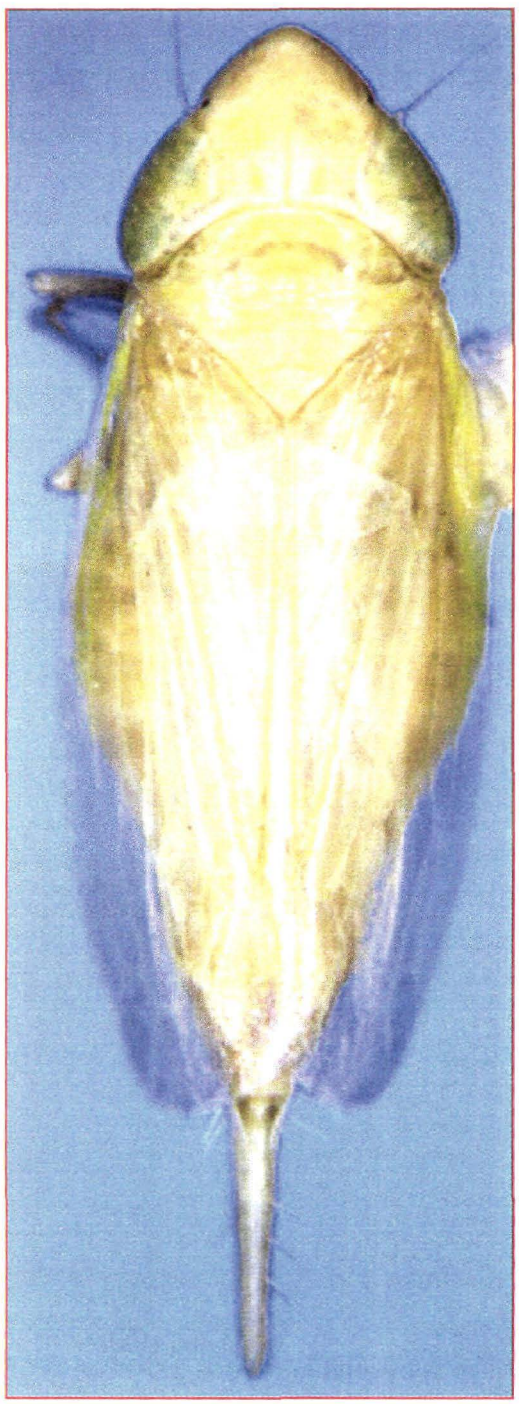
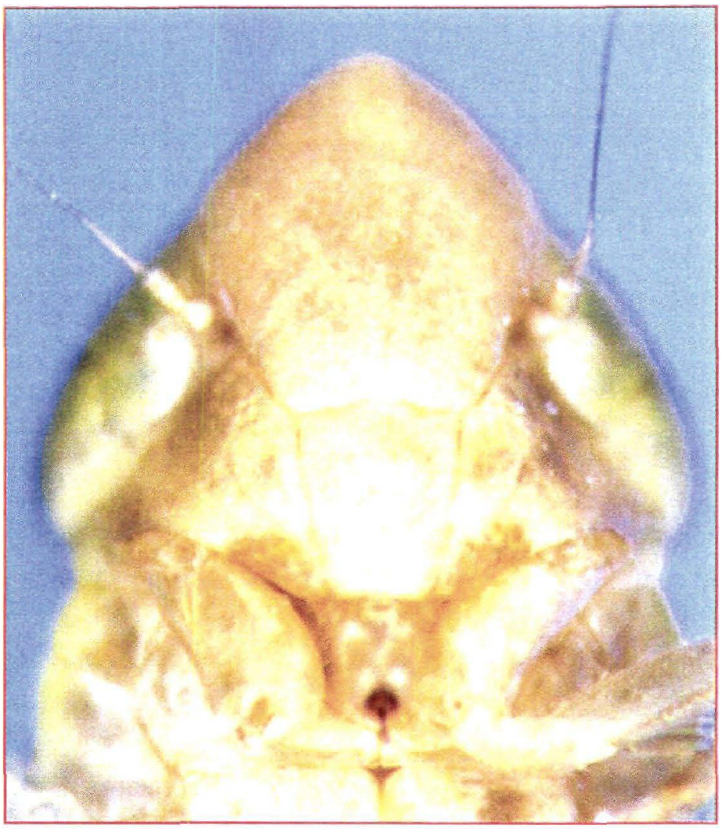
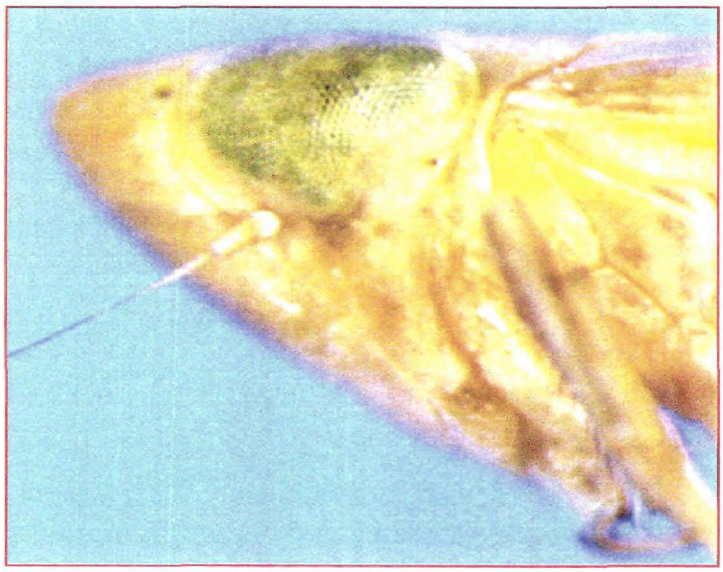


Fig. 57 *Stirellus* sp. 6

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used







Sitellus sp. 6

Plate 31

pygophore and has short and stout aedeagal shaft. In the latter characters it has resemblance to *S. thattaensis* but differs from it in having more acutely angled apex of head.

***Stirellus (Stirellus)* sp. 7**

(Plate 32 & Fig. 58)

Stramineous or pale brownish. Vertex about 1.5 times as long as inter-ocular distance. Vertex triangular, subacutely produced, with two linear impressions on either side of the median line. Clypeus 1.75 times longer than clypellus. Labium almost reaching the end of mid-coxae. Pronotum medially ridged, produced between eyes, anterior margin truncate, posterior margin slightly concave. Forewing with five apical, three subapical cells. Body beneath black with stramineous patches. Hind tibia black with stramineous spines.

Male genitalia: Pygophore declivous in dorsal margin, caudal margin rounded, ventral margin excavated medially, a stout tubercle on ventro-mesal region at about one third distance form apex. Subgenital plate uniserially spinose. Connective with arms longer than stem, with lateral extensions. Style very broad anteriorly, slender posteriorly with well developed preapical lobe, apical apophysis finger-like slightly curved laterally with corrugated surface. Aedeagal shaft almost straight, hooked apically.

Female terminalia: Hind margin of seventh sternite slightly concave, lateral lobes angulate.

Measurements: Male 4.08 mm long, head 1.01 mm wide across eyes, 1.01 mm wide across pronotum. Female 4.3 mm long, head 1.03 mm wide across eyes, 1.03 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 18).

Materials examined: INDIA: Meghalaya, Holotype ♂, Shillong, 1961m, 3. xi.1981. C. A. Viraktamath: 2♂, 1♀, Shillong, 1961m, 3. xi.1981. C. A. Viraktamath (UASB).

Remarks: In this species the style is very broad anteriorly, slender posteriorly with well developed preapical lobe compared to other species of *Stirellus*.

***Stirellus (Stirellus)* sp. 8**

(Plate 33 & Fig. 59)

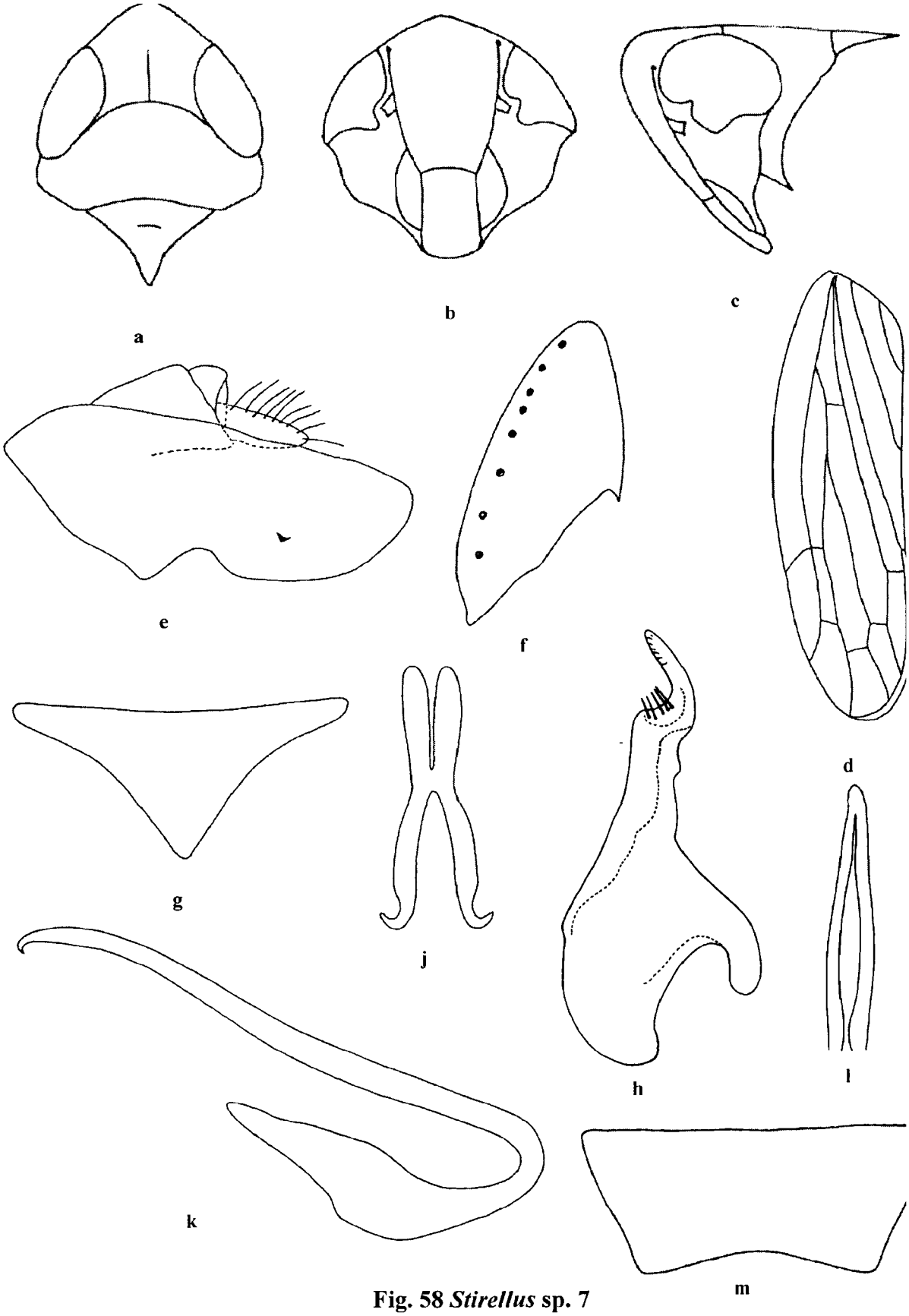


Fig. 58 *Stirellus* sp. 7

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

Stirellus sp. 7

Plate 32

Stramineous or yellowish green. Vertex, 1.25 times as long as inter-ocular distance, subacutely produced. Clypeus twice longer than clypellus, with small stripes or brownish tinge on lateral margin. Clypellus raised, rectangular. Labium reaching mid-coxae. Pronotum medially ridged. Forewing with five apical, three subapical cells. Body beneath black, with pale coloured genital capsule.

Male genitalia: Pygophore slightly tapering caudad, ventrally notched near middle, a stout tubercle near caudal margin on ventral side. Subgenital plate with setae uniseriate. Style with well developed preapical lobe, apical apophysis thick, finger-like with crenulated surface. Aedeagal shaft straight, hooked apically.

Female terminalia: Hind margin of female seventh sternite slightly concave.

Measurements: Male 3.36 mm long, head 0.95 mm wide across eyes, 0.95 mm wide across pronotum. Female 4.26 mm long, head 1.03 mm wide across eyes, 1.07 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 18).

Material examined: INDIA: Andhra Pradesh, Holotype ♂, Bapatla on grass 12.x.11.2006, Shobharani, M; 15♂, 4♀, Bapatla on grass 12.x.11.2006, Shobharani, M; 1♀, 2♂, 14.xii.2006, Shobharani, M; 8♀, 5♂, Nagarjuna Univ. Nr. Guntur, 13.11.2006. Shobharani, M. (UASB).

Remarks: Stirellus sp. 8 resembles *Stirellus* sp. 5, but differs with respect to shape of the apical apophysis of style. The apophysis of the style in *Stirellus* sp. 5 is almost straight but laterally curved in *Stirellus* sp. 8.

***Stirellus (Stirellus)* sp. 9**

(Plate 34 & Fig. 60)

Stramineous or pale yellowish green, vertex slightly longer than inter-ocular distance, vertex with median tranverse orangc fascia in front of eyes, with two prominent black spots between anterior margins of eyes, in some species it is absent, two black circular spots just below the antennal pits. Clypeus 1.75 times longer than clypellus. Labium reaching mid-coxae. Anterior margin of pronotum, basal angles of scutellum orange. Forewing with five apical, three subapical cells. Body beneath stramineous with brownish tinge.

Male genitalia: Pygophore broad at anterior half, declivous caudally, anterior margin of pygophore straight, caudal lobe rounded, ventral margin slightly sinuate medially, six to seven stout setae near to dorsal margin, one stout tubercle at caudal one third near to ventral margin. Subgenital plate triangular, setae uniseriate to biseriate.

