Handbook on
HEMIPTERAN PESTS
IN INDIA

L. K. GHOSH



ZOOLOGICAL SURVEY OF INDIA

This Handbook on hemipteran pests in India is the first attempt to furnish a comprehensive document on pest species of Hemiptera (Insecta) dealing with taxonomy as well as other applied aspects with a view to have all information under one cover. Apart from providing a full taxonomic treatment of all the pest species known from India together with keys for their identification, it also includes in-depth information known, on various other aspects such as bionomics, ecology, damage symptoms, natural enemies-complex, possible control measures etc. of the pest species in the country. General discussion has also been made pertaining to morphology, economic importance, host plant association, distributional pattern, family characters of each group, affinity with related groups etc.

This book deals with details of 161 species belonging to 113 genera under 24 families of the order Hemiptera. An exhaustive bibliography has been provided so as to make a detailed study of a particular chosen aspect of the group. The work has been suitably illustrated (Figs. 1-470 including B & W and colour plates). Efforts have been made to provide an up-to-date information of the pests as far as possible. As this is the only book exclusively on pests of Hemiptera of the subcontinent it is believed that it would be an indispensable source of reference book for a large section of research workers and students in India and neighbouring countries.

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HEMIPTERAN PESTS
IN INDIA

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FOREWORD

Insects are most important and significant pests of crops and plantations, causing enormous crop losses both in terms of quality and quantity yield production. The pest problem in agriculture has gained importance because many are resistant due to indiscriminate use of chlorinated hydrocarbons which kill the natural enemies of insect pests. Contrary to the harmful insects, there are beneficial insects too, which act as biocontrol agents.

Indian Hemiptera includes several species of agricultural pests which are important from the viewpoint of economic damage and loss to various crops. These insects act as menace to agriculture because of the remarkable ability of some hemipteran insects to transmit viral diseases of many a plants in our country.

The work includes 161 pest species in 113 genera and 14 families. The information presented in this work is of inherent interest and utmost value to students of Zoology in general and Entomology in particular. It is not only a useful pest manual of Indian Hemiptera but also an important source of basic information of interest to the taxonomists and agricultural Entomologists.

Dr. L. K. Ghosh has been with the survey for over three decades and his well gained experience has found its expression through this book. I am happy that Zoological Survey of India is bringing out this publication concurrent with its objectives. I am sure, this Handbook will prove useful to the future workers and researchers in this group.

I wish to congratulate the author for the onerous task he has undertaken in consolidating the knowledge of hemipteran insect pests of the Indian region.

Kolkata
March, 2008

Dr. Ramakrishna
Director
Zoological Survey of India

AUTHOR'S PREFACE

Insect pests are one of the important biological constraints which affect production of agricultural crops, vegetables, fruits etc. Pest problems in agriculture, public health and livestock have increased manyfold during the last three decades. Among many other insects, hemipterans play an important role in agriculture and horticulture. The hemipteran pests are minute to large exopterygote insects with styliform suctorial mouth parts. Many hemipterans act as vectors of degradable plant viral diseases and thus cause potential loss to growers.

Most of the information on the pests are scattered and often many are inaccessible to the majority of workers. In view of the above fact there has been a growing need to have a comprehensive document on pest species of Hemiptera which deals with taxonomy as well as other applied aspects so that one can get all information under one cover. The contribution deals with details of 161 pest species belonging to 113 genera under 14 families of the order Hemiptera. The entire work has been suitably illustrated (Figs. 1-402, plates 403-470)

It is believed that the contribution, being first of its kind in India will prove useful to a large section of research workers and students both in India and neighbouring countries. Efforts were made to give as much up-to-date information as possible. Even then, there may be some errors or omissions. It would be appreciated if those are pointed out for improvement in future.

The present work was conducted under the scheme of Emeritus scientist at the Zoological Survey of India, Ministry of Environment and Forests, Govt. of India.

Dr. L. K. Ghosh
Zoological Survey of India
Kolkata

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Dedicated to

MY PARENTS
AND
RESEARCH ASSOCIATES

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INTRODUCTION

Pests are those organisms which compete with man for their food supply, damage their possessions and attack their person. They are vital concern of all mankind. Included among pests are some thousands of economically destructive species of plants and animals classified as bacteria, viruses, fungi, weeds and some vertebrates and invertebrates with special reference of insects. Insects being predominantly feeders of plants, there is hardly any plant which is not harboured by an insect of some type. In spite of the best cultural methods, use of manures and fertilizers, and inventing high yielding varieties, the yield may be disappointingly low, become one or the other pest has been feeding on the roots, stems, leaves, unripe and ripe fruits or grains and seeds during their growth. Food, fibre and plantation crops are equally affected by insect pests. The insects also damage flowering and ornamental plants.

In addition to causing damage by eating plant tissues or sucking plant sap, insects spread many virus diseases of such crops as potato, tomato, tobacco, beans, *bhindi* etc., sometimes reducing the yield to about one half or even less. Thus, insect pests constitute an important limiting factor in agricultural production. A number of insect pests belonging to various orders of insects are known to cause direct or indirect damage to Agriculture, Horticulture, Forestry etc.

The present contribution deals with major pests of Hemiptera in India.

Hemiptera is the largest and most important order of Exopterygote insects. It comprises all types of bugs, cicadas, leafhoppers, scale insects etc. They are moderate to large size sucking insects measuring 2 – 9 cm. They feed on roots, leaves, stems, fruits and seeds. These insects have piercing and sucking type of mouthparts, atrophied palpi, labium in the form of dorsally grooved sheath receiving two pairs of bristle-like stylets and two pairs of wings of which either forewings are often of harder consistency, the apical portion being more membranons than remainder (Heteroptera), or forewings of uniform membranons consistency (Homoptera). Bugs are active insects; they fly, move, jump on their host plant; some are water bugs which swim and live in fresh water ponds and streams, these are also attracted to light. Of these hemipteran bugs, some (Aphididae and Psyllidae) cause various malformations like galls in plants. Some (Capsidae, Pentatomidae and Reduviidae) are predaceous in nature. Some like Cimicidae (bed bugs) the Triotominae and Polyectinidae are blood suckers on mammals. These insects are of great economic importance. Most of the species are responsible for direct or indirect injury to various plants. Some are extremely destructive, e.g. Leafhoppers (Cicadellidae), the whiteflies (Aleyrodidae), the plant lice (Aphididae) and the scale insects (Coccidae). The extensive damage caused by these insects is due to sucking of plant sap and very fast rate of reproduction in case of many Homoptera. Some of the homopterans (Coccids) are, however, useful to mankind because these insects are either a source of stick lac of commerce in India or of dye stuff like cochinal and kermis.

Some heteropterans are predaceous and thus keep check on the populations of other insect pests. The Indian Hemiptera consists of about 6,500 species distributed over 77 families and constitute a little over 8% of the hemipterans known from the world.

The group is represented in all other countries. Some common pests include cotton stainers (*Dysdercus*), chinch bug (*Blissus*), tea blight (*Helopeltis*). Some well known groups are : cicadas (Cicadidae), frog hoppers or cuckoo-spit insects (Cercopidae), tree hoppers (Membracidae), leaf hoppers or jassids (Cicadellidae), lantern flies (Fulgoridae), jumping plant lice or apple sucker (Psyllidae), white flies (Aleurodidae), plant lice or greenfly (Aphididae), scale insects (Diaspididae), lac insects (Tachardiidae), mealy bugs (Pseudococcidae), pond scaters (Gerridae), bed bugs (Cimicidae), squash bugs (Coreidae), sheild bugs (Pentatomidae), giant water bug (Belostomatidae), water scorpions (Nepidae), back swimmers (Notonectidae), water boatmen (Corixidae) and assassin bugs (Reduviidae).

Insect pests are one of the important biological constraints, which affect production of the agricultural crops, fruits etc. Insects attack almost all the aerial parts of the crop plants as well as roots in the soil. The hemipteran pests are minute to large Exopterygota with styliform suctorial mouthparts. Head capsule strongly sclerotised, seldom with separate sclerites delimited by sutures; compound eyes usually large, ocelli present or absent; antennae short to long, filiform or setaceous, with 10 or fewer segments (exception, numerous segments in male Coccoidea); mandibles and maxillae extremely elongate, needlelike piercing stylets, ensheathed in elongate, tubular labium, which is jointed or unjointed; palps absent. Prothorax large, distinct, except in wingless forms; mesothorax represented dorsally by scutellum, usually large, triangular; metathorax small. Forewings larger than hind wings, frequently coriaceous, at least basally; flexed flat or obliquely over abdomen, usually without folds in wing membrane; legs usually adapted for walking, forelegs raptorial in many predatory taxa; tarsi with 3 or fewer segments, frequently with arolia, pulvilli, or other pretarsal structures. Abdomen commonly with anterior 1 to 2 segments reduced or absent, posterior 1 to 2 fused, reduced, associated with genitalia; cerci always absent.

Pest problems in agriculture, public health and livestock have increased manyfold during the last 3 decades. The indiscriminate use of pesticides, increased use of nitrogenous fertilizers, irrigation, monocropping and cultivation of modern high yielding varieties have brought about tremendous change in the pest complex, some of the minor pests have assumed the status of major pests and several major pests have developed resistance to most commonly used pesticides. The non-biopesticides have also accumulated in various components of the environment. Among many other insects hemipterans play an important role in agriculture and horticulture. Many hemipteran species act as vectors of degradable plant viral diseases and thus, causing potential loss to growers. In view of the importance of the group these insects have drawn the attention of entomologists and a good deal of work, both on fundamental

as well as applied aspects, has been done in India. The detail faunal exploratory studies have resulted in enriching our knowledge on bionomics and control of these harmful insects. Unfortunately, most of the information are scattered and often many are inaccessible to the majority of the workers. In view of the above fact there has been a growing need to have comprehensive document on pest species of Hemiptera dealing both with taxonomy and other applied aspects so that one can get all information under one cover. This has prompted the writer to prepare a comprehensive hand book on hemipteran pests of India.

Out of about 6,500 species of Hemiptera, at least 160 are found to be effective pests. The present work deals with these pests in details. The pest species are dealt familywise. Altogether 26 families are considered here. It includes taxonomic studies covering keys to various taxa, original and subsequent references, diagnosis (Family, Genus, Species), host plants, distribution under each species, their taxonomic affinity wherever possible, and peculiarities, if any. Besides, symptoms and damage, Natural enemy-complex, Biology/Life cycle (in brief), pathogenecity and other available ecological notes, Ecology/Life cycle (in brief), economic importance and possible control measure under each pest species are incorporated. Attempts are also made to provide necessary and relevant illustrations pertaining to diagnosis, keys to taxa, damage symptoms etc.

For each group, family characters as well as generalised diagrams of a representative under each family are also given so as to give an overall idea of the group concerned. This contribution will be the first of its kind in the country and it is hoped that it will be of much help not only to the professional agricultural entomologists and horticulturists but also will find favour with the students and teachers of agricultural entomology. It is expected that the information presented in this book will serve as a source for all available information on this subject and will be of great importance for the students, teachers and researches.

Key to the suborders of HEMIPTERA

Forewings usually of equal consistency ..... HOMOPTERA

– Forewings usually thickened basally and membranous apically..... ..... HETEROPTERA

HOMOPTERA

Key to the families of suborder HOMOPTERA

1(2) Pronotum prolonged backward into a hood-like process.... MEMBRACIDAE

2(1) Pronotum normal 3

3(4) Abdomen usually with a pair of distinct process or siphunculi (mere ring in some cases, very rarely absent) arising from 5th or 6th tergite; tarsi mostly two-jointed ..... APHIDIDAE

4(3) Abdomen without such organ 5

5(6) Last abdominal segment terminating in a filament, anal area of wing distinctly reticulated ..... FULGORIDAE

6(5) Last abdominal segment normal; wing when present not as above 7

7(8) Minute insects with broad wings being covered with fine, snow-white waxy powder, presence of pupal case of great taxonomic value ... ALEYRODIDAE

8(7) Wings not as above; pupal case absent 9

9(10) Two pairs of membranous wings usually held in stegopterous manner; antennae 10-segmented; 3 ocelli widely placed on the vertex ..... PSYLLIDAE

10(9) Wings held in normal manner; antennae not 10-segmened, ocelli not widely placed as above 11

11(12) Usually soft-bodied and covered with copious secretion of white wax; females sedentary, apterous often devoid of legs. Males dipteran with atrophied mouth parts 15

12(11) Body without copious secretion of white wax; females not sedentary; apterous with legs; males with usual hemipterous mouth parts 13

13(14) Hind tibiae with two rows of spines; ocelli situated between the eyes. ..... CICADELLIDAE

14(13) Hind tibiae with a number of rows of spines; ocelli situated on vertex ..... CERCOPIDAE

15(16) Abdominal spiracles present; body covered with white powdery wax ..... MONOPHLEBIDAE

16(15) Abdominal spiracles absent 17

17(18) Abdominal segments fused to form distinct pygidium ..... DIASPIDAE

18(17) Abdominal segments not fused to form pygidium as above 19

19(20) Anal cleft present; wax glands not geminate ..... COCCIDAE

20(19) Anal cleft absent; wax gland opening geminate, when present ..... PSEUDOCOCCIDAE

HETEROPTERA

Key to the families of suborder HETEROPTERA

1(2) Presence of prominent large and usually triangular scutellum reaching to apex of the clavus; shield-shaped broad, large body ..... PENTATOMIDAE

2(1) Scutellum not as above; body rather smaller 3

3(4) Ocelli present 5

4(3) Ocelli usualy absent 7

5(6) Antennae inserted either on or below a line drawn from middle of eyes; cuneus absent ..... LYGAEIDAE

6(5) Antennal insertion above a line drawn from middle of eyes; antennae inserted on upper part of sides of head ..... COREIDAE

7(8) Hemelytra and thorax with raised lace-like reticulation; tarsi 2-segmented ... . TINGIDAE

8(7) Lace-like reticulation absent 9

9(10) Body large and robust; usually bright in colour, red and black with predominant tints ..... PYRRHOCORIDAE

10(9) Body smaller and slender; rather pale, not as above, rostrum 4-segmented; hemelytra with a distinct cuneus ..... MIRIDAE

INSECTA : HOMOPTERA : APHIDIDAE

Aphids, commonly known as green flies or plant lice are large group of small soft-bodied homopteran insects. They constitute one of the most important group of phytophagous insects because of their polymorphism, host alternating heteroecious behaviour, reproductive habits as for their role as largest group of insect vectors of plant viruses. Practically no plant part is spared by these insects and as a consequence of their infestations, the plants show various damage, malformations like galls. These insects enjoy a more or less cosmopolitan distribution and are found in abundance in places of temperate climate. Aphids are known for their wonderful adaptations to every situation that is prevalent in our biosphere. Often daunting to evolutionary biologists and entomologists alike the complexity and diversity in aphid life cycle are amazing life cycles which have been carefully studied and documented in many agriculturally important species (Harrewijn and Minks, 1989). In fact, this is a unique test animal to study the intricacies of evolutionary biology in terms of clonal reproductive mode as an adaptation to harvest advantages of sexuality as well as estimate genotypic component of fitness traits.