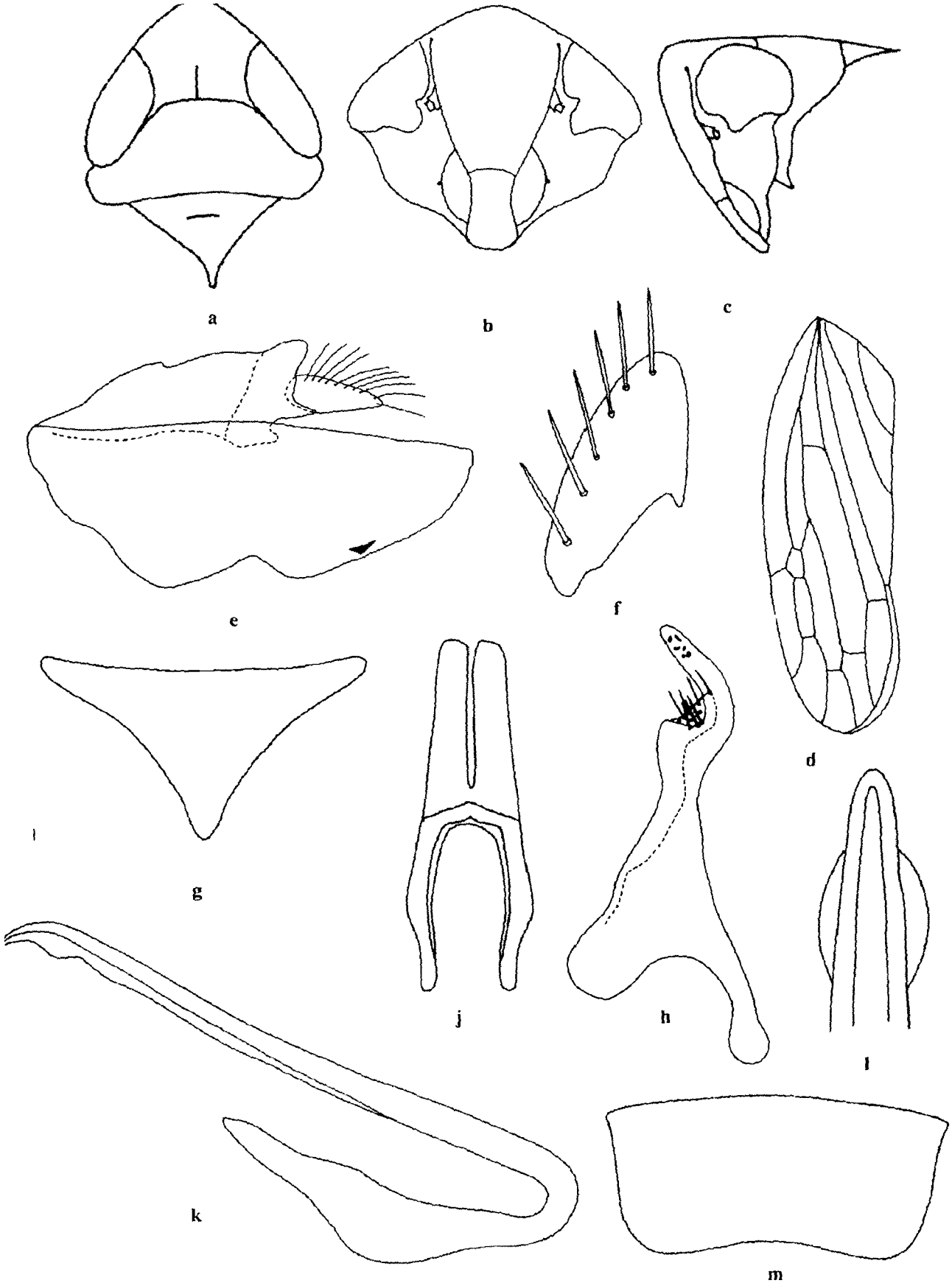


Fig. 59 *Stirellus* sp. 8

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used

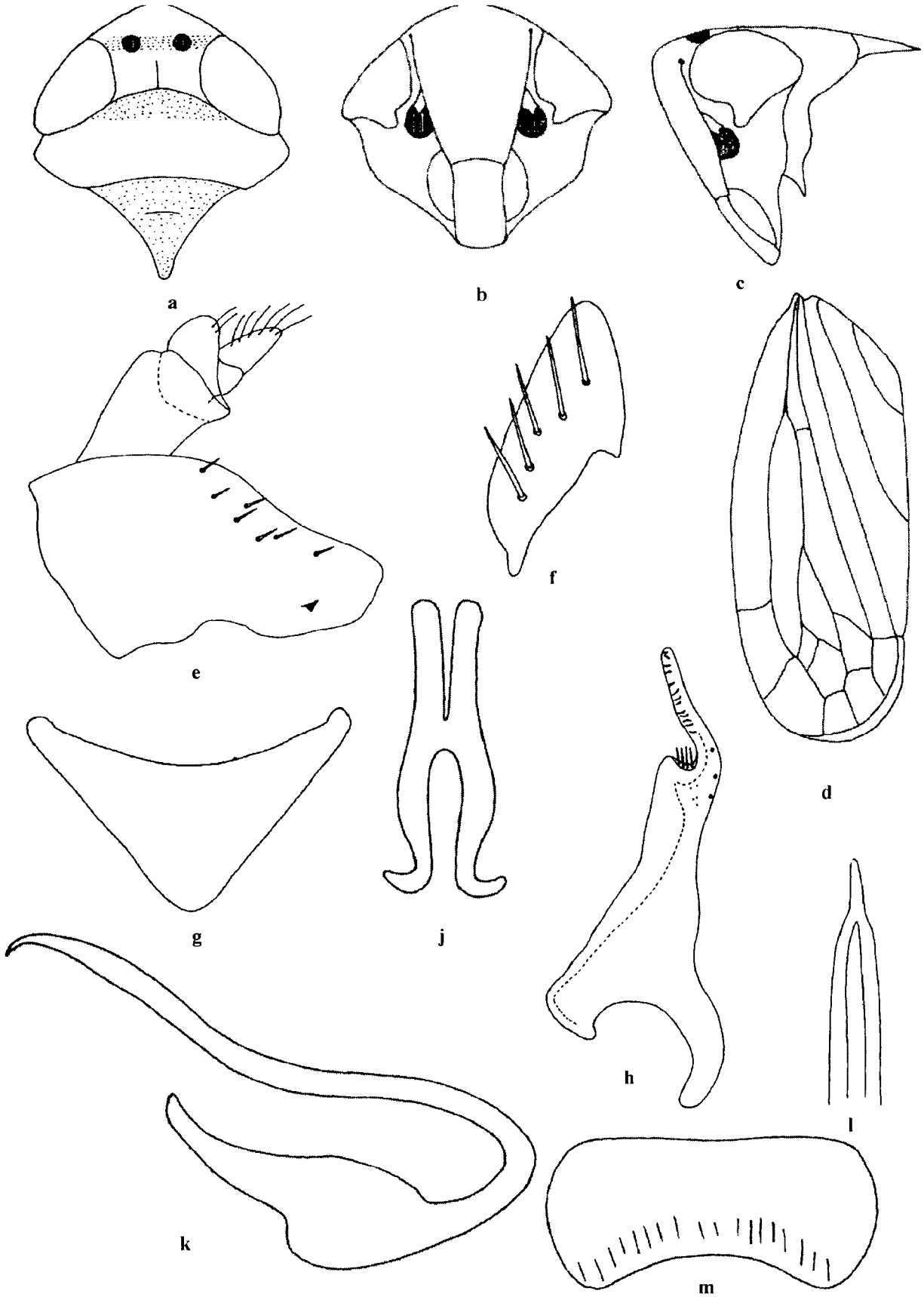
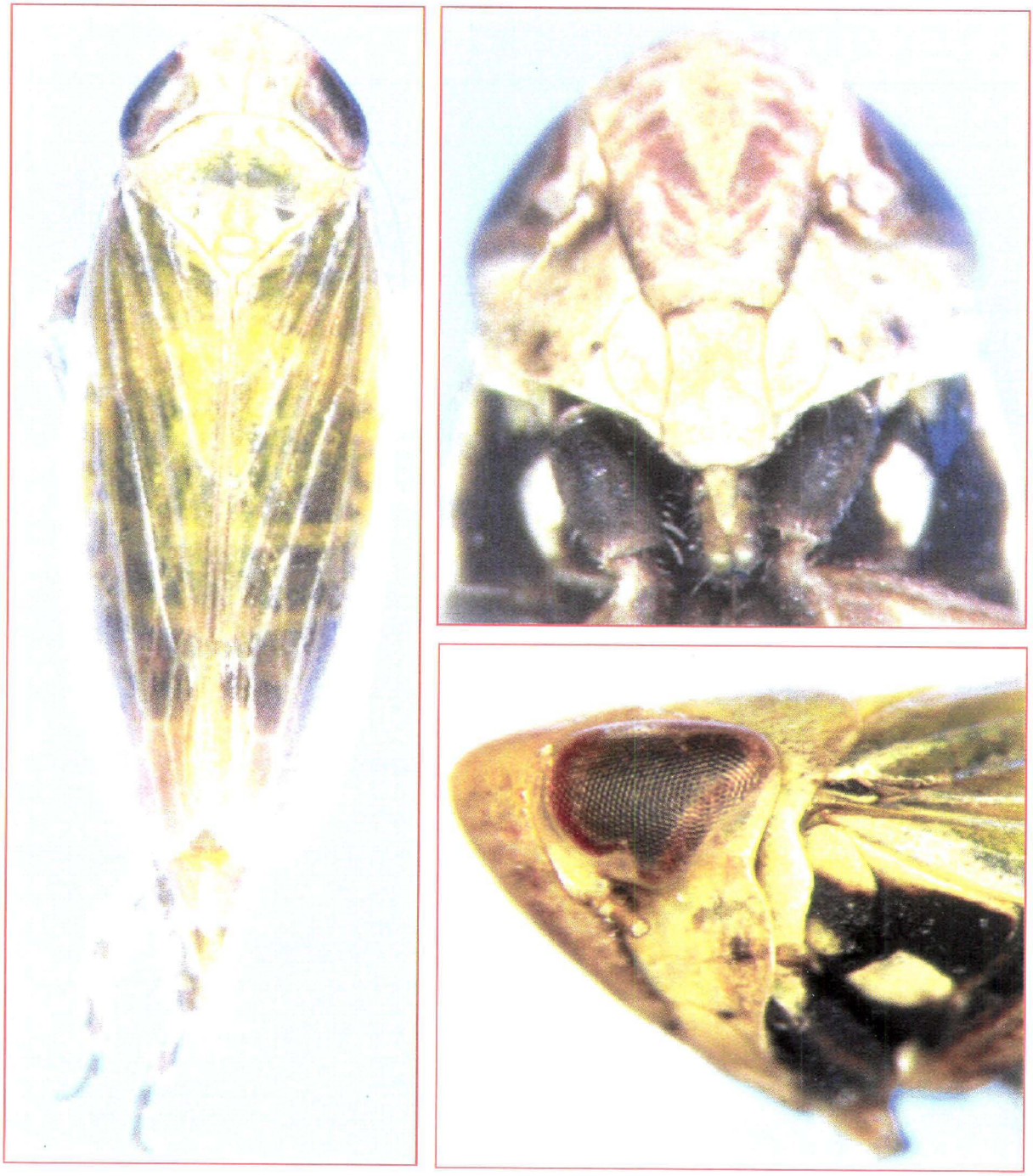


Fig. 60 *Stirellus* sp. 9

Refer legends of Fig. 1, Fig. 2, Fig. 3 of Chapter III for details of alphabets used



Stirellus **sp. 8**

Plate 33

Stirellus **sp. 9**

Plate 34

Table 14. Measurements (in mm) of males of the genus *Stirellus* Osborn and Ball

Measurements	*S. tolla*	*Stirellus* 1	*Stirellus* 2	*Stirellus* 3	*Stirellus* 4	*Stirellus* 5	*Stirellus* 6	*Stirellus* 7	*Stirellus* 8	*Stirellus* 9
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean	Mean±SD	Mean±SD	Mean±SD	Mean
LENGTH										
Total length	3.53±0.15	4.36±0.09	3.90±0.10	2.56±0.05	2.86±0.09	3.60	3.40±0.12	4.08±0.10	3.36±0.11	2.50
Wing	2.80±0.10	3.44±0.05	3.00±0.10	1.92±0.04	2.14±0.05	2.90	2.54±0.05	3.23±0.15	2.68±0.13	1.90
Clavus	1.83±0.12	2.24±0.09	1.97±0.06	1.50±0.00	1.52±0.04	1.70	1.62±0.04	2.13±0.05	1.76±0.15	1.40
Vertex	0.39±0.01	0.64±0.02	0.52±0.03	0.36±0.02	0.39±0.02	0.4	0.47±0.03	0.46±0.01	0.41±0.02	0.30
Pronotum	0.37±0.01	0.40±0.02	0.36±0.01	0.31±0.02	0.31±0.01	0.32	0.36±0.01	0.41±0.01	0.32±0.01	0.33
Scutellum	0.40±0.03	0.46±0.01	0.38±0.03	0.30±0.00	0.32±0.02	0.40	0.33±0.00	0.38±0.00	0.38±0.02	0.30
Clypeus	0.68±0.04	0.88±0.03	0.78±0.00	0.67±0.01	0.59±0.02	0.65	0.67±0.03	0.72±0.04	0.70±0.04	0.57
Clypellus	0.37±0.01	0.19±0.01	0.35±0.00	0.34±0.01	0.36±0.01	0.35	0.35±0.01	0.36±0.01	0.34±0.01	0.30
WIDTH										
Wing	0.60±0.03	0.65±0.00	0.57±0.00	0.55±0.03	0.59±0.01	0.60	0.57±0.02	0.64±0.01	0.60±0.03	0.62
Vertex	0.33±0.00	0.33±0.01	0.30±0.00	0.26±0.01	0.31±0.02	0.30	0.33±0.01	0.34±0.01	0.32±0.01	0.25
Pronotum	1.02±0.06	1.06±0.04	0.94±0.03	0.88±0.03	0.96±0.01	0.98	0.83±0.02	1.01±0.01	0.95±0.01	0.80
Head	1.02±0.04	1.02±0.01	0.91±0.03	0.88±0.01	0.96±0.02	0.95	0.92±0.02	1.01±0.03	0.95±0.02	0.80
Clypellus	0.18±0.01	0.19±0.01	0.16±0.01	0.20±0.01	0.18±0.00	0.20	0.21±0.02	0.19±0.01	0.18±0.00	0.18
Lorum	0.14±0.01	0.15±0.00	0.13±0.00	0.12±0.02	0.13±0.00	0.13	0.10±0.00	0.15±0.01	0.13±0.00	0.13
DISTANCE BETWEEN										
E to E	0.47±0.01	0.51±0.01	0.44±0.01	0.43±0.02	0.47±0.02	0.47	0.48±0.03	0.50±0.00	0.47±0.02	0.40
Antennal pits	0.40±0.00	0.45±0.01	0.38±0.00	0.39±0.01	0.39±0.01	0.37	0.42±0.01	0.43±0.01	0.39±0.01	0.37
Ant. E to ant. V	0.12±0.01	0.29±0.03	0.24±0.01	0.13±0.03	0.14±0.01	0.15	0.20±0.03	0.14±0.01	0.13±0.01	0.13

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex.
No. of specimens used for measurement: One male of *Stirellus* sp. 5 and 2 males of *Stirellus* sp. 9.

Table 15. Measurements (in mm) of females of the genus *Stirellus* Osborn and Ball

Measurements	*S. tolla*	*Stirellus 1*	*Stirellus* 2	*Stirellus* 3	*Stirellus* 4	*Stirellus 5*	*Stirellus* 6	*Stirellus*7	*Stirellus* 8	*Stirellus* 9
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean	Mean±SD	Mean
LENGTH										
Total length	4.25±0.02	5.14±0.15	4.43±0.21	2.76±0.09	2.94±0.09	3.92±0.15	3.70±0.28	4.10	3.86±0.17	3.00
Total length *	4.40±0.00	5.42±0.15	4.73±0.21	3.34±0.11	3.54±0.05	4.92±0.31	4.45±0.21	4.30	4.26±0.17	3.20
Wing	3.40±0.00	3.94±0.09	3.43±0.15	2.08±0.04	2.24±0.09	3.08±0.11	2.85±0.21	3.10	3.02±0.15	2.30
Clavus	2.15±0.02	2.56±0.01	2.17±0.06	1.66±0.05	1.62±0.01	2.02±0.08	1.90±0.00	2.00	2.00±0.12	1.70
Vertex	0.43±0.00	0.80±0.03	0.67±0.03	0.41±0.01	0.44±0.03	0.47±0.02	0.51±0.02	0.50	0.46±0.03	0.35
Pronotum	0.43±0.01	0.46±0.01	0.39±0.01	0.33±0.03	0.33±0.01	0.39±0.01	0.40±0.00	0.43	0.36±0.02	0.33
Scutellum	0.43±0.11	0.52±0.05	0.43±0.00	0.31±0.02	0.34±0.01	0.49±0.03	0.36±0.02	0.40	0.42±0.03	0.33
Clypeus	0.75±0.00	1.04±0.05	0.91±0.04	0.71±0.04	0.67±0.04	0.81±0.04	0.73±0.04	0.75	0.71±0.02	0.58
Clypellus	0.40±0.00	0.44±0.03	0.39±0.01	0.39±0.01	0.37±0.02	0.39±0.01	0.36±0.02	0.37	0.37±0.01	0.33
WIDTH										
Wing	0.69±0.02	0.78±0.04	0.61±0.09	0.58±0.01	0.64±0.03	0.70±0.02	0.56±0.02	0.70	0.67±0.03	0.67
Vertex	0.39±0.02	0.41±0.04	0.36±0.03	0.28±0.00	0.32±0.03	0.37±0.01	0.36±0.02	0.35	0.36±0.02	0.30
Pronotum	1.10±0.00	1.22±0.03	1.05±0.03	0.95±0.02	1.00±0.00	1.10±0.04	0.91±0.02	1.03	1.07±0.05	0.90
Head	1.10±0.04	1.14±0.03	1.03±0.04	0.94±0.02	1.00±0.03	1.09±0.04	1.00±0.04	1.03	1.03±0.05	0.90
Clypellus	0.20±0.00	0.22±0.01	0.20±0.00	0.23±0.02	0.18±0.00	0.21±0.01	0.23±0.00	0.20	0.21±0.01	0.17
Lorum	0.15±0.00	0.16±0.01	0.15±0.00	0.13±0.01	0.14±0.01	0.15±0.01	0.10±0.00	0.13	0.14±0.01	0.13
DISTANCE BETWEEN										
E to E	0.51±0.02	0.59±0.01	0.53±0.01	0.46±0.01	0.50±0.02	0.55±0.03	0.49±0.05	0.50	0.52±0.03	0.43
Antennal pits	0.45±0.04	0.50±0.02	0.43±0.01	0.41±0.03	0.42±0.01	0.46±0.01	0.43±0.04	0.43	0.44±0.02	0.40
Ant. E to ant. V	0.13±0.00	0.42±0.03	0.34±0.01	0.14±0.01	0.15±0.02	0.20±0.02	0.26±0.02	0.20	0.16±0.01	0.13

Note:
Ant. E to ant. V: Anterior margin of eye to anterior margin of vertex
No. of specimens used for measurement: One female of *Stirellus* sp. 7 and 2 females of *Stirellus* sp. 9

Table 16. Measurements (in mm) of male and female genitalia of the genus *Stirellus* Osborn and Ball

Measurements	*capitatus*	*indra*	*jacosa*	*laetus*	*notatus*	*ribeiroi*	*rotundus*
LENGTH							
Valve	0.031	0.028	0.026	0.033	0.048	0.034	-
Subgenital plate	0.048	0.033	0.042	0.041	0.055	0.047	-
Pygophore	0.083	0.072	0.055	0.075	0.090	0.088	-
I segment of the anal tube	0.028	0.031	0.025	0.036	0.044	0.039	-
II segment of the anal tube	0.009	0.011	0.008	0.006	0.012	0.010	-
III segment of the anal tube	0.012	0.017	0.015	0.017	0.012	0.017	-
Connective	0.050	0.042	0.040	0.047	0.054	0.047	-
Style	0.048	0.042	0.039	0.019	0.059	0.064	-
Apophysis of style	0.011	0.010	0.011	0.008	0.012	0.018	-
Aedeagal shaft	0.072	0.063	0.066	0.077	0.072	0.083	-
WIDTH							
Valve	0.055	0.050	0.055	0.055	0.068	0.053	-
Subgenital plate	0.025	0.020	0.025	0.023	0.022	0.021	-
Pygophore	0.050	0.036	0.039	0.040	0.045	0.037	-
Connective	0.011	0.008	0.010	0.011	0.010	0.009	-
Style (anterior part)	0.020	0.020	0.021	0.048	0.022	0.021	-
Style (Posterior part)	0.007	0.006	0.007	0.008	0.009	0.015	-
Atrium	0.033	0.022	0.024	0.028	0.017	0.021	-
Distance from base to shaft	0.033	0.024	0.021	0.030	0.022	0.024	-
LENGTH							
Seventh sternum	0.044	0.033	0.043	0.042	0.040	0.044	0.047
1st gonapophysis	0.244	0.2068	0.186	0.209	0.354	0.355	0.252
Dorsal sculpturing 1st gonapophysis	0.178	0.132	0.117	0.156	0.242	0.438	0.185
2nd gonapophysis	0.231	0.1925	0.182	0.216	0.354	0.198	0.257
Dorsal tooth 2nd gonapophysis	0.111	0.0825	0.083	0.102	0.147	0.198	0.121
Gonoplac	0.206	0.1705	0.149	0.190	0.343	0.308	0.209
Anterior half of gonoplac	0.112	0.0869	0.068	0.102	0.223	0.193	0.114
Pygophore	0.157	0.1364	0.131	0.152	0.195	0.209	0.176
WIDTH							
7th sternum	0.109	0.097	0.094	0.103	0.136	0.117	0.109
1st gonaophysis	0.022	0.0209	0.022	0.028	0.028	0.028	0.032
2 nd gonapophysi	0.015	0.0165	0.017	0.020	0.021	0.017	0.021
Gonoplac	0.033	0.0308	0.032	0.032	0.037	0.033	0.025
Pygophore	0.050	0.0583	0.057	0.066	0.055	0.055	0.066

Table 17. Measurements (in mm) of male and female genitalia of the genus *Stirellus* Osborn and Ball

Measurements	*rubrolineatus*	*solitaris*	*speciosum*	*tolla*	*Sp.1*	*Sp.2*	*Sp.3*
LENGTH							
Valve	0.046	0.028	0.032	0.033	0.033	0.042	0.040
Subgenital plate	0.066	0.047	0.050	0.046	0.053	0.046	0.035
Pygophore	0.116	0.095	0.072	0.087	0.099	0.088	0.072
I segment of the anal tube	0.050	0.033	0.039	0.042	0.044	0.033	0.033
II segment of the anal tube	0.013	0.006	0.012	0.006	0.010	0.009	0.011
III segment of the anal tube	0.025	0.017	0.017	0.017	0.029	0.019	0.017
Connective	0.077	0.053	0.050	0.059	0.058	0.055	0.046
Style	0.057	0.050	0.044	0.055	0.061	0.059	0.043
Apophysis of style	0.015	0.009	0.009	0.009	0.012	0.011	0.011
Aedeagal shaft	0.111	0.083	0.061	0.091	0.088	0.086	0.066
WIDTH							
Valve	0.090	0.066	0.048	0.080	0.064	0.066	0.051
Subgenital plate	0.033	0.028	0.020	0.028	0.032	0.026	0.017
pygofer	0.061	0.044	0.035	0.041	0.050	0.033	0.040
Connective	0.017	0.011	0.009	0.011	0.011	0.010	0.010
Style (anterior part)	0.031	0.019	0.021	0.025	0.022	0.018	0.020
Style (Posterior part)	0.011	0.009	0.007	0.009	0.011	0.009	0.008
Atrium	0.035	0.031	0.022	0.033	0.030	0.028	0.023
Distance from base to shaft	0.031	0.033	0.018	0.030	0.033	0.021	0.022
LENGTH							
Seventh sternum	0.051	0.050	0.050	0.042	0.055	0.110	0.097
1st gonapophysis	0.250	0.242	0.259	0.254	0.292	0.223	0.220
Dorsal sculpturing 1st gonapophysis	0.186	0.191	0.187	0.200	0.226	0.174	0.154
2nd gonapophysis	0.186	0.119	0.242	0.236	0.275	0.237	0.209
Dorsal tooth 2nd gonapophysis	0.120	0.022	0.121	0.110	0.143	0.114	0.103
Gonoplac	0.211	0.226	0.146	0.195	0.243	0.218	0.176
Anterior half of gonoplac	0.114	0.121	0.116	0.110	0.133	0.108	0.088
Pygophore	0.176	0.198	0.165	0.163	0.193	0.167	0.143
WIDTH							
7th sternum	0.134	0.113	0.101	0.107	0.127	0.044	0.036
1st gonaophysis	0.031	0.030	0.028	0.028	0.030	0.018	0.024
2 nd gonapophysi	0.022	0.240	0.022	0.022	0.025	0.017	0.020
Gonoplac	0.033	0.033	0.035	0.032	0.039	0.025	0.024
Pygophore	0.072	0.055	0.051	0.056	0.072	0.050	0.045

Table 18. Measurements (in mm) of male and female genitalia of the genus *Stirellus* Osborn and Ball

Measurements	*Sp.4*	*Sp.5*	*Sp.6*	*Sp.7*	*Sp.8*	*Sp.9*
LENGTH						
Valve	0.031	0.024	0.028	0.033	0.030	0.033
Subgenital plate	0.046	0.047	0.044	0.055	0.041	0.053
Pygophore	0.066	0.083	0.069	0.094	0.083	0.099
I segment of the anal tube	0.026	0.033	0.030	0.033	0.033	0.044
II segment of the anal tube	0.007	0.009	0.008	0.009	0.006	0.010
III segment of the anal tube	0.017	0.019	0.011	0.023	0.017	0.029
Connective	0.048	0.051	0.039	0.055	0.051	0.058
Style	0.042	0.052	0.055	0.061	0.053	0.061
Apophysis of style	0.009	0.010	0.015	0.008	0.010	0.012
Aedeagal shaft	0.074	0.087	0.021	0.084	0.080	0.088
WIDTH						
Valve	0.058	0.066	0.055	0.077	0.064	0.064
Subgenital plate	0.021	0.022	0.019	0.033	0.025	0.032
Pygofer	0.029	0.039	0.034	0.043	0.039	0.050
Connective	0.009	0.011	0.009	0.011	0.011	0.011
Style (anterior part)	0.020	0.019	0.020	0.024	0.018	0.022
Style (Posterior part)	0.007	0.008	0.010	0.009	0.008	0.011
Atrium	0.028	0.030	0.054	0.031	0.031	0.030
Distance from base to shaft	0.021	0.028	0.017	0.022	0.030	0.033
LENGTH						
Seventh sternum	0.042	0.044	0.105	0.042	0.042	0.055
1st gonapophysis	0.204	0.256	0.259	0.209	0.220	0.292
Dorsal sculpturing 1st gonapophysis	0.149	0.201	0.176	0.154	0.160	0.226
2nd gonapophysis	0.208	0.240	0.275	0.220	0.215	0.275
Dorsal tooth 2nd gonapophysis	0.092	0.110	0.106	0.099	0.090	0.143
Gonoplac	0.160	0.198	0.227	0.184	0.174	0.243
Anterior half of gonoplac	0.088	0.110	0.150	0.089	0.095	0.133
Pygophore	0.121	0.165	0.143	0.165		0.193
WIDTH						
7th sternum	0.094	0.108	0.044	0.108	0.108	0.127
1st gonaophysis	0.022	0.029	0.023	0.026	0.022	0.030
2 nd gonapophysi	0.017	0.023	0.018	0.019	0.019	0.025
Gonoplac	0.026	0.032	0.033	0.033	0.032	0.039
Pygophore	0.052	0.057	0.040	0.057	0.154	0.072

Style with well developed preapical lobe, apical apophysis long finger-like, curved laterally. Aedeagus with basal bulbous region convex, shaft loosely recurved, apex hooked with lateral flanges.

Female terminalia: Hind margin of the seventh sternite slightly concave.

Measurements: Male 2.5 mm long, head 0.8 mm wide across eyes, 0.8 mm wide across pronotum. Female 3.2 mm long, head 0.9 mm wide across eyes, 0.9 mm wide across pronotum (Table 14 & 15). *Genitalia measurements*: (Table 18).

Material examined: INDIA: Karnataka, Holotype ♂, Bannerghatta, 26.i.1975, C. A. Viraktamath; 5♂, 2♀, Bannerghatta, 26.i.1975, C. A. Viraktamath; 1♂, Bannerghatta, 10.viii.1975, C. A. Viraktamath; 2♂, Mudigere, 7.iv.1975, C. A. Viraktamath; 1♂, Mudigere, 29.v.2005, Shobharani, M; 2♂, Nandi hills, 30.viii.1980, S. Viraktamath; 1♂, Nandi hills, 17.vii.1979, S. Viraktamath; Meghalaya: 5♀, 2♂, Nangpoh, 762 m, 4.xi.1981, C. A. Viraktamath; Maharashtra, 1♀, Matheran, 915 m, C. A. Viraktamath; Kerala, 1♀, 1♂, Walayar, 26.x.1975, C. A. Viraktamath; West Bengal, 2♂, Calcutta, 17.iv.1975, C. A. Viraktamath (UASB).