Out of estimated world fauna of 4,702 species of aphids (G. Remaudiere and M. Remaudiere 1997) a little over 650 species are on record from India (L. K. Ghosh and Singh 2000). Of these, about 1015 species are known to be in the Oriental region (Agarwala and A. K. Ghosh, 1984). Out of these, Indian crops are infested by over 150 species particularly on vegetables, crops, fruits, fibre crops, pulses, oilseeds, sugarcane, cereals and ornamentals in addition to forest flora. Analysis of available data reveals that about 400 aphid species are found to be available in eastern and northeastern Himalayas (Raychaudhuri, D.N. *et al.*, 1980). This region has a clear admixture of

Palaearctic, Chinese and Malayan fauna. A similar, situation exists in western and northwest Himalayas. Peninsular and Indo-gangetic plains are recorded to have 150 species, while in the Desert region about 19 species are seen.

They are considered to be the most important family of crop-pests on a world scale (Van Emden (ed.) 1972) and infest almost all parts and types of plant species. Although the damage inflicted directly on crops cannot be underestimated, indirect losses due to transmission of viral diseases is enormous and is of special significance. Out of about 300 species tested, 227 have been found to transmit plant viruses (David, 1965; Eastop 1983; Basu and Handa 1987); In India, about 40 species are known to transmit plant viruses (Maniyappa and Veeresh, 1986). Aphids also generate a lot of interest on account of polymorphism, prolific rate of multiplication through parthenogenesis and having overlapping generations. The life-cycle is holocyclic, anholocyclic or combination of both. They are of great economic and academic importance as over 250 species are known to feed on agricultural and horticultural crops (Blackman and Eastop 1984). This work provides information chiefly on the main economically important aphids of Indian crops.

MORPHOLOGY AND TERMINOLOGY

Body of an aphid is normally of three regions *viz.* head, throax and abdomen but fusion may take place between head and prothorax of may be various types of fusion of abdominal segments. The head (Fig. 1) bears a flat or convex frons, with or without lateral frontal tubercles which when present may be smooth, rugose, spinulose, parallel and coverging. Eyes are normally large and compound but in apterae of some group of aphids eyes may be represented by triommatidia. Paired lateral and dorsal tubercles may be present on head, thoracic and abdominal segments and ocular tubercles present on eyes of alatae. Antennae usually consist of two short basal segments and a flagellum of 1-4 segments; the penultimate segment bears a primary rhinarium at the distal end and in the last antennal segment consist of 'base' and slender apical part, called 'processus terminalis' (Fig. 1); secondary rhinarium may vary in shape, size and number and may be variably present on segment III, IV and sometimes on base of segment VI in alatae, and on antennal segment III of apterae in some Aphididae. Rostrum consists of 5 segments, last segment being usually small and fused with 4th segment, combined structure is known as 'Ultimate rostral segment' which bears variable number of accessory hairs besides a tuft of 6 primary hairs at apex. Thorax is composed of pro-, meso-and meta-thorax, the first may fuse with the head, the others may variably fuse among themselves and abdomen. Mesothorax in apterae possesses mid-thoracic furea. Legs consist of usually 5 joints, sometimes coxae and trochanters may be fused. Tarsi (Fig. 1) are usually 2-segmented and the small first tarsal joint bears 2-7 ventral hairs, in some groups dorsal hairs may also be present. Second tarsal joint usually bears dorso and lateroapical hairs and a pair of terminal claws; empodial hairs present between the claws (Fig. 1). Forewing (Fig. 2) possesses

stigma, a straight or curved radial sector, simple, once or twice forked media besides anal and cubital veins; hind wings (Fig. 2) usually smaller than fore wing, bears 2 obligue veins which may be reduced to 1 or may even be absent. Abdomen consists of 9 segments, each of the segments 1-7 usually bears a pair of spiracle.Lateral abdominal tubercles usually present on 1st and 7th tergite, those on 2nd-6th may be variably present; abdominal segment 5 or 6 (Fig. 3) usually bears a pair of siphunculi, of various shapes and characters. However, in some Aphididae, siphunculi are absent. Subanal plate situated ventral to cauda, modification of terminal abdominal segment. Cauda may be of various shapes and bears a few to many hairs.

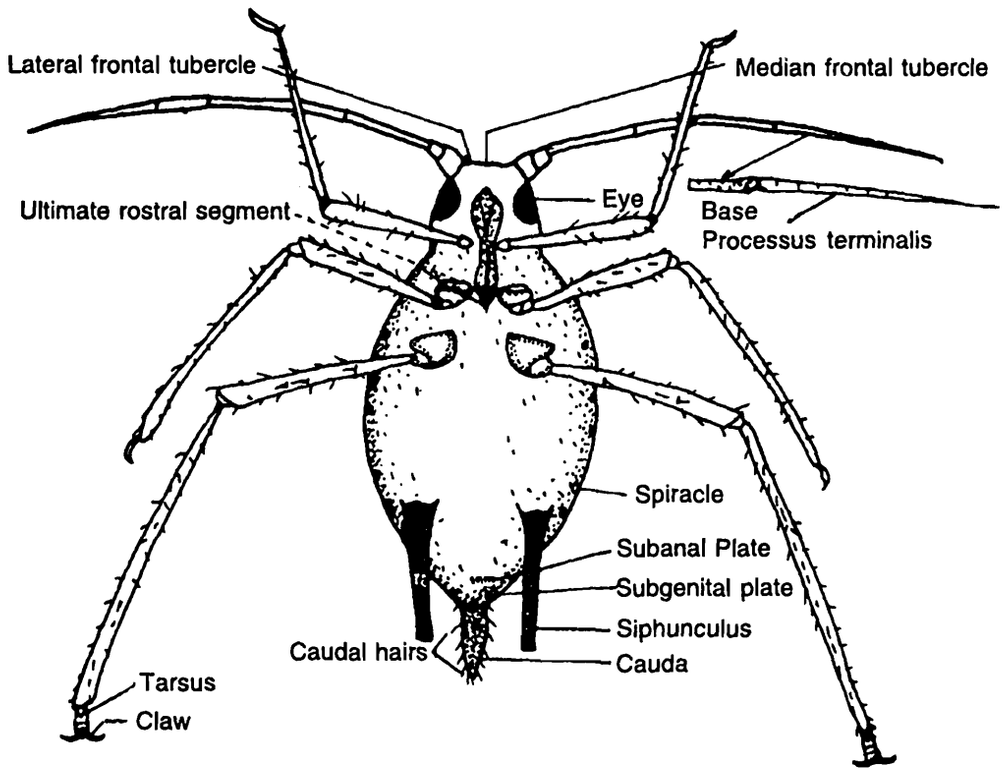


Fig. 1. External morphology of a typical Apterous viviparous female of an Aphid.

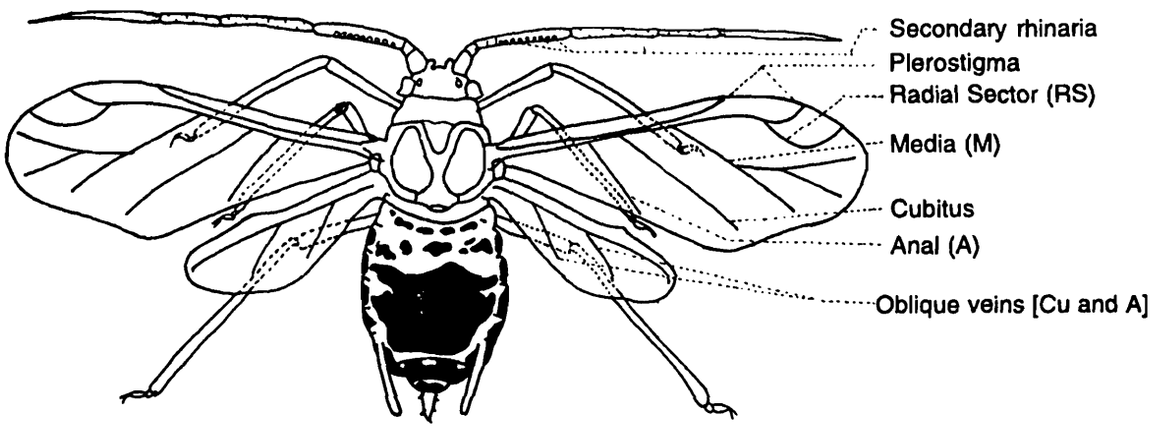


Fig. 2. External morphology of a typical Alate viviparous female

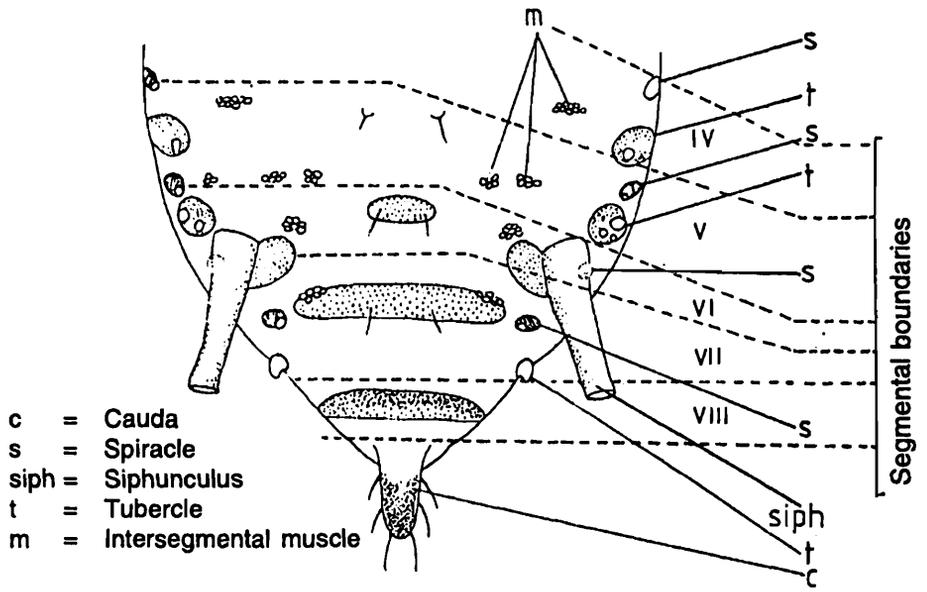


Fig. 3. Posterior segments of abodmen of apterous viviparous famale.

The males are usually alate but smaller in size than alate viviparous females, exhibit sclerotic claspers and bears many secondary rhinaria on antennal segment III, IV, V and sometimes also on VI. The oviparous females are usually apterous and possess numerous pseudosensoria on hind tibiae which are distinctly swollen than those of apterous viviparous females. Female genitalia with rudimentary gonapophyses, vulva etc.

MATERIAL AND METHODS

Habitat : Aphids usually feed in colony on the succulent leaves, stems, foliages, fruits and occasionally form galls inside which they multiply. Sometimes the aphids are found in underground stems and roots. The association of ants and presence of predators like coccinellid beetles are commonly met with.

Collection : The following are the various methods of collecting aphids:

(i) Aphids are generally removed from their host plants with a soft brush soaked in alcohol and fixed either in 96% alcohol or in fluid consisting of 2 vols. of 96% alcohol and I vol. of lactic acid.

(ii) A sheet of strong paper on a thin board is put under the host plant which is shaken gently, the aphids will then fall upon the substratum. Then the insects are collected and preserved in a suitable fluid. A part of an infested plant sample is also collected into tubes and the aphids are transferred into 96% alcohol.

(iii) Another technique is to collect the aphids alive in a rather wide glass tube with a portion of the host plant. In this method, it is often possible to get more material in better condition because nymphs can be reared to adulthood and more alatae can be obtained than by picking directly.

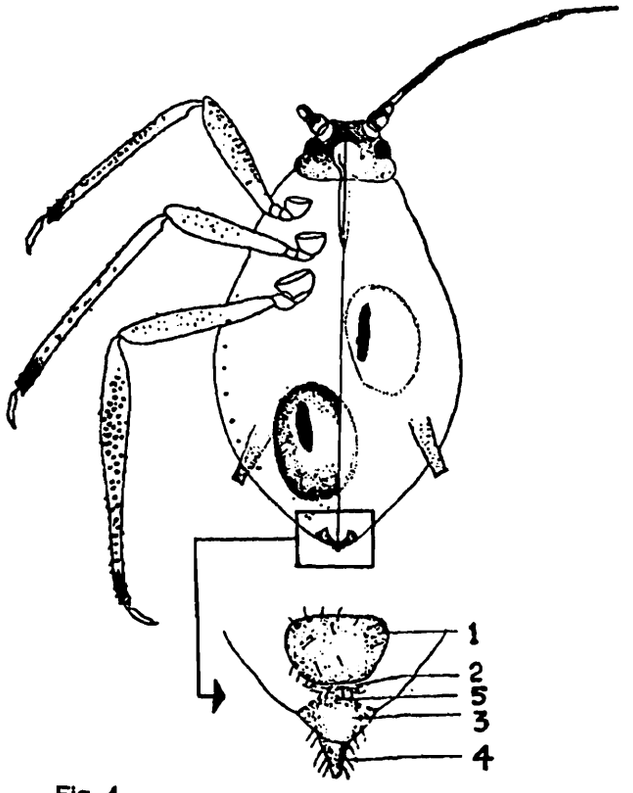


Fig. 4

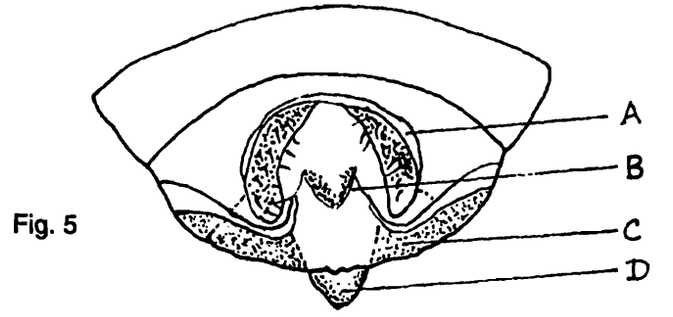


Fig. 5

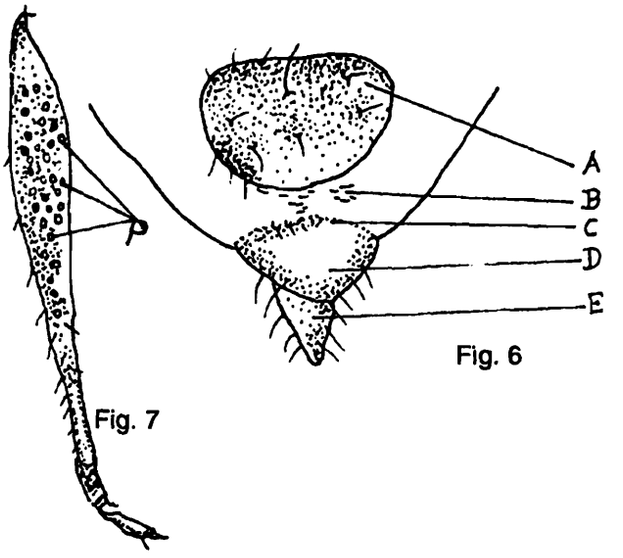


Fig. 6

Fig. 7

Fig. 4-7. 4. Apt. Ovip ♀ of an Aphid; 5. Typical male genitalia, A–Opercula, B–Penis, C–Anal plate, D. Cauda; 6–Typical female genitalia, A–Genital or subgenital plate, B–Genital pore, C–Rudimentary gonapophysis, D–Anal plate, E–Cauda; 7. Hind tibia showing pseudosensoria in apterous oviparous female, P–Pseudosensoria).