Remarks: Stirellus sp. 9 resembles *S. laetus*, however it can be recognized by the black spots present beneath the antennal bases which are absent in *S. laetus*.

4.2.4. Host plants

Most of the species of Stenometopiini were collected on the grass *Cynodon dactylon* L. *S. ribeiroi* was found feeding on khus grass (*Vetiveria zizanioides* (Linn.). *S. capitatus, Stirellus* sp. 1 and *S. (C). longivertex* were collected on the grass *Cymbopogon* spp. and *S. (C). illustrata* was collected on *Saccharum officinarum* L.

4.3. Relationship of the subfamily Penthimiinae and tribe Stenometopiini with Deltocephalinae

The results of the cluster analysis (unweighted Pair-group Centroid) using 96 characters of 42 taxa clearly showed two major clusters, with subfamily Deltocephalinae alone forming a single cluster and the subfamily Penthimiinae forming second cluster (Fig. 61). The first cluster is subdivided into two sub-clusters with all the species of Penthimiinae forming a single cluster and only the genus *Tambila* sp. of the subfamily Penthimiinae forming another cluster. In the first subcluster of Penthimiinae the genera which are having spatulate head (*Vulturnus* sp. and *Uzelina* sp.) are forming

the genera which are having spatulate head (*Vulturnus* sp. and *Uzelina* sp.) are forming one cluster and the genera with anterior margin of the head broadly rounded to face (*Haranga* sp. and *Penthimia* sp.) are forming another cluster.

The second cluster which includes tribes of the subfamily Deltocephalinae is again divided into two clusters, the first cluster includes genus *Goniagnathus* sp. of the tribe Goniagnathini and the second cluster includes the remaining tribes of Deltocephalinae. Among the remaining tribes of Deltocephalinae, Hecalini is forming single cluster and remaining all tribes are in the other cluster. Among the remaining tribes of Deltocephalinae, Scaphytopiini and Chiasmini are forming two separate clusters and remaining tribes in the other cluster. Remaining tribes are divided into two clusters with Stenometopiini alone in one cluster and remaining tribes, Fieberiellini, Doraturini, Deltocephalini, Grypotini, Paralimnini, Scaphoideini, Macrostelini, Balcluthiini, Opsiini and Athysanini in one cluster. Among these tribes Balcluthini and Macrostelini are coming under the same cluster and Opsiini and Athysanini in one cluster.

In the tribe Stenometopiini the *S. (Cymbopogonella) longivertex* is standing separate compared to all other species as it has vertex very long about five to six times longer than width between eyes, frons anteriorly forming a strong median ridge and the gena visible dorsally. Whereas in other species these characters are absent. Further *Stirellus* sp. 4 and *S. ribeiroi* forming separate cluster compared to other species of *Stirellus* as they have irregularly rugose crown texture compared to other species. Species *Stirellus* sp. 3, *S. rubrolineata* and *S. tolla* are forming one cluster as they have the anterior margin of vertex subconically rounded or broadly angular vertex. *Stirellus* sp. 6 and *S. notatus* foms one cluster. *Stirellus* sp. 8, *Stirellus* sp. 7, *Stirellus* sp. 5 and *S. rotundus* forming one cluster. Species *Stirellus* sp. 9, *S. solitaries*, *S. laetus*, *S. jacosa* and *S. indra*, which are having vertex slightly longer than inter-ocular distance are forming one cluster. Species with vertex two to three times longer than inter-ocular distance are forming one cluster. In this cluster *S. (Campbellinella) illustrata* is outstanding compared to other species as it has dorsal process on the pygophore whereas other species lacks this process on pygophore.

Fig. 61 Dendrogram showing the relationship of Penthimiinae and Deltocephalinae

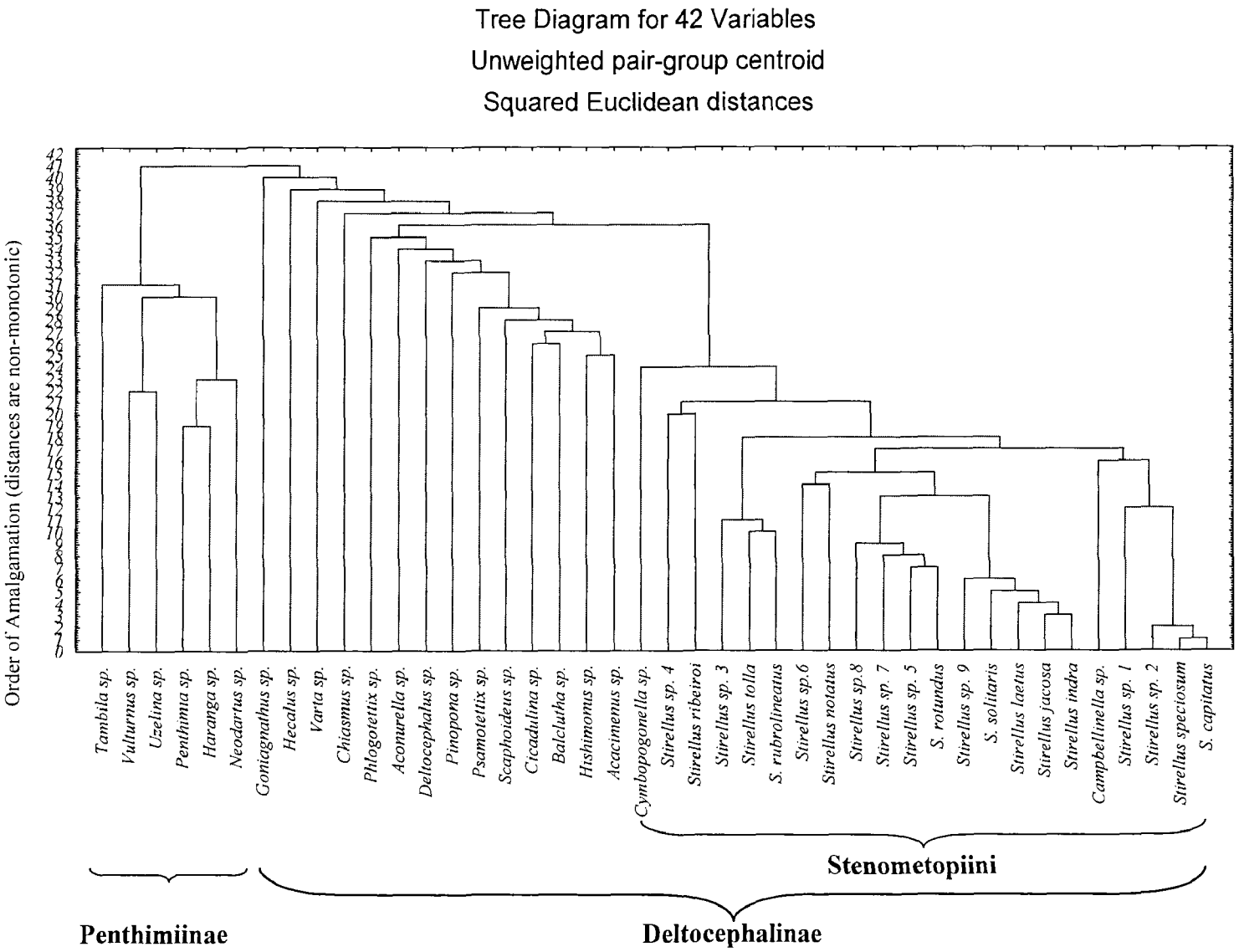


Table 19: Data matrix used for analysis of relationships

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.*Acacimenus variabilis*	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0
2.*Balclutha rubrostriata*	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
3.*Chiasmus uzeli*	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	2	0	0	0	1
4.*Deltocephalus trispinosus*	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	0	1	1	1	0	0	0
5.*Aconurella erebus*	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
6.*Phlogotettix indicus*	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	2	1	0	0	0	0
7.*Goniagnathusfumosus*	1	1	0	0	1	1	1	0	0	0	0	0	0	0	2	1	1	0	0	2	0	0	0	0
8.*Pinopona minuta*	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0
9.*Hecalus porrectus*	1	0	0	0	1	0	1	0	0	0	0	0	1	0	3	1	1	0	0	0	0	3	1	1
10.*Cicadulina bipunctata*	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
11.*Hishimonus phycitis*	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0
12.*Psamotettix* sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1
13.*Scaphoideus morosus*	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	1
14.*Varta rubrofaciata*	0	1	2	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	2	1	0	3	1	1
15.*Haranga orientalis*	1	1	0	1	1	1	0	2	0	1	1	1	1	0	3	2	1	0	0	2	0	1	0	0
16.*Neodartus acocephaloides*	1	1	0	1	1	1	0	3	0	1	1	0	1	0	3	2	1	0	0	2	0	3	0	1
17.*Penthimia compacta*	1	1	0	1	1	1	0	3	0	1	1	1	1	0	3	2	1	0	0	2	0	1	0	0
18.*Tambila gravelyi*	1	1	0	1	1	1	0	3	0	1	1	1	0	0	0	2	1	1	0	2	0	1	0	0
19.*Uzelina thaloriensis*	1	0	0	0	1	1	0	3	0	0	1	1	1	0	3	2	1	1	0	2	0	1	0	0
20.*Vulturnus ornatus*	1	0	0	0	1	1	0	3	0	0	1	1	0	0	1	2	1	1	0	2	0	1	0	0
21.*Stirellus Capitatus*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0
22. *Stirellus indra*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0
23.*Stirellus jacosa*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0
24.*Stirellus laetus*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0
25.*Stirellus notatus*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	1	0
26.*Stirellus ribeiroi*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0
27.*Stirellus rotundus*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	0	0
28.*Stirellus rubrolineata*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0
29.*Stirellus speciosum*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0
30.*Stirellus solitaris*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0
31.*Stirellus tolla*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0
32. *Stirellus* sp.1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	1	0
33. *Stirellus* sp.2	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0
34.*Stirellus* sp.3	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0
35. *Stirellus* sp.4	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	0	0
36. *Stirellus* sp.5	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	0	0
37. *Stirellus* sp.6	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0
38.*Stirellus* sp.7	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	0	0
39.*Stirellus* sp.8	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	0	0
40. *Stirellus* sp.9	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0
41. *S. (C.) illustrata*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	1	0	2	0	1	0	1	0
42. *S. (C.) longivertex*	0	0	0	0	1	1	1	0	1	0	0	0	0	1	1	0	1	0	2	0	1	0	1	0

Table 20: Data matrix used for analysis of relationships

Characters	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1.*Acacimenus variabilis*	0	1	0	0	1	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	1	1	1	1
2.*Balclutha rubrostriata*	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	1	0	0
3.*Chiasmus uzeli*	0	1	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	2	1
4.*Deltocephalus trispinosus*	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0
5.*Aconurella erebus*	2	1	0	1	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0
6.*Phlogotettix indicus*	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	1	1	1	1
7.*Goniagnathusfumosus*	3	1	0	0	1	0	1	1	1	1	2	0	1	1	0	0	1	0	1	0	1	0	1	1
8.*Pinopona minuta*	0	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	1	0	1	0	1	1	1	0
9.*Hecalus porrectus*	0	1	0	0	1	0	1	1	1	0	1	0	1	1	0	0	1	0	1	0	1	0	1	1
10.*Cicadulina bipunctata*	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	1	1	0	0	0	1	1	0	0
11.*Hishimonus phycitis*	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	1	0	1	0
12.*Psamotettix* sp.	0	1	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	2	1
13.*Scaphoideus morosus*	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	0	1	1	0	0	1	1	1	0
14.*Varta rubrofaciata*	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0
15.*Haranga orientalis*	2	1	0	1	0	1	1	1	1	1	2	1	1	1	0	0	1	0	1	1	1	0	1	1
16.*Neodartus acocephaloides*	2	1	0	1	1	1	1	1	1	0	2	1	1	1	0	0	1	0	1	1	1	0	1	1
17.*Penthimia compacta*	2	1	0	1	0	1	1	1	1	0	2	1	1	1	0	0	1	0	1	1	1	0	1	1
18.*Tambila gravelyi*	1	1	0	1	0	1	1	1	0	0	2	1	1	1	0	0	1	0	1	1	1	0	1	1
19.*Uzelina thaloriensis*	2	1	0	1	0	1	1	1	0	0	2	1	1	1	0	0	1	0	1	0	1	0	0	0
20.*Vulturnus ornatus*	2	1	0	1	0	1	1	1	0	0	2	1	1	1	0	0	1	0	0	0	1	0	0	0
21.*Stirellus Capitatus*	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
22. *Stirellus indra*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
23.*Stirellus jacosa*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
24.*Stirellus laetus*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
25.*Stirellus notatus*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
26.*Stirellus ribeiroi*	2	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
27.*Stirellus rotundus*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
28.*Stirellus rubrolineata*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
29.*Stirellus speciosum*	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
30.*Stirellus solitaris*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
31.*Stirellus tolla*	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
32. *Stirellus* sp.1	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
33. *Stirellus* sp.2	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
34.*Stirellus* sp.3	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
35. *Stirellus* sp.4	2	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
36. *Stirellus* sp.5	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
37. *Stirellus* sp.6	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
38.*Stirellus* sp.7	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
39.*Stirellus* sp.8	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
40. *Stirellus* sp.9	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
41. *S. (C.) illustrata*	0	1	1	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0
42. *S. (C.) longivertex*	2	0	2	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0

Table 22: Data matrix used for analysis of relationships

Characters	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1.*Acacimenus variabilis*	0	3	0	1	0	1	0	0	1	1	1	2	1	1	1	0	0	0	0	1	1	0	0	1
2.*Balclutha rubrostriata*	0	3	0	1	0	1	0	0	1	1	1	2	1	1	1	0	0	0	0	1	1	0	0	1
3.*Chiasmus uzeli*	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1
4.*Deltocephalus trispinosus*	0	3	0	1	0	1	0	0	1	1	1	2	1	1	1	0	0	0	0	1	3	0	1	1
5.*Aconurella erebus*	0	3	0	1	0	1	0	1	0	1	1	2	1	1	1	0	0	1	0	1	1	0	0	1
6.*Phlogotettix indicus*	0	3	0	1	0	1	0	0	1	1	1	5	1	1	1	0	0	0	0	1	0	0	0	1
7.*Goniagnathusfumosus*	0	3	2	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	0	1	1
8.*Pinopona minuta*	1	3	0	1	0	1	0	0	0	1	1	2	1	1	1	0	0	0	0	1	1	0	0	1
9.*Hecalus porrectus*	0	3	0	0	0	1	0	0	1	1	1	2	1	1	1	0	0	0	0	1	1	0	0	2
10.*Cicadulina bipunctata*	0	3	0	1	0	1	1	0	1	1	1	2	1	1	1	0	0	0	0	1	1	0	0	1
11.*Hishimonus phycitis*	0	3	0	1	0	1	0	0	1	1	1	2	1	1	1	0	0	0	1	1	1	0	0	1
12.*Psamotettix* sp.	0	3	0	1	0	1	0	0	1	1	1	2	1	1	1	0	0	0	0	1	0	0	0	1
13.*Scaphoideus morosus*	0	3	0	1	0	1	0	0	1	1	1	2	1	1	1	0	1	0	0	1	1	0	0	1
14.*Varta rubrofaciata*	0	3	0	1	0	1	0	1	0	1	1	3	1	1	1	0	0	0	0	1	1	0	0	0
15.*Haranga orientalis*	0	4	0	1	0	1	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1
16.*Neodartus acocephaloides*	0	3	0	1	0	1	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1
17.*Penthimia compacta*	0	3	0	1	0	1	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1
18.*Tambila gravelyi*	0	3	0	1	0	1	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1
19.*Uzelina thaloriensis*	0	3	0	1	0	1	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1
20.*Vulturnus ornatus*	0	3	0	1	0	1	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1
21.*Stirellus Capitatus*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
22. *Stirellus indra*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
23.*Stirellus jacosa*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
24.*Stirellus laetus*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
25.*Stirellus notatus*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
26.*Stirellus ribeiroi*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
27.*Stirellus rotundus*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
28.*Stirellus rubrolineata*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
29.*Stirellus speciosum*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
30.*Stirellus solitaris*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
31.*Stirellus tolla*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
32. *Stirellus* sp.1	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
33. *Stirellus* sp.2	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
34.*Stirellus* sp.3	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
35. *Stirellus* sp.4	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
36. *Stirellus* sp.5	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
37. *Stirellus* sp.6	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
38.*Stirellus* sp.7	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
39.*Stirellus* sp.8	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
40. *Stirellus* sp.9	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
41. *S. (C.) illustrata*	0	1	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1
42. *S. (C.) longivertex*	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1

Checklist of species of Penthimiinae and tribe Stenometopiini of Deltocephalinae from the Indian subcontinent

Subfamily Penthimiinae

Genus *Haranga* Distant

Haranga Distant 1908: 248. Type species: *Haranga orientalis* Distant, by original designation.

Haranga decurtata Distant 1908: 250.

Distribution: India: Karnataka, Tamil Nadu.

Haranga orientalis Walker 1851: 841, Distant 1908: 249.

Distribution: India: Sikkim, West Bengal. Nepal.

Haranga scutellaris Distant 1908: 249.

Distribution: India: Assam, West Bengal. Sri Lanka.

Genus *Malichus* Distant

Malichus Distant 1918: 24. Type species: *Malichus capitatus* Distant, by original designation.

Malichus capitatus Distant 1918: 25.

Distribution: Sri Lanka.

Genus *Neodartus* Melichar

Neodartus Melichar 1903: 266. Type species: *Neodartus acocephaloides* Melichar, by original designation.

Neodartus acocephaloides Melichar 1903: 163.

Distribution: India: Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Orissa, Pondicherry, Punjab, Sikkim, Tamil Nadu, West Bengal. Sri Lanka.

Genus *Penthimia* Germar

Penthimia Germar 1821: 46. Type species: *Cercopis atra* Germar, by monotypy.

Ectopiocephalus Kirkaldy 1906: 463. Type species: *Ectopiocephalus vanduzeei* Kirkaldy, by monotypy.

Penthimia attenuata Distant 1918: 22.

Distribution: India: Karnataka, Kerala, Meghalaya, Sikkim, Tamil Nadu, West Bengal.

Penthimia castanea Walker 1857: 98; Distant 1908: 243.

Distribution: Myanmar.

Penthimia compacta Walker 1851: 842; Distant 1908: 242.

Penthimia subnigra Distant 1908: 243-244. **syn. nov.**

Distribution: India: Assam, Bihar, Gujarat, Himachal Pradesh, Karnataka, Punjab, Maharashtra, Tamil Nadu, West Bengal.

Penthimia curvata **sp. nov.**
Distribution: India: Karnataka.

Penthimia erebus Distant 1908: 245.
Distribution: India: Karnataka, Tamil Nadu. Sri Lanka.

Penthimia fraterna Distant 1918: 21.
Distribution:India: Karnataka,Tamil Nadu.

Penthimia funebris Distant 1918: 19.
Distribution:India: Tamil Nadu.

Penthimia juno Distant 1908: 245.
Distribution: Sri Lanka.

Penthimia maculosa Distant 1908: 244. **Stat. nov.**
Distribution: India: Assam, Maharashtra, West Bengal. Myanmar, Mergui Archipelago.

Penthimia majuscula Distant 1918: 18.
Distribution:India: Karnataka.

Penthimia meghalayensis **sp. nov.**
Distribution: India: Meghalaya.

Penthimia melanocephala de Motschulsky 1863: 95; Distant 1908: 241.
Distribution: India: Karnataka. Sri Lanka. Myanmar.

Penthimia montana Distant 1918: 17.
Penthimia nilgiriensis Distant 1918:16 **syn. nov.**
Distribution:India: India: Tamil Nadu. Myanmar.

Penthimia mudonensis Distant 1912: 444; 1918: 20.
Distribution: Myanmar: Tenasserim.

Penthimia noctua Distant 1918: 22.
Penthimia nitida Distant 1912: 444; 1918:21 **syn. nov.**
Penthimia distanti Baker 1924: 367, *nom. nov. pro. nitida* Distant 1912 not Lethierry 1876 **syn. nov.**
Distribution: India: West Bengal. Myanmar.

Penthimia quadrinotata Distant 1918: 21.
Distribution: India: Tamil Nadu.

Penthimia sahyadrica **sp. nov.**
Distribution: India: Karnataka, Kerala.

Penthimia scapularis Distant 1908: 244;1918: 21.
Distribution: India: West Bengal.

Penthimia scutellata (Distant) **comb. nov.**
Neodartus scutellatus Distant 1908: 246; 1918:25
Distribution: India: Karnataka, Gujarat, Rajasthan, Tamil Nadu. Sri Lanka. Myanmar.

Penthimia spiculata **sp. nov.**
Distribution: India: Karnataka.

Penthimia thoracica Distant 1918: 19.
Distribution: India: Tamil Nadu.

Penthimia tumida **sp. nov.**
Distribution: Kerala, Tamil Nadu.

Genus *Tambila* Distant
Tambila Distant 1908: 247. Type species: *Tambila greeni* Distant, by original designation.

Tambila badia (Distant) **comb. nov.**
Penthimia badia Distant 1918b: 17.
Distribution: India: Karnataka.

Tambila conspersa Distant 1918: 24.
Distribution: Sri Lanka.

Tambila fletcheri Distant 1918:23.
Distribution: Sri Lanka.

Tambila gravelyi Distant 1918: 23-24.
Distribution: India: Maharashtra, Karnataka, Kerala, Tamil Nadu.

Tambila greeni Distant 1908: 247-248; 1918: 23.
Tambila opulenta Distant 1918: 23. **syn. nov.**
Distribution: Sri Lanka.

Tambila variabilis (Distant) **comb. nov.**
Penthimia variabilis Distant 1918: 18.
Distribution: India: Tamil Nadu.

Tambila vittatifrons (Distant) **comb. nov.**
Penthimia vittatifrons Distant 1918: 17.
Distribution: Sri Lanka.

Genus *Uzelina* Melichar
Uzelina Melichar1903: 181. Type species *Uzelina laticeps* Melichar, by original designation.

Uzelina laticeps Melichar 1903: 182; Distant 1908: 267.
Distribution: Sri Lanka.

Uzelina thaloriensis Sharma 1986: 39-42.
Distribution: India: Jammu and Kashmir.

Genus *Vulturnus* Distant
Vulturnus Kirkaldy 1906: 463. Type species *Vulturnus vulturnus* Kirkaldy, by original designation.

Vulturnus flavocapitatus (Distant) **comb. nov.**
Penthimia flavocapitata Distant 1918: 20.
Distribution:Indla: Tamil Nadu.

Vulturnus ornatus Distant
Vulturnus speciosus Distant 1912: 445; 1918: 27. **syn. nov.**
Distribution: Sri Lanka.

Vulturnus spatulatus **sp. nov.**
Distribution: Nepal.

Subfamily Deltocephalinae
Tribe Stenometopiini
Genus *Stirellus* Osborn and Ball
Genus *Stirellus* Osborn and Ball 1902: 250 as a subgenus of *Athysanus* Burmeister 1838: 14. Type species: *Athysanus bicolor* Van Duzee
Allectus Distant 1918: 75. Type species *Allectus notatus* Distant, by original designation.

Anemochrea Kirkaldy 1906: 329. Type species: *Anemochrea mitis* Kirkaldy by original designation.

Anemolua Kirkaldy 1906:329. Type species: *Anemolua hanuala* Kirkaldy by original designation.

Arya Distant 1908: 338. Type species: *Arya rubrolineata* Distant, by original designation.

Bella Pruthi 1930: 44. Type species: *Bella apicalis* Pruthi, by original designation.

Bituitus Distant 1918: 70. Type species: *Bituitus projectus* Distant, by original designation.

Campbellinella Distant 1918: 69. Type species: *Campbellinella illustrata* Distant, by original designation.

Doratulina Melichar 1903: 198-199 Type species: *Doratulina jacosa* Melichar, by original designation

Giletiella (Sic) Osborn 1930: 23: 689. Type species: *Deltocephalus labiata* Gillette, by original designation.

Kinonia Ball 1933: 28: 224. Type species: *Kinonia elongata* Ball, by original designation.

Nandidrug Distant 1918: 74. Type species: *Nandidrug speciosum* Distant, by original designation.

Paivanana Distant 1918: 95. Type species: *Paivanana indra* Distant, by original designation.

Paternus Distant 1918: 71. Type species: *Paternus pusanus* Distant, by original designation.

Penestirellus Beamer and Tuthill 1934: 21. Type species: *Penestirellus catalinus* Beamer and Tuthill, by original designation.

Phrynophyes Kirkaldy 1906: 237. Type species: *Phrynophyes phrynophyes* Evans.

Pseudoconura Linnavuori 1952: 182. Type species: *Pseudaconura luxorensis* Linnavuori .

Sunda Pruthi 1936: 112. Type species: *Sunda ribeiroi* Pruthi, by original designation.

Umesaona Ishihara 1961: 246. Type species *Umesaona asiatica* Ishihara, by original designation.

Viridomarus Distant 1918b: 69. Type species: *Viridomarus capitatus* Distant, by original designation. **syn. nov.**

Volusenus Distant 1918: 72. Type species: *Volusenus lahorensis* Distant, by original designation.

Subgenus *Campbellinella* Distant

Genus *Campbellinella* Distant 1918: 69. Type species: *Campbellinella illustrata* Distant, by original designation.

Stirellus (Campbellinella) illustrata (Distant)

Campbellinella illustrata Distant 1918: 69

Distribution: India: Karnataka, Gujarat, Tamil Nadu.

Subgenus *Cymbopogonella* Viraktamath

Subgenus *Cymbopogonella* Viraktamath 1976: 79. Type species: *Doratulina (Cymbopogonella) longivertex* Viraktamath, type by original designation

Distribution: India: Karnataka.

Stirellus (Cymbopogonella) longivertex (Viraktamath)

Distribution: India: Karnataka.

Subgenus *Stirellus* Osborn and Ball

Stirellus (Stirellus) capitatus (Pruthi) **comb. nov.**
Viridomarus capitatus Distant 1918: 70
Bella apicalis Pruthi, 1930: 45. **syn. nov.**
Distribution: India: Andhra Pradesh, Jammu and Kashmir, Karnataka.

Stirellus (Stirellus) indra (Distant) **comb. nov.**
Typhlocyba indra (Distant) 1908: 415 : Pruthi 1934: 98
Distribution: India: Karnataka, Kerala, Meghalaya, Orissa, West Bengal.

Stirellus (Stirellus) jacosa (Melichar) **comb. nov.**
Doratulina jacosa Melichar 1903: 199
Distribution: India: Karnataka, Kerala, Tamil Nadu. Sri Lanka.

Stirellus (Stirellus) laetus (Melichar) **comb. nov.**
Deltocephalus laetus (Melichar) Comb. nov. (1908): 483 : Rao 1986 : 55-56
Distribution: India: Karnataka, Kerala. Sri Lanka.

Stirellus (Stirellus) notatus (Distant) **comb. nov.**
Allectus notatus Distant 1918: 76
Distribution: India: Tamil Nadu.

Stirellus (Stirellus) ribeiroi (Pruthi) **comb. nov.**
Sunda ribeiroi Pruthi 1936: 112
Distribution: India: Karnataka, Gujarat, Punjab, West Bengal.

Stirellus (Stirellus) rotundus (Pruthi) **comb. nov.**
Arya rotundus Pruthi 1930: 40
Distribution: India: Madhya Pradesh, West Bengal.

Stirellus (Stirellus) rubrolineatus (Distant) **comb. nov.**
Arya rubrolineata Distant 1908: 338
Distribution: India: Andhra Pradesh, Karnataka, Meghalaya, West Bengal.

Stirellus (Stirellus) solitaris (Melichar) **comb. nov.**
Aconura solitaris Melichar 1903: 188
Distribution: Karnataka. Sri Lanka.

Stirellus (Stirellus) speciosum (Distant) **comb. nov.**
Nandidrug speciosum Distant 1918: 74
Distribution: India: Jammu and Kashmir, Karnataka, Kerala, Tamil Nadu.

Stirellus (Stirellus) tolla (Pruthi) **comb. nov.**
Aconura tolla (Pruthi) 1930: 39
Distribution: India: Assam, Karnataka, West Bengal. Pakistan.

Stirellus (Stirellus) sp. 1
Distribution : India: Andhra Pradesh.