(iv) More sophisticated method may be adopted by using tubes of standard width that can be fitted to an exhauster, and thereby the aphids are sucked in from the threshing board. This acts very quickly and the aphids are not damaged by handling. But the sample should not be large. In fact, the procedure is followed by every European worker.

(v) However, the best method of collecting aphids in the field is to collect them alive along with their respective host plants. The portion of each infested plant along with the aphids is then placed in an expanded plastic bag or in tubes or in tins plugged with cotton. the advantage lies here in the fact that it may be possible to have winged specimens that come out within a day or two from the original sample containing both the immature forms and wingless adults. As a result, desirable number of apterous and winged adults along with different stages of nymphs may be collected for study.

Apart from this, appropriate colour notes, nature of damage to plant, site of infestation, attendant ants or predators, parasites, if any, may be accurately recorded

in the laboratory. Data for each sample may be kept separately in the field note book and each container should bear a label.

(vi) Regarding the collection of root aphids digging method is adopted. This is generally done by following the external symtoms of the host plants, the roots of which are liable to be infested by the plant lice, or by observing the association of ants that act as an index in helping the collector to locate the site of infestation in a plant. The rest of the procedure is to be followed as mentioned in the preceding technique.

Yellow Pan Trap Method : This is a device meant for collecting winged aphids specially of migratory habit. This method consists of a yellow coloured tray containing only water. The tray is kept at suitable place of varied altitudes where there is a passage of free air current. While flying at certain heights, winged aphids are attracted perhaps by yellow colour and fall on water. These aphids are then collected and preserved in 70% alcohol. This process is maintained at every 24 hours. The water is preferably changed after each catch.

Light Trap : This method of aphid collection is not so effective as in aforesaid methods.

Preservation : The best way of preserving aphids is to put them in the fluid consisting of 2 vols. of 95% alcohol and I vol. of 75% lactic acid. Lactophenol also plays an important role in preservation. In this process the live aphids are placed directly into vials containing the clearing fluid made of saturated solution of lactic acid with clear phenol crystals. In this solution, the aphids are generally cleared within a few hours of day. In lactophenol the aphid material may be kept for up to 3 years without ill effects.

Labelling : A specimen carries no meaning at all, if it is not properly labelled so far as systematic studies are concerned. While labelling, the following points should be noted.

Name of the host plant and location on host

Locality : (Name, District, State and if necessary, latitudes, longitude and altitude).

Date of Collection :.....

Collector :.....

It is also desirable to maintain a field note book to record all the necessary details in regard to host plant, colouration, nature of damage to plants, site of infestation, presence of ant/predator etc. and other peculiarities, if any. A herbarium should also be made so as to record the correct plant sample.

Transportation : The aphid specimens which are collected in the field, should be put into a tube containing fluid of 95% alcohol and 75% lactic acid. While sending the material from the field to the laboratory, if it takes much time to reach, from field

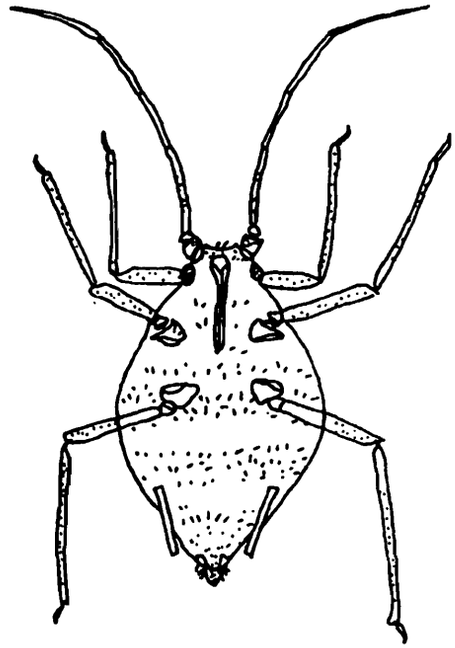


Fig. 8. A typical Apterous viviparous female of an Aphid.

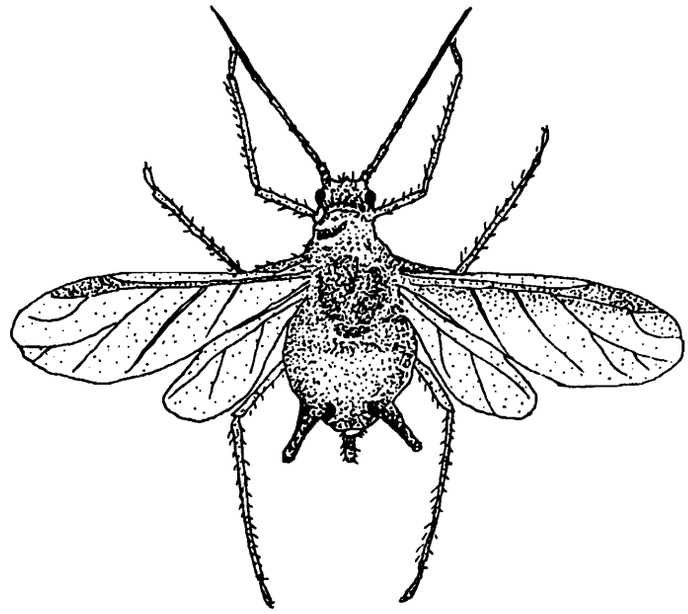


Fig. 9. A Typical Alate viviparous female of an Aphid.

to the laboratory there is every possibility of damage of specimens owing to the frequent agitation. Due to obvious reasons, lactic acid is mixed with alcohol because it not only keeps the specimens soft but also checks damage of the appendages and maintains the orientation of chaetotaxy which are of paramount importance in aphid taxonomy.

The label should be inserted in each tube which is closed with wet cotton plug. Similar label should also be provided outside each tube. Care should be taken that no trace of air remain inside the tube. The tubes, thus labelled, are placed in another container of 90% alcohol. Now, it is ready for postal transit after necessary packing.

Mounting : The aphids preserved in alcohol are to be cleaned for mounting and permanent storage on slides. For this purpose aphids are washed in alcohol and boiled in a water bath for 5-7 minutes; after carefully decanting off the alcohol, 10% KOH is added to the tube and specimens are boiled for 3-5 minutes for clearing. After removing the KOH, the specimens are boiled in Chloral phenol solution (saturated) for about 10 minutes. After clearing, the specimens may be mounted in Berlese medium which is composed of Chloral hydrate 20 gm., Gum accacia (powdered) 12 gm., Glycerine 12 C.C. and distilled water 40 C.C. Eastop and van Emden (1972) may be consulted as to collection, preservation and mounting techniques.

BIOLOGY AND LIFE-CYCLE

Aphids, date back about 300 million years to the mesozoic (Van Emden, 1972). These small creatures have survived the changes over the years because of high order

of adaptability or variability due to polymorphism and special mode of reproduction. In aphids, several types of terms are used (Hille Ris Lambers, 1966). These are as follows :

Fundatrix : Commonly apterous viviparous parthenogenetic female which develops from the fertilized egg, also known as stem mother. This morph is highly adapted to the primary host plant (where egg laying takes place).

Virginopara : Parthenogenetic viviparous females giving birth to larvae.

Emigrant : Alate viviparous female which leaves the primary host plant and colonizes the other hosts (secondary).

Immigrant : Alate viviparous female which leaves the secondary host plant to produce oviparae or even males on the primary host plant.

Exules : Apterae and alatae that are born on and colonize on secondary host plants.

Oviparous female : The female that lays eggs after mating with a male.

Male : Generally alate form. Apterous form is also known.

Gynopara : Alate that produces only oviparae.

Sexupara : Alate that produces both oviparae and males.

Andropara : Apterous that produces only males.

Sexuales : Oviparous and males.

Anholocyclic : Morphs incapable of producing sexuales.

Holocyclic : The morphs producing both males and oviparae.

Thus, very complicated but intresting forms exist in the life of most of the aphids *viz.*, *Myzus persicae* (Sulzer), *Aphis gossypii* (Glover), *Brachycaudus helichrysi* (Kalt.). *Sitobion rosaeiformis* (Das).

Each aphid passes through four nymphal instars. The first three instars are usually of similar duration while the fourth one is of rather longer duration. The development of alatae generally takes atleast 24th more than that of apteare at 20°C, the difference being due to an extended fourth instars. The prelarviposition period is generally short in apterae (0.5-3 days at 20°C) and relatively longer and more variable in alatae, which may require a flight period before larviposition; although under certain conditions alatae may be produced, which larviposit young before flying or do not fly at all. Usually the larval development of aphids is a rapid process. The species which exploit short-lived herbaceous plants need to complete their developments as quickly as possible while others take longer time.

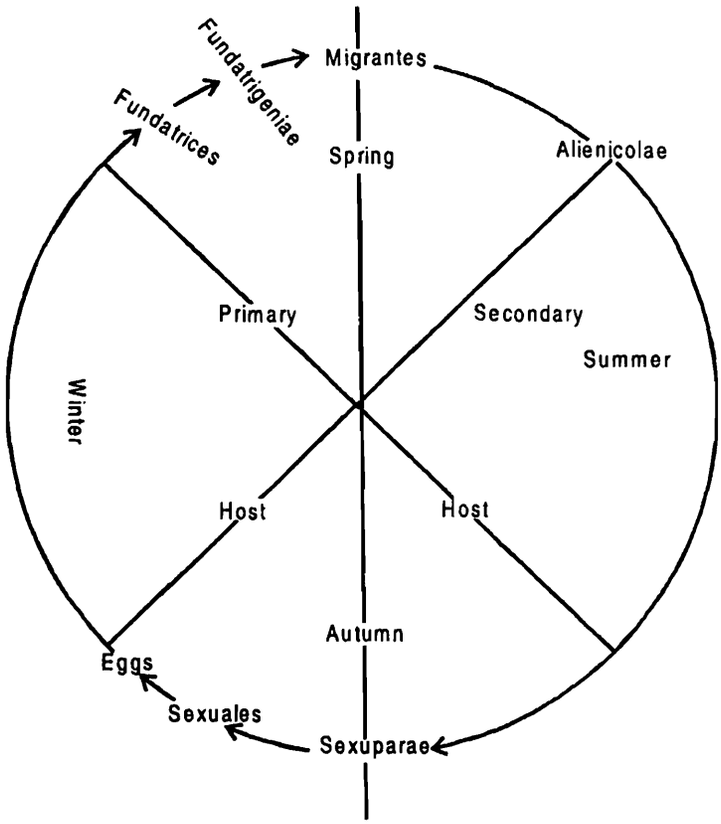


Fig. 10. Typical Life cycle of an Aphid

Various patterns of life-cycle are known to occur among aphids. But generally they are of two types, autoecious (host specific) and heteroeceous (host alternating). Autoecious species of aphids are monophagous, living on one or a few species of a particular genus of plants while heteroecious aphids spend autumn, winter and spring on a primary host and the summer usually on secondary herbaceous plants. During the life-cycle of aphids different morphs are produced. Heteroecious life-cycle of an aphid is illustrated in Fig. 10.

In European countries with temperate climate, the sexuals i.e. males and oviparous females are formed in autumn (October onwards), as during this period, the day length and temperature start decreasing. These are the two main factors responsible for production of sexuals. The gynoparae alatae start-flying to the primary host plant to produce oviparae. Later, males also start arriving. The mating takes place and eggs are laid by oviparae. Each oviparous female lays about 4-13 eggs. These eggs overwinter upto the end of March/April. Hatching takes place in April/May. Upto even eight generations are passed on the primary host plants. The emigrants (alatae) start infesting numerous secondary host plants at near-by or far-off places. But take-off is guided by adequate light and a definite air temperature such as 15.5 to 17°C. Number of flying aphids depends on the population produced on the plant, thus a direct correlation is not expected. When they are in flight, two different processes occur. Initially they fly at great heights of above 1500-1660 m and are not attracted to any

crops and then, after sometime, they alight on crops guided by yellow or green colours which are attractive to them. After alighting, they probe on the plant surface. Alate aphids generally are carried away at wind speed of 3.6 km/h to locations far away from the starting point. Flights have been recorded upto the height of 3000 m in the air. They can even cover a distance of 1500 km. It is also noteworthy that after alighting on a right host aphids may again take off when the sun comes out of a passing cloud, or land again as the light goes off when a cloud covers the sun. After settling on the secondary host plants, these forms reproduce asexually upto September/ October and immigration to primary host plants starts to complete the cycle. This is known as holocyclic life-cycle of an aphid. Some of the species, particularly those aphids which have spread to many parts of the world, are either holocyclic or anholocylic (without sexual reproduction), or a combination of both, according to environmental conditions they encounter in different regions. In India, the life cycle and biology of only a few aphid species are known (Gautam and Verma, 1982; Ghosh and Verma, 1990, Verma and Chauhan, 1993).

Among aphids some are anholocyclic while others are holocyclic. Virginoparae develop in long-day summer conditions but under short-day autumn a generation of oviparae and males arise. Several factors like population density, temperature and sometimes the quality of food governs the production of alatae and apterae. Although the sexual morphs are unusually, though not invariably induced by short photoperiods, the lineages differ in the sexual and parthenogenetic life cycles. In species where there is no host alteration, such as, *Megoura viciae*, the oviparae and males are produced in short-days period as intermediate progeny between virginoparae. In host-alternating species, such as, *Aphis fabae* an additional morph, the gynoparae is interposed between virginopara and ovipara. In such case, it is obligatory for the alatae to migrate from the summer herbaceous host-plant to the winter woody host plant. Under short-day and uncrowded conditions the first generation females develop into normal apterous virginoparae which in turn give rise in generation 2 to gynoparae and males. Generation 3 comprises only oviparae. On the other hand, under short day and crowded conditions from birth, generation I develops directly into alate virginoparae.