Stirellus (Stirellus) sp. 2
Distribution: Karnataka

Stirellus (Stirellus) sp. 3
Distribution: Andhra Pradesh, Karnataka, Kerala, Orissa, Tamil Nadu.

Stirellus (Stirellus) sp. 4
Distribution: Karnataka.

Stirellus (Stirellus) sp. 5
Distribution: Andhra Pradesh.

Stirellus (Stirellus) sp. 6
Distribution: Delhi.

Stirellus (Stirellus) sp. 7
Distribution: Meghalaya.

Stirellus (Stirellus) sp. 8
Distribution: Andhra Pradesh.

Stirellus (Stirellus) sp. 9
Distribution: Karnataka, Kerala, Maharashtra, Meghalaya, West Bengal.

DISCUSSION

V. DISCUSSION

The results of the present revisionary studies on the subfamily Penthimiinae and the tribe Stenometopiini of the subfamily Deltocephalinae encompassing 1672 specimens from the Indian subcontinent revealed the presence of 39 species in seven genera in the subfamily Penthimiinae and 22 species with single genus in the tribe Stenometopiini of Deltocephalinae. The results of these studies are discussed here.

5.1. Subfamilies Penthimiinae and Deltocephalinae

The results of the cluster analysis (Unweighted Pair-group Centroid) using 96 characters of 42 taxa (Fig. 61) indicated that the subfamily Penthimiinae is different from the Deltocephalinae as they formed distinct clusters with 40 per cent dissimilarity refuting the suggestion that Zahniser and Dietrich (2004) Penthimiinae and Deltocephalinae are synonyms. Therefore, the subfamily Penthimiinae is treated as distinct from Deltocephalinae.

5.2. Subfamily Penthimiinae

The first comprehensive study on the Indian Penthimiinae was done by Distant (1908, 1918) wherein he dealt with seven genera and 39 species. Sharma (1986) added one new species to the genus *Uzelina* Melichar. A total of seven genera, *Haranga* Distant, *Malichus* Distant, *Neodartus* Melichar, *Penthimia* Germar, *Tambila* Distant, *Uzelina* Melichar and *Vulturnus* Kirkaldy have been recorded from the Indian subcontinent and all the seven genera have been studied during the present investigation.

5.2.1. Generic affinities

The genus *Haranga* resembles the genus *Penthimia* in having anterior margin of the head convexly rounded to face with entire anterior margin transversely striated. The lateral frontal sutures do not reach ocelli. The genus *Haranga* can be recognized as pointed out by Distant (1908) by its long scutellum sometimes reaching apex of the clavus. In the case of *Penthimia* scutellum is very short. In *Haranga*, the hind femoral spinulation is 2+2+1+1 whereas in *Penthimia* it is 2+2+1.

The genus *Malichus* is related to *Tambila* but differs from it in having foliaceous head which is almost as long as pronotum and scutellum combined (Distant, 1918). The genus is represented at present only by a single female type from Sri Lanka (Distant, 1918).

The genus *Neodartus* Melichar is very distinct compared to other genera of Penthimiinae. It can at once be recognized by the ocelli being located on the anterior rim of the head (Distant, 1908, 1918; Evans 1972; Linnavuori, 1977). Evans (1966) placed four species in *Neodartus* that were earlier placed in the genus *Neovulturnus* Evans but the position of ocelli in these indicate that they may not belong to this genus. Linnavuori (1977) also removed the African species placed in this genus to other genera.

In the genus *Penthimia* head is convexly rounded to face and the anterior margin is transversely striated. Lateral frontal suture does not reach the ocellus. This genus resembles *Haranga* with respect to external appearance (*i.e.*, head characteristics, presence of hair bearing punctures on the head, thorax and tegmina; in the laterally carinate pronotum and in having tegmina with accessory veins associated with R1, and a wide appendix (Evans, 1972).

The genera *Tambila*, *Vulturnus* and *Uzelina* resemble each other in having spatulate head and marginally rimmed vertex with five to six transverse carinae (Distant, 1908, 1918; Evans, 1972; Linnavuori, 1977). In the genera *Tambila* and *Vulturnus* lateral frontal sutures reach ocelli whereas in the genus *Uzelina* they do not reach ocelli. The genus *Tambila* includes large robust species compared to *Vulturnus* as rightly stated by Distant (1918).

The genus *Uzelina* resembles *Vulturnus* externally, but can be differentiated by the lateral frontal sutures which reach ocelli and the entire body with brownish reticulations in *Vulturnus* compared to *Uzelina* wherein the lateral frontal sutures do not reach the ocellus and the body surface is without such reticulations (Evans, 1972). In addition, it has also been found during the present study that the fronto-clypeus is flat in the *Vulturnus* and *Uzelina* whereas it is arcuate in *Tambila*.

5.2.2. Relationship among the species in the genus *Haranga* Distant

The genus *Haranga* is represented by three species namely *H. decurtata*, *H. orientalis* and *H. scutellaris*. All the three species occur in the subcontinent (Distant, 1908, 1918). *H. decurtata* is known only by the female and can be readily differentiated

from *H. orientalis* based on the female seventh sternum. *H. decurtata* has hind margin of female seventh sternite with median shallow U-shaped notch with pointed lateral angles whereas in *H. orientalis* the hind margin of seventh sternite has a median excavation and the lateral margins of the excavation have triangular projection. *H. orientalis* and *H. scutellaris* can be distinguished based on the shape of the aedeagus. Aedeagal shaft in *H. orientalis* has serrated lateral margins, with two to three rows of spicules on ventral margin at posterior half, whereas in the case of *H. scutellaris* the aedeagal shaft is broad at base and abruptly narrowed towards apex with serrated lateral margins. *H. decurtata* is recorded for the first time from Karnataka.

5.2.3. Relationship among the species in the genus *Neodartus* Melichar

Distant (1908, 1918) reported three species from the Indian subcontinent, *N. acocephaloides*, *N. scutellatus*, *N. rufopunctatus*. In the present study, *N. scutellatus* and *N. rufopunctatus* have been transferred to the genus *Penthimia*, thus at present *N. acocephaloides* is the only species under this genus in the entire Oriental region. This species can easily be recognized by the presence of the ocelli on the marginal rim of the vertex.

5.2.4. Relationship of the species under the genus *Penthimia* Germar

Penthimia is the largest genus in the subfamily Penthimiinae with 22 described species from the Indian subcontinent. All the species have been studied here. The present study added five new species, *Penthimia spiculata* sp. nov., *Penthimia sahyadrica* sp.nov., *Penthimia tumida* sp. nov., *Penthimia meghalayensis* sp. nov. and *Penthimia curvata* sp. nov., along with one new combination and three new synonyms.

P. attenuata externally resembles *P. melanocephala* in having black head, reddish brown thorax and wings. It is likely that *P. attenuata* and *P. melanocephala* may be conspecific because of similar but distinctive colouration (Distant, 1908, 1918, Motschulsky, 1863). However it needs to be confirmed by the study of the type of *P. melanocephala.*

P. castanea can be differentiated from other species based on its uniformly polished reddish brown colour, with face black, extending to outer margin of vertex between and in front of ocelli (Distant, 1908).

P. compacta and *P. subnigra* considered distinct species by Distant (1908) have been treated as synonyms in the present study. The holotypes of *P. subnigra* and *P.*

compacta have similar colouration. Hence they have been synonymised here. *P. compacta* Walker is considered as the valid name because of priority.

Examination of types of *P. distanti* and *P. noctua* revealed that they are male and female of the same species and hence are treated as synonyms with the name *P. noctua* Distant as the valid name because of priority. *P. meghalayensis* and *P. curvata* resemble *P. noctua* with respect to genitalia and morphological characters, but they differ slightly with respect to the structure of the aedeagal shaft. In the case of *P. meghalayensis* aedeagal shaft is broad up to three fourth and abruptly tapers with hooked apex. In *P. curvata*, the aedeagal shaft gradually narrows apically and slightly bent dorsally forming a hook. In the case of *P. noctua* aedeagal shaft gradually tapers towards apex forming a pointed hook and the preatrium is very well developed which is reduced in *P. meghalayensis* and *P. curvata*.

P. erebus and *P. attenuata* resemble each other in the structure of male genitalia and colouration (dark coloured male of *P. attenuata*, female *P. erebus* not known). However, they differ in the detailed structure of aedeagal shaft. The median keel on the dorsal surface of the aedeagal shaft found in *P. erebus* is absent in *P. attenuata*. The lateral apical flanges at the apex of the aedeagal shaft present in *P. attenuata* are poorly developed in *P. erebus*.

P. fraterna resembles *P. montana* with respect to the shape of the aedeagal shaft. In *P. montana* the aedeagal shaft gradually tapers towards apex, whereas in *P. fraterna* it is slightly constricted near the base. *P. fraterna* differs from other species of *Penthimia* in having a peculiar S-shaped style.

P. funebris resembles *P. scutellata* with respect to colouration of head and pronotum and can be differentiated with respect to the scutellum. The scutellum of *P. scutellata* is pale, smooth, shining yellowish with four black spots at basal margin, two central spots black (Distant, 1908), whereas in the case of *P. funebris* anterior half of each lateral margin of scutellum is pale brownish (Distant, 1918).*P. juno* resembles *P. scutellata* Distant but has punctuations on vertex which are visible centrally. The scutellum has depression in anterior half where it is punctate and has a faint short carina.

Distant (1918) synonymised *P. maculosa* with *P. scapularis*. The type series of *P. maculosa* is a mixture of species and contains specimens collected from Mussorie, Myitta and Calcutta. Examination of type series of *P. maculosa* revealed that specimens from Myitta belonged to one species but those from Mussoorie and Calcutta to *P.*

scapularis with the designation of specimens from Myitta as lectotype the species can now be clearly identified. Remaining specimens from Mussoorie and Calcutta have been removed from the type series.

P. melanocephala resembles the female of *P. attenuata*. *P. melanocepahala* has entire head jet black and rest of the body reddish brown and inner claval margin black (Distant, 1908). Some specimens of *P. atra* Fabricius are similar to this species.

Examination of type series of *P. montana* and *P. nilgiriensis* revealed that these are male and female of the same species. The former being male and the latter female and hence the synonymy. The name *P. montana* is treated as the valid name of the species. The aedeagal shaft of *P. montana* resembles that of *P. fraterna*. In *P. montana,* the aedeagal shaft gradually tapers towards apex, whereas in *P. fraterna* it is slightly constricted near the base.

P. mudonensis is distinct from other species of *Penthimia* in having following characters. Body above reddish brown, vertex of head with the anterior and basal margins, a central longitudinal line, and the eyes black. Forewing has large tassellate apical area, which is not found in other species (Distant, 1918). The type specimen is present in IARI, New Delhi.

P. quadrinotata is mainly characterized based on obscure central longitudinal yellowish-brownish fascia on pronotum (Distant, 1918). The aedeagal shaft is very distinct with well developed median ridge on ventral margin and the apical apophysis of the style finger-like curved laterally with truncated apex, which is not the case in other species of *Penthimia*.

P. scutellata was treated under the genus *Neodartus* by Distant (1908) but the structure of head and position of ocelli indicate that it belongs to the genus *Penthimia*. This species is sexually dimorphic. The scutellum of male is black whereas that of female is bright yellow. *P. scutellata* resembles *P. erebus* externally but differs in absence of a median dorsal ridge to aedeagal shaft present in *P. erebus*.

P. thoracica resembles *P. majuscula* in having greenish head and pronotum (Distant, 1918). But can be distinguished based on the markings on the body. *P. thoracica* has red transverse bow between head. Pronotum and scutellum is marked with bright red. Wings red with brownish hue and granulated yellow spots (Distant, 1918). Whereas *P. majuscula* has posterior and lateral margins of vertex and pronotum margined withdark brown, wings chocolate brown and scutellum with three marginal black spots (Distant, 1918).

P. spiculata (Karnataka: Nagarahole), *P. sahyadrica* (Karnataka: Dharmasthala) and *P. curvata* (Karnataka: Bandipur) are reported from Karnataka, *P. tumida* (Meghalaya: Nangpoh) and *P. meghalayensis* (Meghalaya: Nangpoh) are reported from Meghalaya.

P. spiculata resembles *P. tumida,* as both of them have similar aedeagal shaft in lateral view with well developed dorsal apodeme and shaft curved caudo-dorsally. But can be differentiated based on the external appearance and detailed male genitalia characters. *P. spiculata* has spicules on lateral margins of aedeagal shaft whereas in *P. tumida* they are absent. *P. tumida* has both clypeus and clypellus tumid which is not the case in *P. spiculata.*

P. sahyadrica resembles *P. majuscula* with respect to male genitalia; however the aedeagus in the *P. sahyadrica* has large, well developed dorsal apodeme compared to that in *P. majuscula* and differently shaped style and subgenital plates. *P. majuscula* is greenish yellow in color (Distant, 1918) whereas *P. sahyadrica* is black in color.

P. meghalayensis and *P. curvata* resemble *P. noctua* externally (Distant, 1912) with respect to body color. All three of them can be differentiated based on the detailed male genitalia structure. The aedeagus of *P. meghalayensis* has more prominent lateral flanges compared to that in *P. noctua* and apical hook of shaft is slender in *P. noctua* compared to that in *P. meghalayensis. P. curvata* has more slender distally tapered apical apophysis of the style compared to that in *P. noctua* and lacks the preatrial processes which are well developed in *P. noctua.*

5.2.5. Relationship among the species in the genus *Tambila* Distant

Distant (1908 and 1918) dealt with the five species *Tambila* from the Indian subcontinent namely, *T. conspersa*, *T. fletcheri*, *T. gravelyi, T. greeni* and *T. opulenta.* In the present study seven species, including one synonymy and three new combinations, are included under the genus.

T. badia (Distant), comb. nov. was earlier placed by Distant (1918) in the genus *Penthimia,* but this species has spatulate head and lateral frontal sutures almost reaching ocelli, which is not the case in *Penthimia* and therefore it has been transferred to the genus *Tambila.*

Distant (1918) described *T. conspersa* as "scutellum with a small spot near each basal angle and the apex pale yellowish" however, the examination of the type revealed that it is much more brownish than other species of *Tambila* and scutellum is not pale.

T. fletcheri can be recognized by the greenish head and thorax and both *T. conspersa* and *T. fletcheri* are represented only by the female sex from Sri Lanka.