In aphids, the type of ovary is peculiar in that development begins before the mother's birth in the grandmother's body. In the ovipara, the large germaria form yolky haploid eggs while in virginopara or gynopara the germaria produces oocytes that develop parthenogenetically into diploid embryos.

Although work on the endocrinology of aphid polymorphism and life history is very much limited, it appears that both neurosecretory products and juvenile hormones come into play, controlling the production of embryos as oviparae or virginoparae under photoperiodic conditions in a non host-alternating aphids. Juvenile hormones also determine dimorphism in virginoparae and gynoparae in host-alternating aphids.

They (JH) as well influence external morphology, parthenogenetic reproduction and probably sex determination. However, it is yet to be definitely established whether juvenile hormones fully control determination of alate and apterous morphs in long-day aphids under crowded conditions.

ECONOMIC IMPORTANCE

Aphids as vector

Aphids form the largest group amongst the insect vectors and about 227 species are recorded as vectors of plant viruses. The aphid, *Myzus persicae* alone is known to transmit more than 100 plant viruses. The method of picking up the virus is piercing of the host tissue and sucking of the tissue sap using modified mouth parts. In aphids, the paired mandibles and maxillae are modified to form hollow stylet which rest in the grooved labium. Each of the paired maxillary stylet is doubly grooved in its inner side with a ridge in between through its entire length. When the two maxillary stylets come together they form two fine channels, the dorsal one being the food channel while the ventral one, the salivery channel through which contents of the salivary gland or saliva is pushed at the time of feeding. While feeding, the cell wall of the host plant breaks due to the enzymatic reaction of saliva, making an easy passage for the stylets to reach vascular bundles, the usual site of feeding through intracellular region. Most of the aphid transmitted viruses produce mosaic symptoms and to a lesser extent yellow dwarf, yellow vein mosaics, etc. on host plants. The aphid transmitted viruses are mainly of two categories.

i) *Non-persistent* : In the non-persistent (stylet-borne) case the virus is acquired and inoculated in a few seconds during limited probes into plant tissue. The virus is also lost rapidly. High concentration of the virus imparts high virulence for infection. Viruses typically transmitted in the non-presistent mode are found in several groups e.g., potato virusY(PVY), clover yellow vein virus and narcissus yellow stripe etc. Thus, in case of migrating aphids if they were in the air for longer duration and also had no access to the virus infected plant before, cannot transmit the virus on landing.

ii) *Persistent* : In the persistent type of relationship, infectivity capacity of the vector is retained without additional acquisition feeding on the source and thus, the aphid remains virulent for life-time. The relationship can further be of circulative type of that of propagative type. In the circulative type, the virus is ingested, absorbed, translocated and finally brought to the salivary gland of the aphid and then put into the plant tissue while feeding. The virus thus circulates within the body of the vector and does not multiply. Many of the viruses transmitted by aphids are of circulative type, e.g., potato leafroll virus (PLRV), barley yellow luteovirus (BYDV) etc. In the propagative type, the transmission pattern is similar to that of circulative viruses except that these multiply within the body of the aphid and the virus infection

simulataneously spreads slowly through different tissues and organs e.g. lettuce necrotic yellows, sawthistle yellow vein etc.

The information on the losses to crops by individual viruses transmitted by aphids is lacking. Moreover, the crop losses caused by virulent aphids vary from region to region under different environmental conditions. The mere presence of the aphid does not mean that it is viruliferous and infective. Many conditions are needed for the effective transmission of viruses, like presence of proper aphid species; virus carrying hosts; stage of the crop; vector picks up the virus from the infected plant, processes it properly for transmission, finds a suitable host, inoculates it; and the plant again processes the virus for other non-viruliferous aphids.

MAJOR APHIDS INFESTING CROPS IN INDIA

The aphid fauna of India is represented by about 653 species spread over 208 genera (L. K. Ghosh and Rajendra Singh, 2000). About 63% of these species are endemic. The aphids are present on one host or the other throughout the year either in plains/hills/plateau region which is due to the prevailing suitable weather conditions in such places. They are serious pests on many agricultural and horticultural crops including oil seed crops (rape-seed and mustard, groundnut, safflower etc.) pulses (pigeonpea, chickpea, cowpea etc.). fruit trees (apple, plum, peach, walnut, citrus etc.). vegetables (cabbage, cauliflower, tomato, chillies etc). cereals (wheat, sorghum, barley, maize), fodder crops (barseem, clover etc.), ornamental plants (*Chrysanthemum* spp., roses etc.) besides numerous trees and other plants. Some information on the aphids of economic importance is available in India (A.K. Ghosh 1972). Status of some of these aphids is given in Table-1.

Table 1. Status of major aphid pests of agricultural/horticultural importance

Aphid species	Main host	Nature of damage		Extent of losses
		Pest	Vector	
Myzus persicae	Potato, peach	Pest	Transmits viral diseases	over 50.0%
Lipaphis erysimi	Rapeseed-Mustard	Pest	Transmits over 10-viral diseases.	upto 96.0%
Aphis gossypii	Cotton/vegetables	Pest	Transmits over 50 viruses	-
A. craccivora	Pigeonpea, groudnut	Pest	Over 30 viruses	-
Uroleucon (Uromelan)	Safflower	Pest		upto 60.0%
Therioaphis trifollii	Lucerne, barseem	Pest	Transmits viral diseases	Quality is lowered

Table 1. *Contd.*

Aphid species	Main host	Nature of damage		Extent of losses
		Pest	Vector	
T. maculata				
Rhopalosiphum maidis, R. padi	Wheat, barley, maize	Pest	Transmits several viral diseases	100% in barley grain
Eriosoma lanigerum	Apple	Pest		Quality is reduced
Brachycaudus helichrysi	Peach	Pest	Transmits viral diseases	Quality is reduced
Toxoptera aurantii	Citrus spp.	Pest	Transmits Citrus tristeza	Quality is reduced
T. citricidus				
Macrosiphum rosaeiformis, M. rosae	Roses	Pest		Quality is reduced
Macrosiphoniella sanbornii	Chrysathemum spp.	Pest		Quality is reduced

Source : Verma, 2000

APHID HOST PLANT INTERACTION

The studies on insect-plant interactions in the present decade have evolved to clarify the host range of phytophagous insects like aphids. Plants can release their allelochemicals in the form of attractant or repellent for influencing several species of insects including aphids. (Klocke & Kubo, 1982; Ananthakrishnan, 1990; Sharma, 1993). Naturally, plants can produce a number of secondary metabolities for their defence mechanism (Kennedy, 1972; Sharma, 1979; Rembold, 1984). Moreover, allelochemicals may act as a specific tool for evolving varied interactions, between host plants and insects (Dicke & Sabelic 1988). these allelochemicals or secondary metabolites may act also as antifeedents which can be considered as feeding deterrent and gustatory repellent (Chapman, 1974).

The diversity of plants tend to increase diversity of aphid and the diversity of phytophagons insect like aphid would tend to augment the diversity of plant (Ananthakrishnan 1986). Such diversity led to the formulation of the adaptive zone hypothesis, wherein a highly successful species proliferates into many habitats and speciates into multiple forms (Smiley, 1985). This generated quite some interest in co-evolutionary interactions between species.

The insects like diversification of modern plants and phytophagous aphids is presumed to be due to the co-evolutionary process. It implies a step-wise evolution within populations of both plants and insects including aphids, the defences of plants providing the selective process for counter adaptation by the plantlice which in turn select for modified defenses in plants (Ehrlich & Raven 1964). The aphid which stimulates the plant itself responds to the evolutionary phytophagous aphids (monophagy, oligophagy and polyphagy) allows close adaption ot the microhabitat and phenology of a particular species of plant. The importance of the biochemical component in co-evolution was stressed by many workers on the basis of discrimination of aphids between host plants and non host plants through differential behaviour responses to several secondary substances many of which are toxic to plant lice.

The occurrence of almost similar secondary substances in various food plants of a particular aphid species, genus or subfamily of aphid is, therefore, of interest. As a result of aphids gaining protection from the secondary substances of plants, increased selection of plants with noxious chemicals resulted due to pressure from herbivorous insects.

Another important area where plants become adapted to aphid attack relate to the biology of gall formation. Plant galls are plant adaptation to be attacked by gall insects, endowing them with more favourable conditions of microclimate, providing an optimal enviroment for rapid reproduction and abundant food for the duration of the season. Initiation and exploitation of plant tissues leading to the formation of plant galls by aphids is considered as a highly developed form of phytophagism. Gall aphid-host plant association seems to exemplify an advanced/specialised level of "trophic strategy" This is evident from the organisation of a nutritive zone in galls, an adaptation of the aphid life cycle in relation to the phenology of the host plant also appears to be a decisive factor in aphids with specialised life cycle (Anathakrishnan, 1984).

CLASSIFIED LIST OF APHIDIDAE (PESTS ONLY)

Subfamily I APHIDINAE
Tribe APHIDINI
Subtribe APHIDINA
Genus 1 ***Aphis*** Linnaeus

1. *Aphis craecivora* Koch
2. *A. fabae* Scopoli
3. *A. glycines* Matsumura
4. *A. gossypii* Glover
5. *A. nasturtii* Kaltenbach
6. *A. nerii* B. d. Fonscolombe

7. *A. pomi* de Geer
8. *A. punicae* Passerini
9. *A. spiraecola* Patch

Genus 2 ***Toxoptera*** Koch

10. *Toxoptera aurantii* (Boyer de Fonscolombe)
11. *T. citricidus* (Kirkaldy)

Subtribe RHOPALOSIPHINA

Genus 3 ***Hyalopterus*** Koch

12. *Hyalopterus pruni* (Geoffroy)

Genus 4 ***Hysteroneura*** Davis

13. *Hysteroneura setariae* (Thomas)

Genus 5 ***Melanaphis*** van der Goot

14. *Melanaphis sacchari* (Zehntner)

Genus 6 ***Rhopalosiphum*** Koch

15. *Rhopalosiphum maidis* (Fitch)
16. *R. padi* (Linnaeus)
17. *R. rufiabdominalis* (Sasaki)

Genus 7 ***Schizaphis*** Borner

18. *Schizaphis graminum* (Rondani)

Tribe MACROSIPHINI

Genus 8 ***Acyrthosiphon*** Mordvilko

19. *Acyrthosiphon pisum* (Harris)

Genus 9 ***Aulacorthum*** Mordvilko

20. *Aulacorthum solani* (Kaltenbach)

Genus 10 ***Brachycaudus*** van der Goot

21. *Brachycaudus helichrysi* (Kaltenbach)

Genus 11 ***Brevicoryne*** van der Goot

22. *Brevicoryne brassicae* (Linnaeus)

Genus 12 ***Hyadaphis*** Kirkaldy

23. *Hyadaphis coriandri* (Das)

Genus 13 ***Lipaphis*** Mordvilko

24. *Lipaphis erysimi* (Kaltenbach)

Genus 14 ***Macrosiphoniella*** del Guercio

25. *Macrosiphoniella sanborni* (Gillette)

Genus 15 ***Macrosiphum*** Passerini

26. *Macrosiphum centranthi* (Thomas)

27. *Macrosiphum rosae* (Linnaeus)

Genus 16 ***Myzus*** Passerini

28. *Myzus cerasi* Fabricius
29. *Myzus ornatus* Laing
30. *Myzus persicae* (Sulzer)

Genus 17 ***Pentalonia*** Coquerel

31. *Pentalonia nigronervosa* Coquerel

Genus 18 ***Rhopalosiphoninus*** Baker

32. *Rhopalosiphoninus latysiphon* Davidson

Genus 19 ***Sitobion*** Mordvilko

33. *Sitobion miscanthi* (Takahashi)
34. *Sitobion rosaeformis* (Das)

Genus 20 ***Uroleucon*** Mordvilko

35. *Uroleucon (Uromelan) carthami* H.R.L.
36. *Uroleucon (Uromelan) compositae* (Theobald)
37. *Uroleucon (Uroleucon) sonchi* (Theobald)

Subfamily II DREPANOSIPHINAE

Genus 21 ***Chromaphis*** Walker

38. *Chromaphis juglandicola* (Kaltenbach)

Genus 22 ***Therioaphis***

39. *Therioaphis trifolii* (Monell)

Genus 23 ***Tinocalloides*** Basu

40. *Tinocalloides montanus* Basu

Subfamily III GREENIDEINAE

Tribe CERVAPHIDINI

Genus 24 ***Schoutedenia*** Rubsaamen

41. *Schoutedenia emblica* Patel and Kulkarny

Tribe GREENIDEINI

Genus 25 ***Greenidea*** Schouteden

42. *Greenidea atrocarpi* (Westwood)

Subfamily IV HORMAPHIDINAE

Genus 26 ***Cerataphis*** Lichtenstin

43. *Cerataphis palmae* (Ghesquire)

Genus 27 ***Ceratovacuna*** Zehntner

44. *Ceratovacuna lanigera* Zehntner

Subfamily V LACHNINAE

Genus 28 ***Nippolachnus*** Matsumura

45. *Nippolachnus piri* Matsumura

Genus 29 ***Pyrolachnus***

46. *Pyrolachnus pyri* (Buckton)

Subfamily VI PEMPHIGINAE

Genus 30 ***Eriosoma*** Leach

47. *Eriosoma lanigerum* (Hausmann)

Genus 31 ***Geoica*** Hartig

48. *Geoica lucifuga* (Zehntner)

Genus 32 ***Pemphigus*** Hartig

49. *Pemphigus immunis* Buckton

Genus 33 ***Tetraneura*** Hartig

50. *Tetraneura (Indotetraneura) javensis* van der Goot

51. *Tetraneura (Tetraneura) nigriabdominalis* (Sasaki)

SYSTEMATIC ACCOUNT

Family APHIDIDAE

The family Aphididae comprises a distinct group of small phytophagous insects belonging to Homoptera. The members of the family can be easily recognised by antennae of apterae usually 4-6 segmented, of alatae 5-6 segmented as in all morphs bearing two primary rhinaria; processus terminalis may be longer or shorter than the base of last antennal segment; eyes of apterae and alatae usually compound; siphunculi usually present and cauda often developed; forewings with distinct radial sector; aphids with parthenogenetic viviparous and oviparous morphs; mostly on dicotyledons, some on coniferae.

Key to the subfamilies of the family APHIDIDAE

1(2) First tarsal segments of adults with 9 or more ventral hairs and sometimes with a pair of dorsal hairs. Body and appendages with many long and fine hairs. Head with a median suture; p.t. always shorter than base of segment VI; siphunculi cone-shaped or mere ring, bearing hairs; cauda broad, simicircular ..... LACHNINAE

2(1) First tarsal segments atmost with 7 ventral hairs. Head usually without a median suture; siphunculi elongate, cylindrical, clavate or cone-shaped or ring-like with or without hairs; cauda of various shapes 3

3(4) Tergite 8 and cauda shortened; head in apterae usually fused with pronotum; dorsoapical hairs on second tarsal segments usually with expanded apices, if otherwise, then head in apterae either completely or atleast laterally free from pronotum 5

4(3) Tergite 8 and cauda usually normal; head in apterae usually distinct from pronotum, if rarely fused, then eyes 3-faceted 9

5(6) Head in apterae free from pronotum either completely or atleast laterally; dorsoapical hairs on second tarsal segment fine; siphunculi if present, appear either as chitinous rings or as slightly truncated cones with chitinised apical ring and siphunculi surrounded by a ring of hairs; eyes in apterae 3-faceted ..... PEMPHIGINAE

6(5) Head in apterae fused with pronotum; one or more of apical hairs arising dorsally or dorsolaterally from second tarsal segment of at least apterae with swollen apices 7

7(8) First tarsal segments usually with 5 or 7 ventral hairs; siphunculi usually long and sometimes may appear as short truncate hairbearing cones; sometimes posterior abdominal segments with long hairbearing processes. ..... GREENIDEINAE

8(7) First tarsal segments usually with less than 5 ventral hairs; siphunculi never more than truncated cone; posterior abdominal processi absent ..... HORMAPHIDINAE

9(10) Empodial hairs usually strap-lipe, if hair-like then in apterae head fused with pronotum and eyes 3-faceted; subanal plate slightly or distinctly indented or bilobed or very seldom entire; cauda usually knobbed ..... DREPANOSIPHINAE

10(9) Empodial hairs always fine; head and pronotum in apterae usually separate. Subanal plate never indented or bilobed; p.t. usually longer than base of last antennal segment; eyes multifaceted, siphunculi and cauda usually elongate; body sometimes with processi, first tarsal segment bears 2, 3, 4 or 5 ventral hairs and without dorsal hairs. ..... APHIDINAE

Subfamily APHIDINAE

Key to the tribes of APHIDINAE

Spiracles of abdominal segments 1 and 2 placed close together; antennal tubercles often well developed ..... **Macrosiphini**

– Spiracles of abdominal segments 1 and 2 placed far apart; antennal tubercles usually not well developed ..... **Aphidini**

Tribe APHIDINI

Key to the subtribes of APHIDINI

Lateral tubercles on abdominal segments 1 and 7 posterodorsal to the spiracles of these segments; frons with a "rhopalosiphine" type of small projection just inner to the antennal sockets ..... **Rhopalosiphina**

Lateral tubercles on abdominal segments 1 and 7 posteroventral to the spiracles of those segments; frons normal and without any projection as above .... **Aphidina**

Subtribe APHIDINA

Key to the genera of subtribe APHIDINA

Hind tibiae with a row of "peg"–like hairs along with normal hairs and 5th & 6th abdominal sternites with transverse spinulose striae, these together constituting "stridulatory apparatus" ..... ***Toxoptera*** Koch

– Hind tibiae with normal hairs only; stridulatory apparatus as above absent ..... ***Aphis*** Linnaeus

Genus 1 ***Aphis*** Linnaeus

1758. *Aphis* Linnaeus, *Syst. Nat.* (10th ed.), **1** : 451

Type species : *Aphis sambuci* Linnaeus, 1758

Diagnosis : Body oval to elongate. Head smooth and usually without any lateral frontal tubercle; frons smooth, straight or slightly concave. Antennae usually 6-segmented (sometimes 5-segmented in apterae) shorter to longer than body; flagellum imbricated, pale or pigmented; true apterae usually without secondary rhinaria, alatae with roundish secondary rhinaria on segment III, sometimes also on segments IV & V; flagellar hairs short & sparse, with acute to acuminate or blunt apices; p.t. shorter than or up to 4.3 times as long as base VI; primary rhinaria ciliated. Compound eyes with distinct or indistinct triommatidia. Rostrum sometimes reaching up to hind-coxae; u.r.s. normal in shape, sometimes heart-shaped, or stiletto-shaped, shorter to slightly longer than ht_2 and usually bearing 2 to 4 secondary hairs, which may be upto 9 and shorter or longer than primary ones. Midthoracic furca sessile or consisting of two separate arms. Abdominal dorsum smooth or rugose and sometimes with usual aphidine polygonal reticulation, very rarely with dorsal sclerotic patch in apterae, and usually with scattered segmental sclerites in alatae (Fig. 11A). Spiracle normal. Post-siphuncular sclerite rarely present; dorsal hairs often short with acuminate or blunt spines, sometimes being quite long with acute apices. Siphunculi subcylindrical or tapering, imbricated, dark, rarely smooth, pale and with only a small flange (Figs. 11A, 11C, 12, 14). Cauda (Figs. 12, 14, 22, 28, 36, 41, 48, 67, 79, 87) usually elongate, pale or dark, shorter than siphunculi, with a basal constriction and with 4-20 hairs.

Legs pale to dark, sometimes distal parts of femora darker and tibiae and tarsi always brown, with normal imbrications; alatae often with darker legs; F. T. C. 3, 3, 2 or 3, 3, 3. Wing venation normal.

Key to the species of *Aphis*

1(2) First segment of hind tarsus usually with 3 hairs; siphunculi longer than cauda bearing 10–12 hairs; yellow to dark yellow in life ..... *nerii* B.d.F.

2(1) First segment of hind tarsus always with 2 hairs 3

3(4) 8th abdominal tergite with 3–8 hairs; siphunculi about 1.7–2.0 times as long as cauda bearing 14–18 hairs; blackish in life ..... *fabae* Scopoli

4(3) 8th abdominal tergite with only 2 hairs 5

5(6) Abdominal dorsum usually completely sclerotic; posterior abdominal dorsum with a pale area around siphunculi and with distinct "aphidine" type of polygonal reticulation (Figs. 11b, 12); cauda somewhat pointed and bears 5–7 hairs; shiny black in life ..... *craccivora* Koch

6(5) Abdominal dorsum pale and smooth 7

7(8) Longest hair on hind femora as long as or longer than its maximum width, abdominal tergite 7 with 4 hairs. ..... *spiraecola* Patch

8(7) Longest hair on hind femora appreciably shorter than its maximum width 9

9(10) Siphunculi pale, smooth and dusky near apices; cauda pale to blackish, about 0.6-1.1 times as long as siphunculi and bears 6-10 hairs; p.t. 2.5-3.0 times as long as base of a.s.; pale greenish in life ..... *punicae* Passerini

10(9) Siphunculi brown to blackish 11

11(12) Second tarsal segment with only primary hairs; cauda usually with 5 hairs; dusky to brownish in life ..... *nasturtii* Kaltenbach

12(11) Second tarsal segment with both primary and secondary hairs. 13

13(14) Cauda dark brown to black, rarely pale; secondary hairs on u.r.s. never more than 4. 15

14(13) Cauda usually pale to dusky but never black; secondary hairs on u.r.s. variable (2–9); hairs on posterior abdominal tergites at most as long as b.d. III, yellowish in life ..... *glycines* Mats.

15(16) Siphunculi strongly tapering, about twice as long as cauda bearing 7-20 (usually 8) hairs; u.r.s. somewhat elongated, about 1.5 times as long as ht2; green in life ..... *pomi* de Geer

16(15) Siphunculi comparatively shorter and relatively thicker but not as above; siphunculi 1.2-1.8 times as long as cauda bearing 5–7 hairs ....*gossypii* Glover

1. ***Aphis craccivora*** Koch
(= *A. medicaginis* van der Goot)
Black Aphid or Groundnut Aphid
(Figs. 11-22, 403, 404, 418, 419)

1854. *Aphis craccivora* Koch, *Die Pflanzenlause Aphiden,* Nunburg, **1** : 124.

1758. *Aphis rumicis* Linnaeus, *Syst. Nat.* (10th *ed.*), **1** : 451.

1843. *Aphis laburni* Kaltenbach, *Monogr. der Familen der Pflanzenlause,* Aachen, : 1-222.

1917. *Aphis medicaginis* Koch; van der Goot, *Rec. Indian Mus.,* **14** : 49-58.

1927. *Aphis rumicis* Linn. : George, *J. Asiat. Soc. Beng.* (N.S.), **23** : 1-12.

1940. *Aphis craccivora* Koch : Ghulam Ullah, *Indian J. Ent.,* **2** : 13-25.

1956. *Aphis craccivora* Koch : Banerjee and Basu, *Curr. Sci.,* **24** : 61.

1958. *Aphis craccivora* Koch : Basheer, *Indian J. Ent.,* **20** : 66-67.

1959. *Aphis craccivora* Koch : Raychaudhuri and Ghosh, *Indian Agric.,* **3** : 17-22.

1961. *Aphis craccivora* Koch : Chatterjee *et al., Ibid.,* **5** : 87-88.

1963. *Aphis craccivora* Koch : Behura, *Proc. 1st Summer School of Zoology* (Simla 1961), Govt. India Publ. : 25-78.

1970. *Aphis craccivora* Koch : Ghosh L. K., *Sci. & Cult.* **36** : 419-420.

1972. *Aphis craccivora* Koch : Rao and Kulkarni, *Marathwada Univ. J. (Nat. Sci.),* **11** : 287-288.

1975. *Aphis craccivora* Koch : Verma and Singh, *Curr. Sci.,* **44** : 368.

1978. *Aphis craccivora* Koch : Stary and Bhagat, *Acta ent. bohemoslov,* **75** : 389-393.

1979. *Aphis craccivora* Koch : Kurl and Misra, *Geobios,* **6** : 286-287.

1980. *Aphis craccivora* Koch : Raychaudhuri, D.N. (*ed.*), Aphids of Northeast India and Bhutan : 1-521.

1981. *Aphis craccivora* Koch : Agarwala *et al., Entomon,* **6** : 233-238.

1984. *Aphis craccivora* Koch : Agarwala *et al., Acta ent. bohemoslov.,* **81** : 15-21.

1990. *Aphis craccivora* Koch : Ghosh, L.K., *Mem. zool. Surv. India,* **17**(3) : 22-28.

1994. *Aphis craccivora* Koch : Ghosh, L.K. and Basu, R.C., *Fauna of West Bengal, State Fauna Series,* **3** : 156. Zool Surv. India.

1998. *Aphis craccivora* Koch : Ghosh and Basu, *Fauna of Meghalaya, State Fauna Series,* **4** : 108. Zool Surv. India.

2000. *Aphis craccivora* Koch : Ghosh and Basu, *Fauna of Tripura, State Fauna Series,* **7** (Part 2) : 351. Zool Surv. India.

2001. *Aphis craccivora* Koch : Chakrabarti and Sarkar, *J. Aphidol.*, **15** (1 & 2) : 11.

Apterous viviparous female : Body somewhat oval, blackish, 1.6-2.8 mm long with 1.2-1.6 mm as its maximum width. Head smooth with small antennal tubercles not extending beyond vertex, Antennae 6-segmented, (Figs. 13, 17, 18) 0.5-0.8 times as long as body, a.s. I somewhat rounded with small wrinklings, particularly on inner side; a.s. II with some imbrications especially on ventral and inner sides; rest of the antennae progressively more distinctly imbricated from base towards apex, flagellum with several fairly short to medium hairs, secondary rhinaria absent; p.t. 2.1-2.8 times as long as base of segment VI; Rostrum reaches up to hind coxae, u.r.s. (Fig. 20) 0.85-1.0 times as long as ht2. Abdominal dorsum (Fig. 12) rather blackish with a dark continuous medium patch with polygonal reticulations, this area appearing shining black in life; hairs on dorsum with acuminate apices, longest hair on anterior tergites 0.5-0.8 times as long as b.d. III. Siphunculi (Fig. 21) black, strongly imbricated, cylindrical, about 0.14-0.20 times as long as body and 1.5-2.0 times as long as cauda. Cauda (Fig. 22) elongate, black, spinose, tapering to apex and somewhat constricted at basal 0.3 to 0.5 portion, bearing 5-6 hairs including dorsal subapical one. Subgenital plate with up to about 16 hairs of moderate length. F. T. C. 3 : 3 : 2.

Alate viviparous female : Body 1.7-2.5 mm long with 0.6-1.3 mm as its maximum width. Head smooth, brownish; antennae about 0.7-0.8 times as long as body; p.t. 1.5-2.8 times as long as base of a.s. VI; a.s. III (Figs. 13, 17) with 3.8 circular secondary rhinaria near base. Rostrum extends upto mid coxae; u.r.s. about 0.80-0.85 times as