The examination of the types of *T. greeni* and *T. opulenta* revealed that they are the male and female of the same species. They have similar colouration. They are therefore synonymised here and the name *T. greeni* Distant (1908) is considered the valid name. *T. gravelyi* and *T. greeni* have similar male genitalia. However, *T. gravelyi* has more prominent basal plate to aedeagal shaft compared to that in *T. greeni*. *T. gravelyi* was found feeding on *Artocarpus heterophyllus* Lam. and *Dodonea viscosa* (L.). *T. gravelyi* is recorded for the first time from Karnataka.

T. variabilis (Distant) comb. nov. was earlier treated by Distant (1918) as one of the species of the genus *Penthimia*. It has spatulate head and lateral frontal suture on the face almost reach the ocelli suggesting that it is a species of the genus *Tambila* rather than *Penthimia*. The type species of *P. variabilis* is not found in BMNH. However, two males found in TNAU collection are from the type locality and agree with the description. The colour markings are distinctive of the species. *T. variabilis* can be differentiated from *T. greeni* and *T. gravelyi* by the absence of the basal lobe-like plate of aedeagal shaft which is present in both *T. gravelyi* and *T. greeni*.

T. vittatifrons Distant (1918) comb.nov. also has a spatulate head and the face with frontal sutures reaching ocelli and hence has been transferred here to the genus *Tambila* from *Penthimia* where it was placed by Distant (1918).

5.2.6. Relationship among the species in the genus *Uzelina* Melichar

The genus *Uzelina* is represented by two species namely, *U. laticeps* Melichar and *U. thaloriensis* Sharma. *U. laticeps* was not studied however, Linnavuori (1977) illustrated the male genitalia and Distant (1908) gave English version of Melichar's (1903) German description. *U. thaloriensis* externally resembles *U. laticeps* but differs in the structure of aedeagal shaft. The aedeagal shaft in *U. thaloriensis* gradually widens apically (Sharma, 1986) whereas in *U. laticeps* it abruptly widens near apical region (Linnavuori, 1977).

5.2.7. Relationship among the species in the genus *Vulturnus* Kirkaldy

The genus *Vulturnus* is represented by two species namely *V. ornatus* Distant and *V. speciosus* (Distant, 1918). These two species occur in Sri Lanka. The present study proposes one new combination and one new species. The type locality of the new

species is Nepal. Examination of type specimens of *V. ornatus* and *V. speciosus* revealed that they are male and female of the same species and hence they are considered synonyms. *V. ornatus* resembles *V. spatulatus* but differs in having much narrower aedeagal shaft and strongly serrated lateral margins without prominent triangular lobes at apex. *V. spatulatus* externally resembles *V. ornatus* but the pronotum is uniformly maculate and the aedeagus is spatulate with prominent lateral triangular lobes. *V. flavocapitata* was earlier treated by Distant (1918) under the genus *Penthimia* however the head being spatulate, lateral frontal sutures reaching ocelli and smaller size, flat frontoclypeus places this species in the genus *Vulturnus*. This species can be readily recognized by the unmaculated head.

5.2.8. Host plant relationship

Availability of host plant records of Penthimiinae is very megre. With the available host plant record and also host plants recorded during the present study the following conclusions have been drawn. Some of the species of Penthimiines are polyphagous, *e. g. N. acocephaloides, P. compacta* and *T. gravelyi. N. acocephaloides* was found feeding on *Artocarpus heterophyllus* Lam., *Anacardium occidentale* L., *Clerodendron inerme* (L.), *Santalum album* L., *Mimosa pudica* L., *Ocimum sanctum* L., *Phaseolus vulgaris* L., *Cajanus cajan* L., *Mangifera indica* L., *Dodonea viscosa* (L.) and *Duranta goldiana*. Viraktamath and Viraktamath (1995) recorded *N. acocephaloides* on *Clerodendron inerme*. Pruthi (1934) recorded the same on sandal and *Dodonea viscosa. P. compacta* was found feeding on *Santalum album* L., *Cajanus cajan* L., *Ocimum sanctum* L. and *Phaseolus vulgaris* L. Pruthi (1934) recorded this species on sandal. *T. gravelyi* was found feeding on *Artocarpus heterophyllus* Lam., and *Dodonea viscosa* (L.). Whereas some of the species like *P. scutellata* were very host specific and was feeding only on *Santalum album* L. Pruthi (1934) also recorded *P. scutellata* only on *S. album*. Looking into these records most of the species of Penthimiines appear to be polyphagus, whereas a few like *P. scutellata* are monophagus. In general these leafhoppers become polyphagous in adult stage. Therefore, in order to understand host plant relationship in depth one needs to carefully study the oviposition hosts and nymphal developmental hosts. But this information is not available for most of leafhoppers in general and Penthimiinae in particular. With the available, though very scanty adult host records, it is observed that Penthimines use a variety of plants across plant families for their survival.

5.3. Subfamily Deltocephalinae

Ninety six characters of the 42 taxa of the representative tribes of the subfamily Deltocephalinae and Penthimiinae were studied. The tribe Stenometopiini clustered along with Fieberiellini, Doraturini, Deltocephalini, Grypotini, Paralimnini, Scaphoideini, Macrostelini, Balcluthini, Opsiini and Athysanini. This cluster was distinct from the cluster containing the tribes Goniagnathini, Hecalini, Scaphytopiini, and Chiasmini. This clearly indicates that tribe Stenometopiini is one of the tribes of Deltocephalinae and Subfamily Penthimiinae is treated as separate subfamily from Deltocephalinae.

5.3.1. Tribe: Stenometopiini

Stenometopiini are exclusively grass feeders distributed world wide. Species of Stenometopiini show a great degree of morphological variation, especially in the shape of the head and form of the body. However, the characters of the male and female genitalia are surprisingly uniform. Till date there is no comprehensive work regarding this tribe on a world wide basis.

A total of twenty nine species reported from the Indian subcontinent. Of the twenty nine, thirteen species were included under this study along with nine unnamed species.

5.3.2. Generic affinities

Emeljanov (1962) synonymised *Anemochrea* Kirkaldy, *Anemolua* Kirkaldy, *Arya* Distant, *Bella* Pruthi, *Bituitus* Distant, *Campbellinella* Distant, *Gilettiella* (Sic) Osborn, *Kinonia* Ball, *Nandidrug* Distant, *Paivanana* Distant, *Paternus* Distant, *Penestirellus* Beamer and Tuthill, *Phrynophyes* Kirkaldy, *Pseudaconura* Linnavuori, *Sunda* Pruthi, *Trebellius* Distant. *Umesaona* Ishihara and *Volusenus* Distant, plus *Aconura* of author (not Lethierry) with *Stirellus* Osborn and Ball and gave *Stirellus* as the valid name for the genus based on priority.

Vilbaste (1965) considered *Anemochrea* Kirkaldy, *Arya* Distant, *Bella* Pruthi, *Bituitus* Distant, *Campbellinella* Distant, *Nandidrug* Distant, *Paivanana* Distant, *Paternus* Distant, *Phrynophyes* Kirkaldy, *Sunda* Pruthi, *Trebellius* Distant, *Umesaona* Ishihara and *Volusenus* Distant, plus *Aconura* of author (not Lethierry) as junior synonyms of *Doratulina* Melichar.

In the present study the genera *Stirellus* Osborn and Ball (1902) and *Doratulina* Melichar (1903) are considered as synonyms and *Stirellus* Osborn and Ball as the valid name, as the male genitalia of the species reported under this genus are similar to those species reported under the genus *Doratulina*. Mahmood *et al.* (1972) also stated that the male genitalia of the species of *Stirellus* and the genus *Doratulina* are very similar with minor differences. The genus *Viridomarus* Distant (type species: *V. capitatus* Distant) is here treated as a juniour synonym of *Stirellus* as both share very similar male genitalia. Whereas Distant (1918) treated it as a distinct genus.

The cluster analysis (Unweighted Pair-group Centroid) using 96 characters of 22 taxa (Fig. 61) of the tribe Stenometopiini resulted in a dendrogram having *S. (Cymbopogonella) longivertex* clustering separately from all other species of *Stirellus*. This justifies its inclusion in a subgenus distinct from *Stirellus (Stirellus)*. This subgenus is characterized by extremely long vertex and dorsally visible gena. Viraktamath (1976) treated the subgenus *Cymbopogonella* Viraktamath (1976) under the genus *Doratulina* Melichar.

Vilbaste (1965) treated *Campbellinella* Distant (1918) as a junior synonym of *Doratulina* Melichar. However, in the present study, *Campbellinella illustrata*, the type species of the genus, clustered within the species of *Stirellus*. However, it formed a distinct cluster along with *Stirellus* sp. 1, *Stirellus* sp. 2, *S. speciosum* and *S. capitatus*. This cluster is characterized by the vertex being longer than the inter-ocular distance. However, *Campbellinella illustrata* is unique among the species of *Stirellus* as defined in this study in that it possesses dorsal process on the male pygophore which the other species lack. Therefore, it is justified to treat the genus *Campbellinella* as a subgenus of *Stirellus*.

Distant (1918) included two species in his genus *Galerius* Distant, namely *G. indicatrix* Distant (type species) and *G. aberrans* Distant. Vilbaste (1965) without studying the male genitalia of these species considered *Galerius* as a junior synonym of *Stirellus*. However, examination of male genitalia of *Galerius* indicated that this synonymy is unjustified as *G. indicatrix* possesses male genitalia that is very different from *Doratulina* Melichar. Therefore, this genus is reinstated as a valid genus. However, *G. aberrans* has male genitalia very similar to those of *Stirellus* and hence it has been transferred here to the genus *Stirellus*.

5.3.3. Relationship among the species in the subgenus *Stirellus* Osborn and Ball

The subgenus is represented by twenty seven species recorded from the Indian subcontinent. Out of these eleven species were included in this study. The present study added nine more species, which may be new, since stenometopiines are widely distributed throughout the world and no comprehensive revisionary work regarding this group is available, these nine species are not regarded as new species and not given specific names pending a worldwide revision of the genus which is very much required.

S. apicalis (Pruthi, 1930) is synonymised with *Viridomarus capitatus* (Distant, 1918) based on the aedeagal characters and bell-shaped body. But Distant (1918) treated *V. capitatus* under the genus *Viridomarus* Distant and Pruthi (1930) treated *S. apicalis* under the genus *Bella*. Later Vilbaste (1976) synonymised the genus *Bella* with *Doratulina* Melichar. But in the present study both *S. apicalis* and *V. capitatus* are treated as synonyms and the name *S. capitatus* as the valid name for the species.

S. jacosa Melichar and *S. indra* (Distant) resemble each other with respect to shape and markings on the head, but former is brachypterous (Melichar, 1903) and the latter is macropterous (Distant, 1908). These two species can be differentiated based on shape of aedeagal shaft. Aedeagal shaft in *S. jacosa* is sinuate whereas in *S. indra* it is straight. Earlier *S. jacosa* and *S. indra* were under the genus *Doratulina* and *Paivanana* respectively. Later, Vilbaste (1965) synonymised these two genera with *Doratulina*. In the present study these two species are treated as species under the genus *Stirellus*. *S. indra* was earlier reported from West Bengal whereas in the present study it has been reported from Karnataka, Meghalaya, Mizoram, Maharashtra, and Tamil Nadu. Melichar (1903) reported *S. jacosa* from Sri Lanka only. In the present study this species has been reported from Kerala, Karnataka and Tamil Nadu.

S. laetus (Melichar) was earlier under the genus *Deltocephalus*. Rao (1986) transferred this species from *Deltocephalus* to *Doratulina* based on the characters of the male genitalia and external features. *S. laetus* can be differentiated from other species of *Stirellus* based on its triangularly produced vertex with median transverse orange fascia between eyes (Rao, 1986). *S. laetus* resembles *Stirellus* sp. 9 with respect to the male genitalia and external features, but lacks two black spots between eyes and beneath antennal bases that are present in *Stirellus* sp. 9. *S. laetus* was earlier reported from Silent Valley and Sri Lanka. It is a new report from Karnataka.

S. notatus (Distant) was earlier treated under the genus *Allectus* Distant. Later Vilbaste (1976) synonymised *Allectus* with *Doratulina*. Viraktamath & Viraktamath

(1980) redescribed the species including male genitalia. At present this is treated as one of the species under the genus *Stirellus*. *S. notatus* can be differentiated from other species by the two prominent black spots (connected beneath on upper margin of face) on head and the anterior caudal margin of the pygophore has black coloured borders.

S. ribeiroi (Pruthi) was under the genus *Sunda* (Pruthi). This species is characterized based on the shape of the vertex, markings on the frontoclypeus (Pruthi, 1936). This species can be readily distinguished from the other species of *Stirellus* based on the shape of the subgenital plate which is having insinuated outer margin and shape of the style. This species has been reported for the first time from Karnataka.

S. rotundus (Pruthi) and *S. rubrolineatus* (Distant) resemble each other externally. Earlier these two species were under the genus *Arya* Distant. When Vilbaste (1976) synonymised *Arya* with *Doratulina* they were considered under the genus *Doratulina*. *S. rotundus* has broadly rounded vertex without any markings (Pruthi, 1930). *S. rubrolineatus* has vertex subconically produced with orange fascia that is medially interrupted and two oblique spots near the base on either side of median line (Distant, 1908).

S. speciosum (Distant) has very distinctive colouration. Vertex triangularly produced with two longitudinal fasciae. Pronotum with three and scutellum with one central longitudinal orange fasciae (Distant, 1918). This species resembles *S. thattaensis* from Pakistan with respect to shape of the head and aedeagal shaft. Aedeagal shaft is shorter in both the above mentioned species compared to other species of *Stirellus* from India. This species was earlier reported from Karnataka and Jammu and Kashmir. In this study it has been recorded from Kerala, Delhi and Tamil Nadu.

S. solitaris (Melichar) resemble *S. tolla* (Pruthi) but differs in having more acutely pointed head (Melichar, 1903), whereas *S. tolla* has broadly rounded head (Pruthi, 1930). *S. tolla* is a new report from India.

Stirellus sp. 1 resembles *S. viridulus* (Pruthi) comb. nov. in colouration (Pruthi, 1930), but head is narrower than pronotum. *Stirellus* sp. 1 resembles *S. pusanus* (Distant) comb. nov. in having head narrower than pronotum but differs from *S. pusanus* in lacking the dark spots at the base of the scutellum. *S. solitaris* was reported for the first time from India and also from Karnataka.

Stirellus sp.2 resembles *Stirellus* sp. 1. In both the species vertex is twice as long as inter-ocular distance and acutely produced, but can be differentiated based on

the shape of pygophore. The pygophore of *Stirellus* sp.2 has the dorsal margin almost straight whereas in the case of *Stirellus* sp. 1 it is declivous.