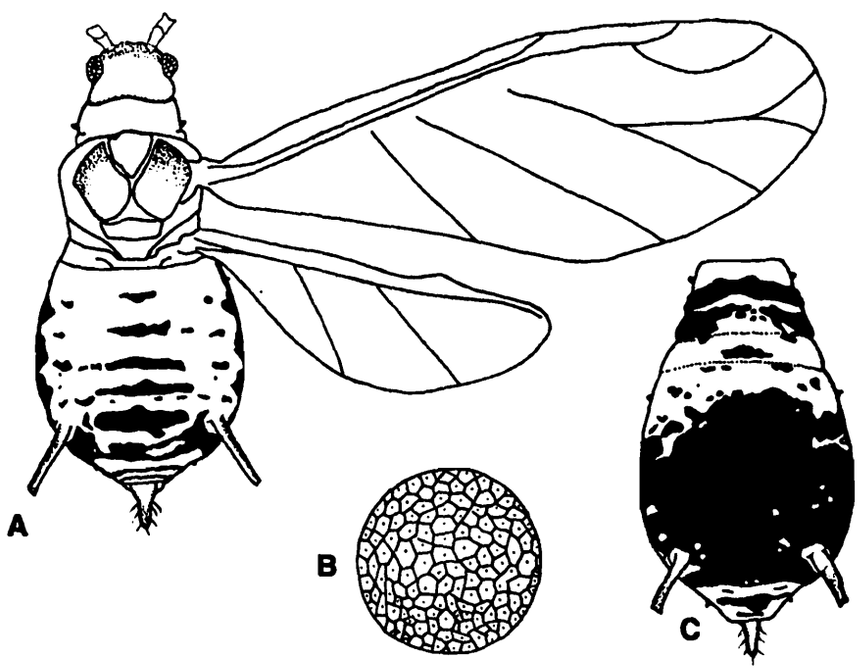
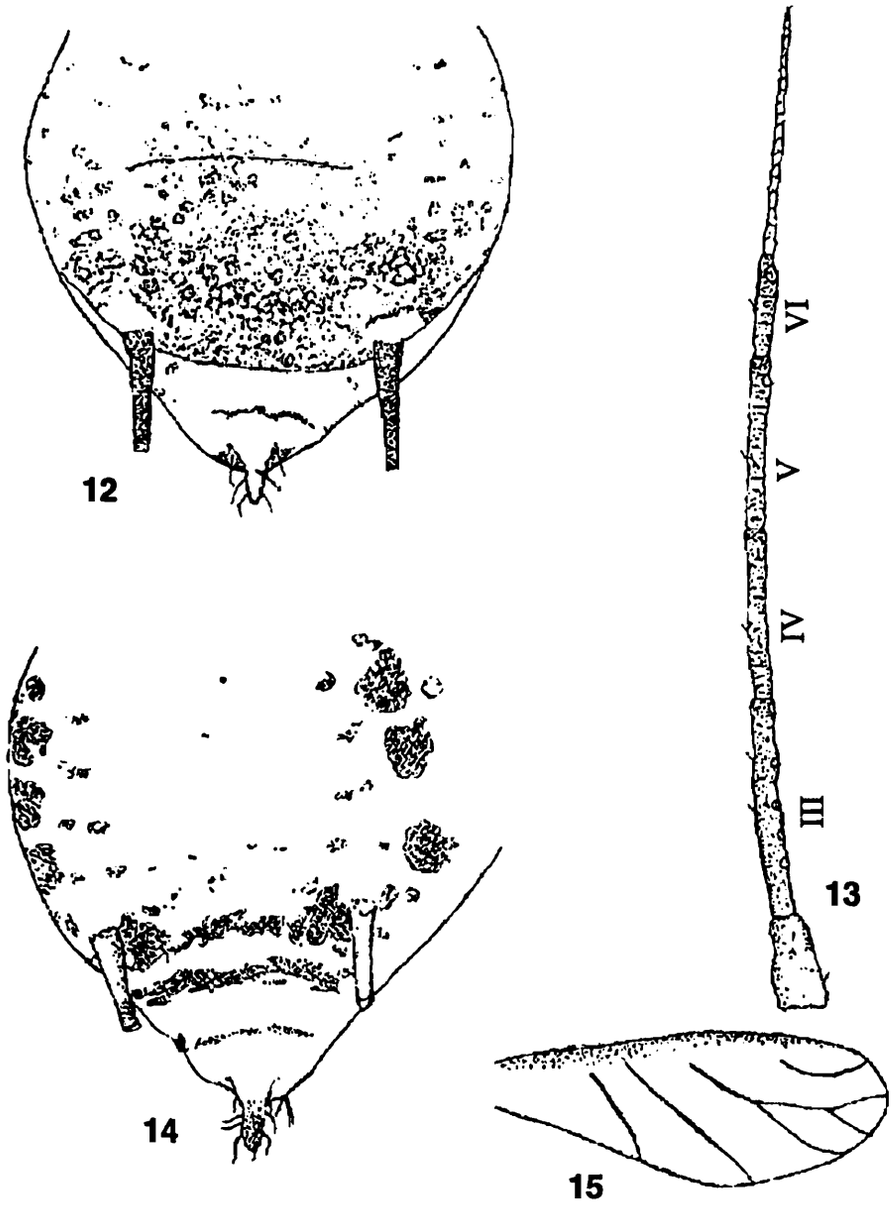


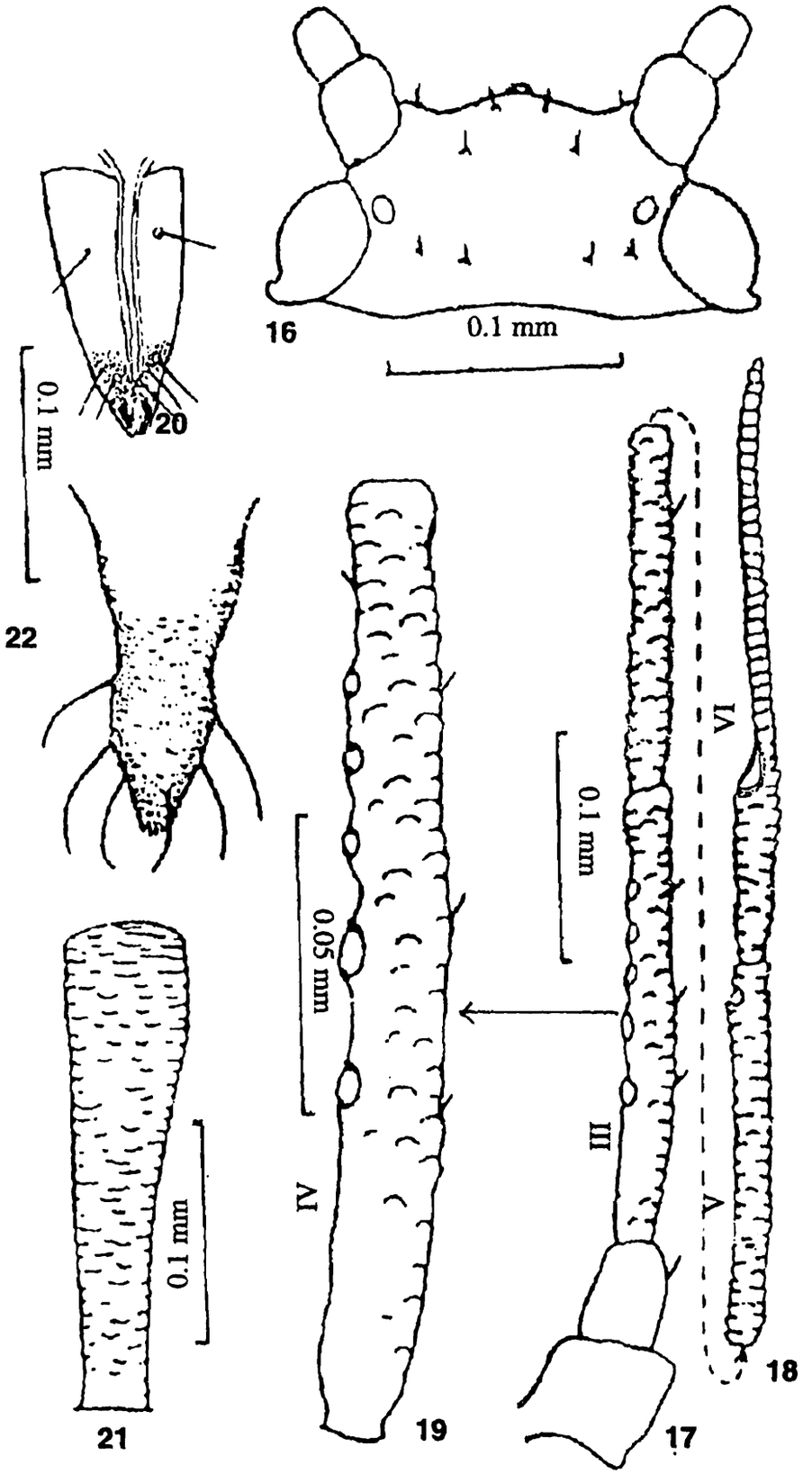
Fig. 11. *Aphis craccivora* Koch : A. Alate viviparous female showing wing venation and abdominal pigmentation, B. Marking on dorsum of abdomen of apterous viviparous female, C. Apterous viviparous female showing pigmentation.



Figs. 12-15. *Aphis craccivora* : 12. Apterous viviparous female, posterior abdominal dorsum; 13. Alate viviparous female, antenna; 14. Alate viviparous female, posterior abdominal dorsum; 15. Alate viviparous female, wing.

long as ht2; dorsum of abdomen frequently with rather long dark segmental bars across the abdominal tergites besides distinct postsiphuncular sclerites longest hair on anterior abdominal tergites about 0.7-1.0 times as long as b.d. III. Siphunculi (Fig. 21) blackish, strongly imbricated, 0.10-0.20 times as long as body, 1.7-1.9 times as long as cauda (Fig. 22). Cauda blackish, strongly spinose somewhat constricted near at the middle, bearing 5-9 hairs. F. T. C. 3, 3, 2. Wing venation normal (Fig. 11A, 15).

**Host plants* : The aphid species is known to infest at least 90 plant species belonging to 23 plant families in India [Raychaudhuri D.N. (ed) 1983; Chakrabarti



Figs. 16-22. *Aphis craccivora* Koch : Alata; 16, Head; 17, a.s.I-IV; 18, a.s.V and VI; 19, a.s. III enlarged; 20, u.r.s.; 21, siphunculus; 22, cauda.

and Sarkar 2001] These include cultivated crops, fruit trees, vegetables, ornamental plants and also weeds. Among the legumes the species damages lucerne, beans, pigeonpea, chickpea, clover dentil, peas etc. Sometimes it becomes very severe on cowpea (Ahmad *et al.* 1990). *Zizyphus mauritiana* has been reported as an alternate food plant of the species during summer (Dorge *et al.* 1996).

Symptom and Damage : The nymphs and adults of aphid damage the plant by sucking the sap from tender portion *i.e.* top shoots, flowers, buds, developing pods and usually from the under side of the leaves. Due to its feeding there is heavy drain of vital plant sap and the depletion of assimilates. As a result, there is increase in transpiration rate (van Emden, 1973). Due to pest infestation leaves, shoot and flowers deform and do not develop properly (Thakur *et al.,* 1984). Due to secretion of honey dew black mould develops on infested plants. These interfere in photosynthesis (Sachan *et al.,* 1994). Under favourable conditions the damage caused is very high and there is severe reduction in yield (Lal, 1992).

The species acts as a vector of the following plant viral diseases :

Bean common mosaic; Blackgram mosaic; Brinjal mosaic; Broadbean mosaic; Cardamom mosaic, or katte disease; Chickpea leaf reduction; Chrysanthemum aspermy; Citrus tristeza; Cowpea mosaic; Groundnut rosette; Hyoscyamus mosaic; Marigold mosaic; Onion yellow dwarf; Papaya mild mosaic; Pea mosaic; Peanut mottle; Phaseolus atropurpureus mosaic; Pigweed mosaic; Poppy mosaic; Pumpkin mosaic; Radish mosaic; Safflower mosaic; Solanum aviculare mosaic; Solanum torvum mosaic; Soybean mosaic; Urdbean leaf crinkle; Vegetable marrow mosaic; [Source : Muniyappa & Veeresh, 1982]

Natural enemies complex :

Predators : *Brumoides suturalis* (Fabricius); *Cheilomenes sexmaculata* (Fabr.); *Chrysoperla carnea* Staph.; *Coccinella septempunctata* Linnaeus; *Coccinella nigritus* Fabricius; *Cyclosa insulata* Cesta; *Harmonia dominata* (Fabricius); *Harmonia octomaculata* Fabricius; *Ischiodan javanica* Wiedmann; *Ischiodan scutellaris* Fabricius; *Leacange celebesiana* Walker; *Leucopis* spp.; *Micraspis cardoni* (Weise); *Micraspis discolor* (Fabricius); *Propylea japonica* (Thunberg); *Pseudospidimerus circumflexa* (Mots.); *Scymnus curtisii* (Weise); *Scymnus flexibilis* (Mulsant); *Scymnus latemaculatus* Motschulsky; *Scymnus nubilis* (Mulsant); *Scymnus quadrillum* Motschulsky; *Scymnus xerampelinus* Mulsant; *Thea cincta* (Fabricius); *Theridion* spp.; *Xanthogramma scutellare* Fabricius [Coleoptera : Coccinellidae]; *Chlaenius panagaeoides* (Laferte) [Coleoptera : Carabidae]

Parasitoids : *Trioxys indicus* Subba Rao and Sharma; *Lipolexis scutellaris* Mackauer

Fungus : *Entomorphthora fresenii* (Nowakowski)

Biology : Both apterous and alate viviparous females reproduce asexually. Female lays the young ones within 24 hours of attaining that stage. It can reproduce for

maximum of 12 days. Both winged and nonwinged viviparous female breed throughout the year. A single female is in a position to produce about 1743 numbers in fortnight (Talati and Butani 1980). However, fecundity and developmental rates are subject to variation depending on host plant, fertility of soil, soil moisture and temperature. Though adult females (apterous) are shinning black, adult alate females are greenish black in colour, newly nymphs are translucent except the reddish brown compound eyes. Later, the body colour changes to light yellow. After about half an hour the nymphs start moving and within an hour or so start feeding (Chhabra *et al. 1993).* Four moults are involved to reach adulthood. Biology is affected by the prevailing weather. Reproduction is the highest in February and lowest in June. Aphids live for upto 16-68 days during winter and 9-20 days during remaining period of the year in Indian conditions. The species completes 31 overlapping generations in a year (Bakhetia and Sidhu 1976).

Distribution : India : all over.

Elsewhere : Cosmopolitan.

Remarks : *Aphis craccivora* Koch, commonly known as black aphid, attacks many plants and most often leguminous crops. It is a major pest of bean and cowpea. The species is recorded as a vector of many plant virus diseases. Leaves, stems and fruits of peas, beans are often severally infested and suffer heavy injury. It also infests a large number of ornamental plants, attacking leaves, flowers and other young growth and sometimes causing severe damage. Considering the phytophagous nature of the pest, much work has been done on its biology, host preference and chemical control (Bernard 1969; Bakhetia & Sidhu, 1977). According to Reddy *et al.* (1983) bean is the most preferred host plant. Sexuales of the species has so far been reported on leguminous plants in Germany (Falk, 1957/58) and on *Tinospora cordifolia* (Family Leguminosae) in Calcutta (Basu, R.C. *et al.* 1968). Verma and Khurana (1974) reported males and oviparous females on green gram (*Phaseolus aureus*) during December, 1973 at Haryana (India).

Sometimes alatae of *A. craccivora* and *A. gossypii* are confused particularly if small, lightly coloured specimens are involved. However, both can be separated by the relative lengths of u.r.s. and h.t.2. Also, it differs from *gossypii* in the transverse sclerites on the individual tergites much longer, particularly on the posterior segments, when they often extened along the entire width of the tergites, uniting with the postsiphuncular and marginal sclerites. An excellent morphological account has been given by Cottier (1953).

It is one of the most serious pests of groundnut in India. In the North Plain Zone of India, *A. craccivora* Koch is one of the predominant pests of mungbean, urdbean, mothbean, ricebean, cowpea, *arhar*, gram, lentil and fieldpea. It also attacks soybean crop, peas, pulses, safflower and some weeks. The aphid is one of the widely distributed species both in India and Elsewhere.

The black aphids suck the sap from the underside of leaves, top shoots and stem. In extreme cases of aphid infestation, the crops get withered and slighed. The disease rossette of groundnut is very important among other viral diseases transmitted by this aphid. The winged aphids infest freshly germinated groundnut plants after overwintering on collateral hosts.

This black coloured aphid species attacks *Bougainvillea* spp. from December to February. Both adults and nymphs infest flowers, tender leaves and the terminal portions of the plant and suck cell sap. It's attack results in the premature fall of the flowers and the downward cupping of the leaves.

Management : At the onset of the pest appearance on growing points, spray 625 ml of malathion 50 EC or 425 ml of dimethoate 30 EC or 425 ml of oxydemeton methyl 25 EC in 200 litres of water per ha. A number of insecticides have been evaluated for management. Most of them have been found effective. These insecticides are acephate (0.02%), bromophos (0.05%), Carbaryl (0.01%), Cypermethrin (0.004%), demeton methyl (0.05%), dimethoate (0.03%), endosulfan (0.07%), fenvalerate (0.004%), lindane (0.1%), malathion (0.05%), menazon (0.05%), methomyl (0.03%), hosdrin (0.02%), primicarb (0.03%), thiometon (0.05%) etc. (Anon., 1981. Tkakur *et al., 1984)* are recommended to protect natural enemies (Sachan *et al.,* 1994). Usually only one spray is required to combat the aphid damage.

2. ***Aphis fabae*** Scopoli 1763 Complex
Bean Aphid
(Figs. 23-28, 405)

1763. *Aphis fabae* Scopoli, *Entomologia carnioiica* : 139.

1775. *Aphis euonymi* Fabricius, *Systema Entomologiae,* : 733-740.

1914. *Aphis fabae solanella* Theobald, *Bull. ent. Res.,* **4** : 325.

1958. David, *Indian J. Ent.,* **19** : 171-180.

1958. David, *J. South Indian Hort.,* **6** : 67-74.

1963. Behura, *Proc. First Summer School of Zoology* : 25-78.

1965. Ganguli, Ghosh, M. R., *Sci. Cult.,* **81** : 541-542.

1965. Kareem & Basheer, *Indian J. Ent.,* : 234-236.

1969. Chowdhuri, Basu, R. C. and Raychaudhuri, D. N., *Sci. Cult.,* **35** : 334-335.

1969. Ghosh, L. K., *Sci. Cult.,* **35** : 493-494.

1969. Basu, A. N., *Oriental Ins.,* **3** : 355-57.

1969. Rao, *Final Tech. Rep.* : 93.

1969. Ramaseshiah and Dharmadhikari, *CIBC Tech. Bull. No.* **11** : 156-164.

1970. Ghosh, L. K., *Sci. Cult.,* **36** : 562-563.

1970. Ghosh, A. K., Basu, R. C. and Raychaudhuri, D. N., *Oriental Ins.*, **4** : 64-76.

1971. Bhalla, *Himachal J. Agric. Res.*, **1** : 51-52.

1971. Ghosh, M. R., Ghosh, A. K. and Raychaudhuri, D. N., *Proc. zool. Soc, Calcutta,* **24** : 47-51.

1971. Chakrabarti, Ghosh, A. K. and Raychaudhuri, D. N., *Sci. Cult.*, **97** : 247-248.

1972. Basu, R. C., Ghosh, A. K. and Raychaudhuri, D. N., *Sci. Cult.*, **38** : 494-495.

1973. Raychaudhuri, D. N., *USPL 480 Project Tech. Report* : 107.

1974. Basu, R. C., Ghosh, M. R. and Raychaudhuri, D. N., *Sci. Cult.*, **40** : 41-43.

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1975. Ghosh, A. K., Biswas, Lahiri, and Rhynth, *Sci. Cult.* **41** : 386-388.

1979. Maity and Chakrabarti, *Sci. Cult.*, **45** : 160-162.

1979. Raychaudhuri, D. N. Dutta, Agarwala, Raha and Raychaudhuri D., *Entomon,* **4** : 163-166.

1980. Raychaudhuri, D. N., Ghosh, L. K. and Das, S. K., *Ins. matsum.*, **20** : 1-42.

1980. Raychaudhuri, D. N. (ed.) Aphids of N. E. India and Bhutan, The Zoological Society, Calcutta : 521 pp.

1980. Agarwala and Raychaudhuri, D. N., *Entomon,* **5** : 39-42.

1981. Agarwala and Raychaudhuri, D. N. *Entomon,* **6** : 207-209.

1981. Agarwala, Ghosh, D., Das, Poddar and Raychaudhuri, D. N., *Entomon,* **6** : 233-238.

1984. Agarwala, Laska and Raychaudhuri, D. N. *Acta ent. bohemoslov,* **81** : 15-21.

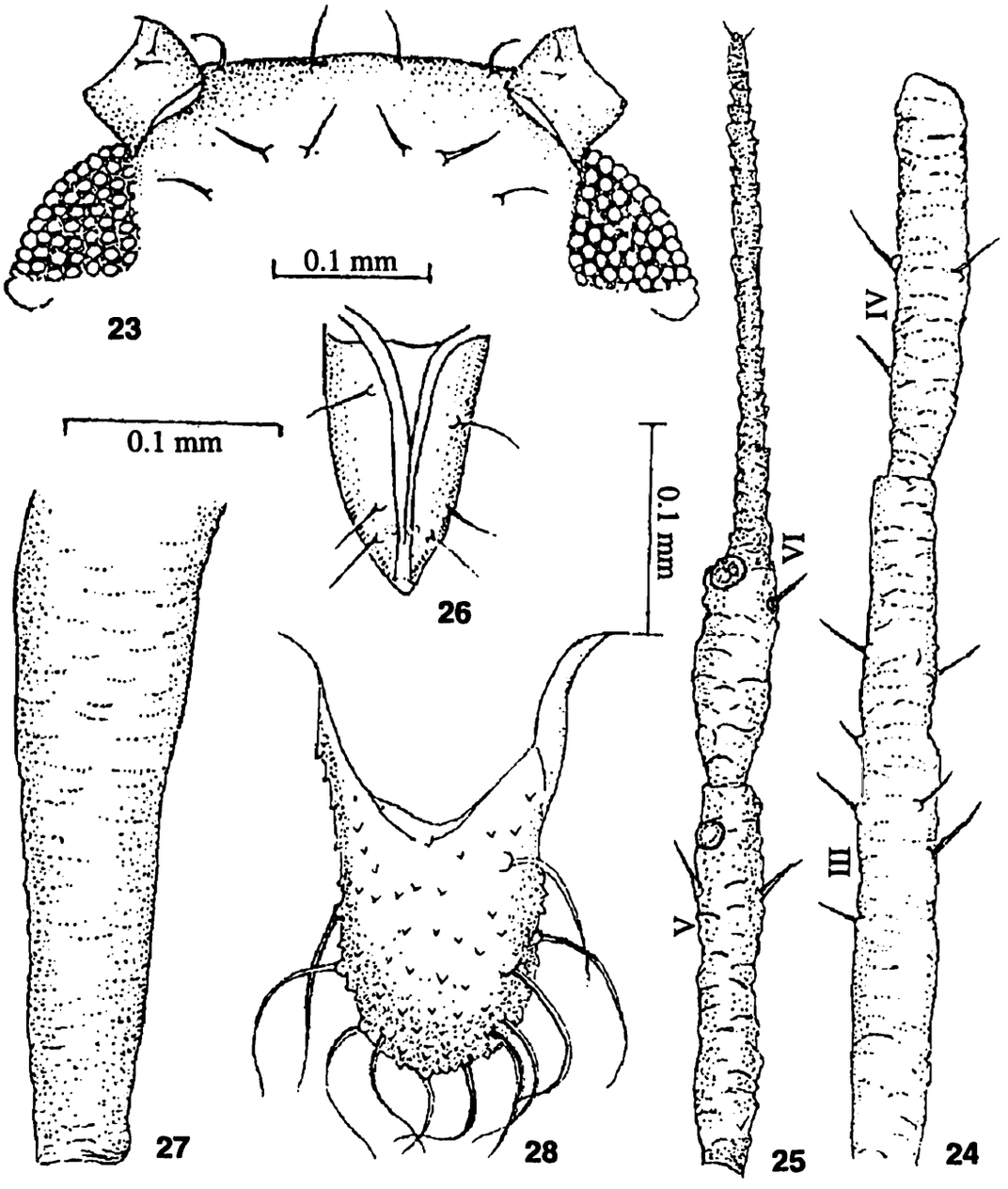
1990. Ghosh, L. K., *Mem. zool. Surv. India,* **17**(3) : 29

1994. Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series* 3, Zool Surv. India : 157.

1998. Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series* 4, Zool Surv. India : 108.

2000. Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series* 7, pt. 2, Zool Surv. India : 351.

Apterous viviparous female : Body blackish, about 1.70-2.8 mm long. Antennae (Fig. 25) pale to dark, about 0.56-0.8 times as long as body, p.t. (Fig. 25) 2.3-3.5 times as long as base of a.s. VI, flagellar hairs 18μ-35μ long and 1.0-1.4 times as long as b.d. III, u.r.s. (Fig. 26) 0.9-1.4 times as long as ht2. Abdominal dorsum with polygonal reticulations with post-siphuncular sclerites besides some other dark sclerites and scattered muskelplatten–like structure, the sclerites may sometimes form segmentally arranged transverse bands on segments vi-viii. longest hair on anterior tergites upto about 1.6-1.7 times as long as b.d. III. 8th tetgite with 3-5 hairs, upto about 2.0-2.5 times as long as b.d. III. Siphunculi (Fig. 27) dark, cylindrical, about 0.15-0.18 times as long as body and 1.5-2.0 times the length of broad and blackish cauda (Fig. 28) bearing 12-18 hairs. F.T.C. 3 : 3 : 2.



Figs. 23-28. *Aphis fabae* : Aptera. 23, Head; 24, a.s. III & IV; 25, a.s.V & VI; 26, u.r.s; 27, Siphunculus; 28, Cauda.

Alate viviparous female : Body blackish, 1.8-2.4 mm long. Antennae about 0.6-0.7 times as long as body; a.s. III with 8-20, IV with 0-8 secondary rhinaria; p.t. about 2.5-3.5 times as long as base of a.s. VI and distinctly longer than a.s. III. u.r.s. 1.0-1.1 times as long as ht2. Abdominal dorsum with segmentally arranged transverse black bands, marginal and post-siphuncular sclerites distinct, sometimes ante-and post siphuncular sclerites may fuse together to encircle the base of siphunculi. Siphunculi dark, about 0.13-0.18 times as long as body and 1.3-2.0 times as long as broad and dark cauda bearing 12-18 hairs. Other characters as in apterae.

Host plants : Polyphagous, infesting plants belonging to N.O. Amaranthaceae, Apocynaceae, Asteraceae, Brassicaceae, Cucurbitaceae, Myrtaceae, Nyctaginaceae, Papillionaceae, Polygonaceae, Rhamnaceae, Rubiaceae, Solanaceae, Ternstroemiaceae, Verbenaceae.

Symptom and Damage : Both nymphs and adults of this dull black aphid infest the leaves, twigs and inflorescence of the host plants. The infestation by this species can be easily recognised by the badly crumpled leaves of the host plant.

Bionomics : Adults of both apterae and alatae reproduce parthenogenetically throughout the year. The life cycle is rather very complicated. It is a polymorphic species. The female deposits about 100 nymphs which become adults in about 10 days, passing through four...moults. When the population is overcrowded and food source is hampered, the number of adult winged viviparous females increases so that they migrate from one plant to another and follow the general life cycle of aphids as mentioned earlier. However, sexual forms of both apterous oviparous females as well as alate males are on record (Raychaudhuri, D. N. *et al.,* 1980) from India. This suggests that the pest species enjoys both anhlolocyclic and holocyclic life cycle in the Indian conditions.

Natural enemy-complex :

Predators : *Coccinella septempunctata* Linnaeus; *Cheilomenes sexmaculata* (Fabr.); *Oenopia quadripunctata* Kapur; *Oenopia kirbyi* Mulsant; *Scymuns (Pullus) hilaris* Mots. [Coleoptera : Coccinellidae]; *O. sauzeti* (Mulsant); *Hyperaspis maindroni* Sicard; *Leucopis* spp. [Diptera : Chamaemyiidae]; *Ischiodon scutellaris* (Fabricius); *Syrphus balteatus* (De Geer); *S. confractor* Wied.; *S. serarills* Wied. [Diplera : Syrphidae]

Parasitoid : *Binodoxys indicus* Subba Rao and Sharma; *Ephedrus plagiator* (Nees); *Lipolexis sculellaris* Mackauer

Vector : The aphid species causes Bean Common mosaic and chilli mosaic disease (Muniyappa, 1976. Kennedy *et al.,* 1962)

Fungus : *Entomophthora aphidis* Hoffman

Distribution : India : all over.

Elsewhere : Virtually cosmopolitan.

Remarks : Body dull black, with blackish siphunculi and cauda. The two basal segments and the tip of antennae blackish, the remainder whitish, distal portion of femora dark, tibiae whitish, blackish only at the apices, tarsi dark. The species is attended by ants. Raychaudhuri, D. N. (1980) has discussed the affinity between *fabae* Scopoli and *fabae salanella* Theobald. However, this aphid differs from typical *fabae* Scopoli in longer siphunculi. It has a wide range of host plants (Solanaceae, Polygonaceae, Asteraceae and Brassicaceae). It sometimes causes serious damage to beans and peas.

Management : As in case of *A. gossypii* Glover.

3. ***Aphis glycines*** Matsumura, 1917
(Figs. 29-36)

1917. *Aphis glycines* Matsumura, *Jour, Coll, Agric, Tohoku Imp, Univ.*, **6** : 360

1980. *Aphis glycines* Mats. D. N. (ed.), *Aphids of Northeast India and Bhutan.* The Zoological Society, Calcutta : 54.

2000. *Aphis glycines* Matsumura : Ghosh, L. K. and Basu, R.C. Insecta : Hemiptera : Aphididae, *Fauna of Tripura* : *State Fauna Series* 7, pt. 2, Zool. Surv. India, Calcutta : 352.

Apterous viviparous female : Body 1.28-1.38 mm long with 0.70-0.75 mm as maximum width near the middle of abdomen. Cephalic hairs blunt to slightly dialated at tip; antennae about 0.75 times as long as body, p.t. (Fig. 33) 2.1-2.5 times as long as base of a.s. VI; a.s. III (Fig. 30) shorter (about 0.8 times) than p.t.; u.r.s. (Fig. 34) 1.2-1.4 times as long as ht2. Abdominal dorsum not pigmented, dorsal hairs on anterior abdominal tergite a little shorter (0.6-0.8 times) than middle diameter of a.s. III and about twice as long as longest hair of the segment, those on 8th tergite a little longer than b.d. III; siphunculi (Fig. 35) dark, about as long as pale cauda bearing 7-10 hairs; 2nd segment of hind tarsus with a pair of secondary hairs on lower surface and sometimes also on upper side; F. T. C. 3:3:2.

Alate viviparous female : Body 1.55-1.65 mm long with about 0.66 mm as the maximum width near the middle of abdomen. Antennae about 0.75 times as long as body; p.t. about 1.2 times as long as a.s. III and about thrice as long as base VI; a.s. III with 6-7 secondary rhinaria; u.r.s. a little longer than ht2, 1.4 times as long as the longest hair on a.s. III. Otherwise, as in aptera.

Host plant : *Glycene max* (N.O. Papilionaceae)

Symptom and Damage : The nymphs and adults damage the plant by sucking the sap from tender portion i.e., top shoots, flowers, buds, developing pods and underside of the leaves of the host plant. As a result, there occurs heavy drainage of vital plant sap. Consequently, leaves, shoots and flowers deform and do not develop properly. Due to 'honey dew' secretion mould develops on infested plant and thereby, interferes in photosynthesis of plant. Under favourable conditions the damage, thus caused, is very high due to which the crop suffers heavy yield-loss.