Stirellus sp. 3 resembles *S. solitaris* (Melichar) externally, but varies with respect to length and detailed male genitalia characters. *Stirellus* sp. 3 is a small species (2.56-3.34 mm) whereas *S. solitaris* is large and measures about 3.56-4.34 mm. The aedeagal shaft of *S. solitaris* is straight and *Stirellus* sp. 3 is sinuate. They also differ with respect to shape of pygophore.

Stirellus sp.4 can be readily distinguished from other species of *Stirellus* by the rugose disc of vertex. This is not the case in other species of *Stirellus.*

Stirellus sp. 5 resembles *Stirellus* sp.8 externally and both of them can be differentiated based on the shape of the apical apophysis of the style. In *Stirellus* sp. 5 apical apophysis is straight, thumb like, whereas in *Stirellus* sp. 8 it is slender and curved laterally.

Stirellus sp. 6 has head broader than pronotum. It also lacks the tubercle on the pygophore and has short and stout aedeagal shaft. In the latter character it has resemblance to *S. thattaensis* (Mahmood *et al,* 1972) but differs from it in having more acutely angled apex of head.

Stirellus sp.7 has style which is very broad anteriorly, slender posteriorly with well developed subapical lobe compared to other species of *Stirellus*.

Stirellus sp. 1, *Stirellus* sp. 5 and *Stirellus* sp. 8 were collected from Andhra Pradesh on grass *Cymbopogon* sp. *Stirellus* sp. 2 and *Stirellus* sp. 4 was reported from Karnataka. *Stirellus* sp. 3 was reported from Karnataka, Andhra Pradesh, Kerala, Orissa, and Tamil Nadu. *Stirellus* sp. 6 was reported from Delhi. *Stirellus* sp. 7 reported from Meghalaya and *Stirellus* sp. 9 reported from Karnataka, Meghalaya and West Bengal.

In the cluster analysis *S. (Cymbopogonella) longivertex* is standing separate compared to all other species as it has vertex very long about five to six times longer than width between eyes, frons anteriorly forming a strong median ridge and the gena visible dorsally. Whereas in other species these characters are absent. Further *Stirellus* sp. 4 and *S. ribeiroi* forming separate cluster compared to other species of *Stirellus* as they have irregularly rugose crown texture compared to other species. Species *Stirellus* sp. 3, *S. rubrolineata* and *S. tolla* are forming one cluster as they have the anterior margin of vertex subconically rounded or broadly angular vertex. *Stirellus* sp. 6 and *S. notatus* foms one cluster. *Stirellus* sp. 8, *Stirellus* sp. 7, *Stirellus* sp. 5 and *S. rotundus*

forming one cluster. Species *Stirellus* sp. 9, *S. solitaries*, *S. laetus*, *S. jacosa* and *S. indra*, which are having vertex slightly longer than inter-ocular distance are forming one cluster. Species with vertex two to three times longer than inter-ocular distance are forming one cluster. In this cluster *S. (Campbellinella) illustrata* is outstanding compared to other species as it has dorsal process on the pygophore whereas other species lacks this process on pygophore.

5.3.4. Host plant relationship

Stenometopiini as in most other tribes of Deltocephalinae inhabit grasses, shrubs and trees in wide range of ecological situations (Nielson and Knight, 2000). There could be further specialization to exploit a particular grass species as in the case of *Stirellus ribeiroi,* which was observed, during the present study, exclusively breeding on khus grass (*Vetiveria zizanioides* (Linn.), and *Stirellus* (*Cymbopogonella) longivertex* breeding on *Cymbopogon caesium* (Viraktamath, 1976). However such detailed records of breeding hosts for most Stenometopiini are lacking, though a few records on which adults were collected such as *S. capitatus* and *Stirellus* sp.1 on *Cynodon dactylon* L. and *Cymbopogon* spp., *Stirellus (Campbellinella) illustrata* on sugarcane (*Saccharum officinarum* L.) during the present study.

5.4. Zoogeographic distribution

Entire world is divided in to six zoogeographical regions, Australian, Afrotropical, Nearctic, Neotropical, Oriental, and Palaearctic regions. The subfamily Penthimiinae is represented in all the six zoogeographical regions. Among all the regions, Oriental, Afrotropical and Australian regions have very rich fauna of Penthimiinae. Among 49 genera of Penthimiinae reported from the world (Oman *et al.*, 1990), 22 are from Oriental region, 14 from Afrotropical region and eight from Australian region. Whereas Neotropical region has only one genus. Two genera share the regions like Oriental and Afrotropical and one genus from Oriental and Afrotropical region. Among all the genera, genus *Penthimia* is very widely distributed in all the regions of the world and cosmopolitan in nature.

From Afrotropical region fifteen genera and sixty one species of Penthimiinae were reported (Linnavuori, 1977, Mac Gillivroy, 1986). Among the 22 genera reported from the Oriental region, seven genera and 39 species were reported from Indian subcontinent (Distant, 1908, 1918, Metcalf, 1962). Whereas Evans (1972) described 36

species from Australian region. Among the seven genera reported from Indian subcontinent, *Malichus* and *Uzelina* are endemic to Sri Lanka.

The genus *Chanohirata* Hayashi and Machida from Japan is very similar to the Oriental Penthimiinae, *Vulturnus* Kirkaldy with respect to external appearance and male genitalia characters.

The Australian genus *Sidelloides* Evans resembles Oriental genus *Uzelina* externally with respect to head characters.

Penthimiines are rich in the Oriental region where the majority (22) of the endemic genera occurs. This group has limited distribution in the Southeast Asia and Pacific regions (Knight, 1983). Of the three genera that were elucidated in the Neotropical region by Linnavuori (1959), only *Eovulturnops* Evans, 1947 is considered endemic. One was provisionally placed in the tribe and other is believed to have been introduced from Africa (Nielson and Knight, 2000).

Of the three genera that occupy more than one zoogeographical region, the genus *Penthimia* is widespread except for Neotropical and Australian regions. Members of this genus in the Nearctic region are believed to be derived from Palaeartic stock (Nielson and Knight, 2000).

According to Nielson and Knight (2000) these Penthimiines may be of early cretaceous origin with the centre of origin in the Oriental region. *Penthimia* is of recent origin in the Oriental region from which it dispersed to the Palaearctic region and to the Nearctic region by dispersal or adventitiously (Linnavuoru 1977).

In all the principal geographical regions, the centre of origin of Penthimiinae is undoubtedly in the Oriental region that including Melanesia, is very rich in forms (Evans 1972, Metcalf 1962). A radiation into Africa has taken place several times. The endemic genera present in the Africa are undoubted tertiary relicts, while others are of a more recent origin. A radiation to Australian region has also been successful (Evans 1966). A northward radiation on contrary, has met with difficulties. The few Palearctic species are recent derivatives of tropical representatives of the genus *Penthimia*. The two Nearctic species are older immigrants of the same stock. The two Neotropical genera closely resembles *Citorus* and have apparently evolved from an ancestor arrived from Africa by adventitious means (Linnavuori, 1977).

Stenometopiini is one of the tribe of the subfamily Deltocephalinae with 28 genera reported from the world (Oman *et al.*, 1990). Among the 28 genera, 17 are

reported from Oriental region and four from Nearctic, three from Australian, three from Ethiopian, one from Neotropical and one from Palearctic region.

Among the 17 genera reported from the Oriental region 11 genera are endemic to Indian subcontinent. According to Nielson and Knight (2000) these Stenometopiines are confined to the old world and likely originated there.

SUMMARY

VI. SUMMARY

The present study dealt with the subfamily Penthimiinae and the tribe Stenometopiini of the subfamily Deltocephalinae.

Subfamily: Penthimiinae

A total of 511 specimens were examined and 39 species in seven genera are recognized.

The genera included in this study are *Haranga* Distant, *Malichus* Distant, *Neodartus* Melichar, *Penthimia* Germar, *Tambila* Distant, *Uzelina* Melichar and *Vulturnus* Kirkaldy.

Three species of the genus *Haranga*, *H. decurtata* Distant, *H. orientalis* Walker, and *H. scutellaris* Distant were studied. *H. decurtata* is known only by the female sex. *H. decurtata* and *H. orientalis* are recorded for the first time from Karnataka and West Bengal, respectively.

Of the three species in the genus *Neodartus* Melichar from the Indian subcontinent, only *N. acocephaloides* Melichar is retained in the genus. *N. scutellatus* Distant and *N. rufopunctatus* de Motschulsky are transferred to the genus *Penthimia* as they have ocelli on the crown of head instead of on the anterior margin. *N. acocephaloides* is a polyphagous leafhopper. It was found feeding on *Artocarpus heterophyllus* Lam., *Anacardium occidentale* L., *Clerodendron inerme* (L.), *Santalum album* L., *Mimosa pudica* L., *Ocimum sanctum* L., *Phaseolus vulgaris* L., *Cajanus cajan* L., *Mangifera indica* L., *Dodonea viscosa* (L.) and *Duranta goldiana* during the present study.

The genus *Malichus* Distant is represented by only one female type of *M. capitatus* Distant from Sri Lanka.

The genus *Penthimia* Germar is the largest genus in the subfamily Penthimiinae with 22 species, including five species new to science. Three new synonyms and one new combination are proposed in the genus. *P. subnigra* Distant is treated as a junior synonym of *P. compacta* Walker based on the similarity of male genitalia and external characters. *P. nilgiriensis* Distant is treated as a junior synonym of *P. montana* Distant and *P. distanti* Baker is treated as a junior synonym of *P. noctua* Distant as they are two sexes of the same species.

P. badia Distant, *P. vittatifrons* Distant and *P. variabilis* Distant are transferred to the genus *Tambila* and *P. flavocapitata* Distant to the genus *Vulturnus*.

P. maculosa Distant is treated as a species distinct from *P. scapularis* Distant and is reinstated.

The new species described are *Penthimia spiculata* sp. nov. (Karnataka: Nagarahole), *P. curvata* sp. nov. (Karnataka: Bandipur), *P. sahyadrica* sp. nov. (Karnataka: Dharmasthala, Aagumbe; Kerala: Thekkady), *P. tumida* sp. nov. (Meghalaya: Nangpoh) and *P. meghalayensis* sp. nov. (Meghalaya: Nangpoh).

P. compacta was found feeding on *Santalum album* L., *Cajanus cajan* L., *Ocimum sanctum* L. and *Phaseolus vulgaris* L., whereas *P. scutellata* was mainly recorded on *Santalum album* L.

The genus *Tambila* Distant is now comprises seven species, *T. badia* (Distant), comb. nov., *T. conspersa* Distant, *T. fletcheri* Distant, *T. gravelyi* Distant, *T. greeni* Distant, *T. variabilis* (Distant) comb. nov., and *T. vittatifrons* (Distant) comb. nov. These species were earlier placed in the genus Penthimia. *T. opulenta* Distant is treated as a junior synonym of *T. greeni* as they are two sexes of the same species and have similar coloration. *T. gravelyi* is reported for the first time from Karnataka. *T. gravelyi* was found feeding on *Artocarpus heterophyllus* Lam. and *Dodonea viscosa* (L.).

The genus *Uzelina* Melichar is represented by two species *viz., U. thaloriensis* Sharma and *U. laticeps* Melichar. *U. thaloriensis* externally resembles *U. laticeps* but differs in the structure of aedeagal shaft.

Vulturnus Distant is represented by three species including one new species. *V. ornatus* Distant, *V. spatulatus* sp. nov. from Nepal, and *V. flavocapitata* (Distant), comb. nov., transferred from the genus Penthimia. *V. speciosus* Distant is treated as junior synonym of *V. ornatus* as they are two sexes of the same species.

Subfamily: Deltocephalinae

The cluster analysis using 96 characters of 42 taxa of the subfamily Penthimiinae and tribes of Deltocephalinae clearly indicated that the tribe Stenometopiini is one of the tribes of Deltocephalinae and the subfamily Penthimiinae is distinct from the subfamily Deltocephalinae.

Tribe: Stenometopiini

A total of 1161 specimens were examined and 22 species in the genus *Stirellus* Osborn and Ball were recognized.

Species of Stenometopiini show a great degree of variation in the shape of the head and form of the body. However, the characters of the male and female genitalia are uniform. Based on this *Stirellus* Osborn and Ball (1902) and *Doratulina* Melichar (1903) are synonymised and *Stirellus* Osborn and Ball is considered as a valid name. The genus *Viridomarus* Distant (type species: *V. capitatus* Distant) is here treated as a juniour synonym of *Stirellus* as both share very similar male genitalia.

The genus *Galerius* Distant with type species *G. indicatrix* Distant resurrected and the species *G. aberrans* is considered under the genus *Stirellus*.

The genus *Stirellus* is divided into three subgenera, *Stirellus* (*Campbellinella* Distant), *Stirellus* (*Cymbopogonella* Viraktamath) and *Stirellus* (*Stirellus*) based on the morphological character analysis. The subgenus *Cymboponella* is represented by a single species *Stirellus* (*Cymbopogonella) longivertex* (Viraktamath) from Karnataka and the subgenus *Campbellinella* by its type species *C. illustrate*. The subgenus *Stirellus* is represented by twenty species, including nine new species, *Stirellus* sp. 1 (Andhra Pradesh), *Stirellus* sp. 2 (Karnataka : Bandipur), *Stirellus* sp. 3 (Karnataka, Andhra Pradesh, Orissa, Kerala, Tamil Nadu), *Stirellus* sp. 4 (Karnataka), *Stirellus* sp. 5 (Andhra Pradesh), *Stirellus* sp. 6 (Delhi), *Stirellus* sp. 7 (Meghalaya), *Stirellus* sp. 8 (Andhra Pradesh), and *Stirellus* sp. 9 (Karnataka, Maharashtra).

S. apicalis (Pruth, 1930) is synonymised with *Viridomarus capitatus* (Distant, 1918) and *S. capitatus* is treated as valid name.

Most of the species of *Stirellus* were collected on *Cynodon dactylon* L., *S. (Campbellinella) illustrata* on *Saccharum officinarum* L., *S. ribeiroi* on khus grass (*Vetiveria zizanioides* (Linn.) and *S.* (*Cymbopogonella) longivertex* on *Cymbopogon* spp.

All the taxa treated here are described and illustrated. Measurements of both male and female of each species are given separately. Keys are provided for genera and species studied. A checklist for the species of Penthimiinae and Stirellinae from the subcontinent is also included.

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