Biology : The pest species passes through four nymphal instars and each instar lasts 2.0, 1.3 and 2.3 days respectively. The fecundity is 11.6 nymphs/adult (Singh and Singh 1995).

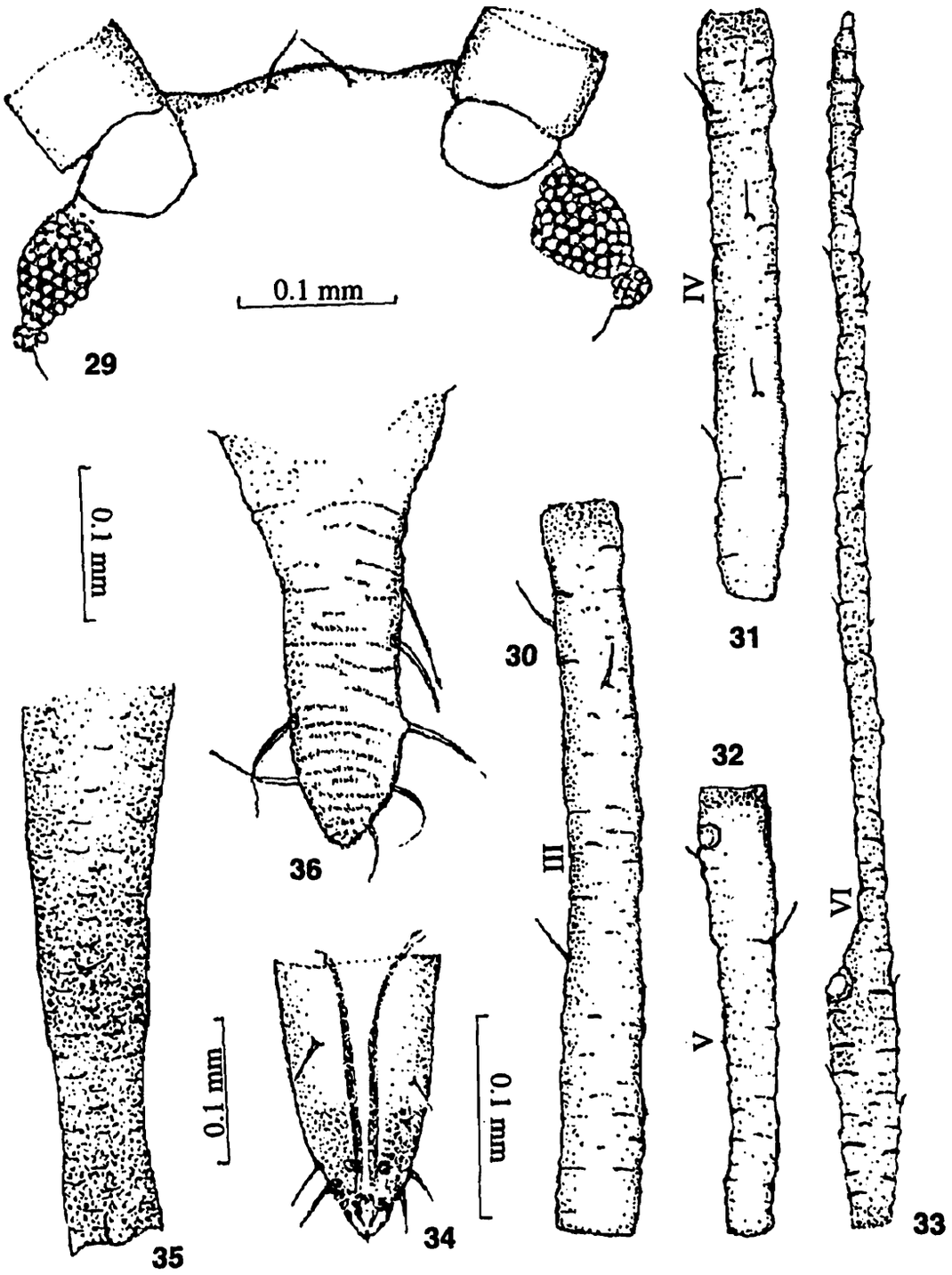
Natural enemy-complex :

Predators : *Coccinella transversalis* (Fabr.); *Cheilomenes sexmaculata* (Fabr.); *Lemnia saucia* (Mulsant); *Lemnia bisellata* (Mulsant); *Scymnus* sp. [Coccinellidae : Coleoptera]; *Episyrphus balteatus* (DeGeer); *Ischiodon scuellaris* (Fabr.); *Paragus serratus* (Fabr.) [Syrphidae : Diptera]; *Micromus timidus* (Hagen) [Neuroptera]

Distribution : India : Manipur, West Bengal.

Elsewhere : China; Japan; Korea; Malayesia; Manchuria; Nepal; Philippines; Taiwan and Thailand.

Remarks : It is an important homopteran pest infesting soybean. It damages different parts of the plants such as leaves, flower and fruit etc. by sucking the cell sap which in turn reduces the vigour of the plant. It has been reported as a vector



Figs. 29-36. *Aphis glycines* Matsumura : Aptera. 29. Head; 30. a. s. III; 31. a.s. IV; 32. a.s. V; 33. a.s. VI; 34. u.r.s.; 35. Siphunculus; 36. Cauda.

of many viral diseases such as Abaca Mosaic, Beet Mosaic, Moong and Bean yellow Mosaic etc. Out of seven aphid species found in India on soybean, *Myzus persicae* (Sulzer), *A. glycines* Matsumura, *A. gossypii* Glover have been reported to transmit "Soybean Mosaic Virus" in different countries. This virus is widespread and occurs in almost all the countries, including India (Agarwala, 1992). Wang *et al.* (1994) reported that the number of *glycines* per plant and plant infestation rate was closely related to yield loss. Predators have been used as important biological control agents of aphid (Agarwal & Saha 1986; Singh and Mishra 1998). According to Singh and Singh (2000), the predators play an important role in regulating the population of *A. glycines* under field conditions. Though the adverse effect of density independent factors seemed to be less, their effect in suppressing the density of the pest species can not be totally ignored.

Management : Application of chloropyrifos 20 EC @ 1.5 l/ha, triazophos 40 EC @ 0.8 l/ha, methomyl 12.5 L @ 2.0 l/ha, ethion 50 EC @ 1.5 l/ha and quinalphos 25 EC l/ha insecticides proved effective and two spray treatments of any one of these may be given at 35-40 and 55-60 days after sowing (Singh and Singh 2000).

4. ***Aphis gossypii*** Glover, 1877 Complex
Cotton Aphid
(Fig. 37-41, 42-59, 406, 407, 420)

1877. *Aphis gossypii* Glover, *Rep Comm. Agric. U. S. A.* for 1816 : 36.

1909. Lefroy and Howlett, *Indian Insect Life* : 786.

1914. Fletcher, Govt. Press Madras, (Aphids) : 499-501.

1917. van der Goot. *Rec. Indian Mus.*, **13** : 175-183.

1919. Krishnamurti, *J. Bombay nat. Hist. Soc.*, **33** : 211-215.

1925. Banerjee, S. N. and Basu, A. N., Curr. Sci., **24** : 61.

1927. George, *J. Asiat. Soc. Bengal (N. S.)*, **23** : 1-12.

1931. Krishnamurti, *J. Bombay nat. Hist. Soc.*, **34** : 411-419.

1938. Deshpande, *J. Bombay nat. Hist. Soc.*, **39** : 740-744.

1940. Ghulamullah, *Indian J. Ent.*, **2** : 13-25.

1948. Krishnamurti, *Indian J. Ent.*, **10** : 51-53.

1956. David, *Madras Agric. J.*, **43** : 103-107.

1958. Basu, A. N. and Banerjee, S. N., *Indian Agric.*, **3** : 89-112.

1958. David, *J. Bombay nat. Hist. Soc.*, **55** : 110-116.

1958. David, *Indian. J. Ent.*, **19** : 171-180.

1959. Raychaudhuri D. N. and Ghosh, A. K., *Indian Agric.*, **3** : 17-22.

1961. Chatterjee, Ghosh, A. K. and Raychaudhuri, D. N., *Indian Agric.*, **5** : 87-88.

1962. Ghosh, A. K. and Raychaudhuri, D. N., *Indian Agric.*, **4** : 228-229.

1962. Ghosh, A. K. and Raychaudhuri, D. N., *J. Bombay nat. Hist. Soc.*, **59** : 238-253.

1979. Kulkarny and Kacker., *Bull, zool, Surv. India.*, **2** : 1-2.

2000. Ghosh, L. K. and Basu, R. C. *In* : *Fauna of Tripura* pt. 2, *State Fauna Series* 7, Zoological Survey of India : 352.

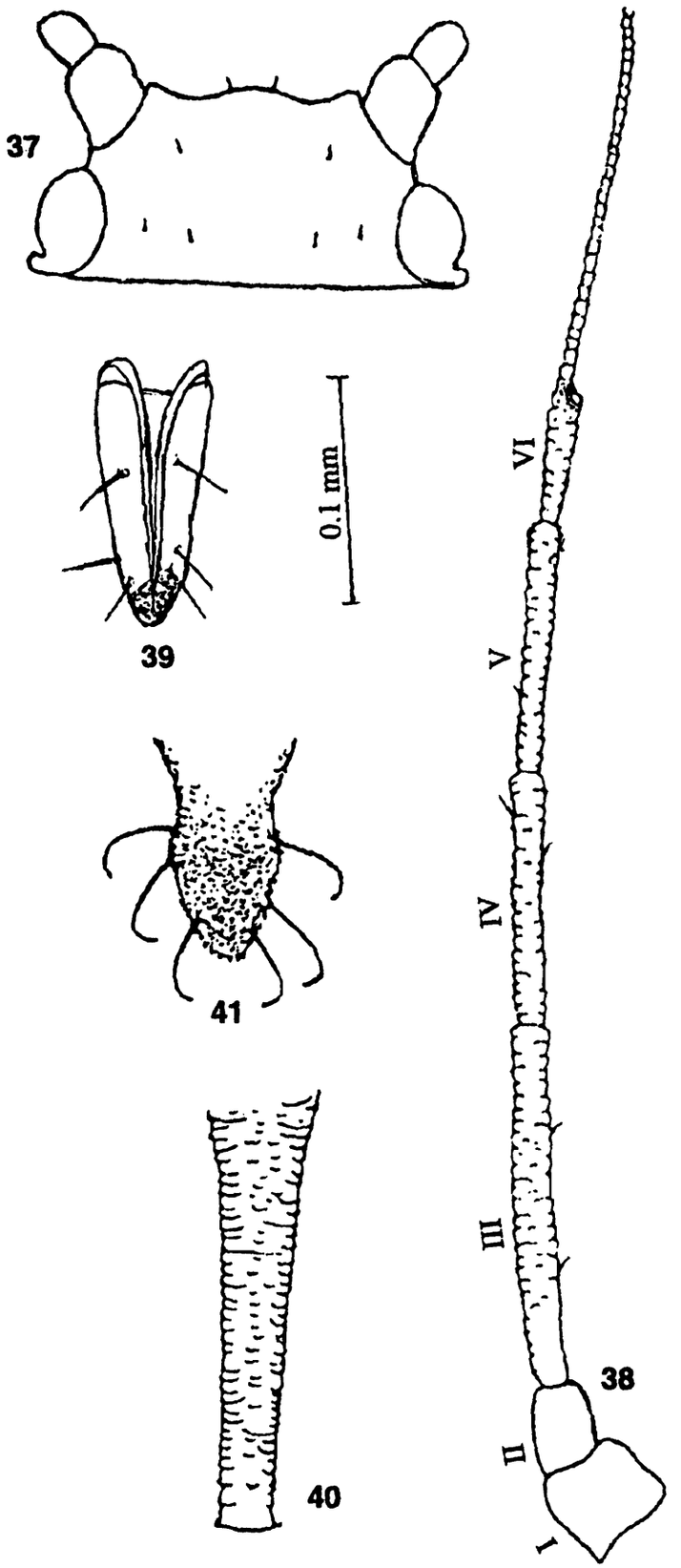
2004. Basu, R. C. and Ghosh L. K. In : Fauna of Manipur Insecta : Hemiptera : Aphididae, State Fauna series 10, *Zoological Survey of India,* : 178.

Diagnosis : *Apterous viviparous female* : Body pale, 0.9-1.8 mm long with 0.7-1.1 mm as its maximum width near the middle of abdomen; antennae (Figs. 38, 46) 0.5-0.7 times as long as body; a.s. IV+V shorter than a.s. VI, pt. 2.0-3.5 times as long as base of a.s. VI. Rostrum reaching beyond midcoxae; u.r.s. 1.0-1.3 times as long as ht2. Abdominal dorsum (Fig. 42) pale to light brown with scattered brown sclerites, longest hair on anterior tergites about 0.6-0.8 times as long as b.d. III, 8th tergite with 2 hairs with blunt to acuminate apices and shorter than b.d. III. Siphunculi (Figs. 42, 47) light brown to dark brown, imbricated, cylindrical, tapering to apex or tapering from base to basal 3rd, about 0.1-0.19 times as long as body and 1.2-1.8 times as long as cauda; cauda (Fig. 41, 48) spinose, dusky and usually slightly constricted near at the middle and bearing 5-6 hairs. F. T. C. 3 : 3 : 2., second tarsal segment with secondary hairs ventrally.

Alate viviparous female : Body pale brownish, 0.9 to 1.8 mm long with 0.5-0.9 mm as its maximum width. Head (Fig. 49) brownish. Antennae (Fig. 50) about 0.6-0.8 times as long body, p.t. subequal to a.s. III and 2.1-3.6 times as long as base of a.s. IV; a.s. III with 5-7 secondary rhinaria distributed over entire length (Fig. 50); u.r.s. 1.0-1.2 times as long as h.t.2. Abdominal dorsum (Fig. 43) pale smooth with some brown scattered segmental sclerites from tergites 6 to 8 inclusive (Fig. 43), and in larger specimens often with such sclerites on some abdominal tergites as well and with distinct post-siphuncular sclerite (Fig.); longest hair on anterior abdominal tergites about 0.6-1.0 times as long as b.d. III. Siphunculi (Fig. 47) brownish to dark, about 0.1 to 0.14 times as long as body, 4.3-4.5 times as is width at apex and 1.5-1.9 times as long as cauda (Fig. 48) bearing 4-7 hairs. Wing venation normal (Fig. 53)

Taxonomically, much confusion exists about the identity of the species. Paddock (1919), Patch (1925), Batchelder (1927), Wall (1933) and Cottier (1953) have dealt with the morphology, variability and synonymy of *Aphis gossypii*. Roy and Behura (1983) have studied seasonal variation in morphological structures.

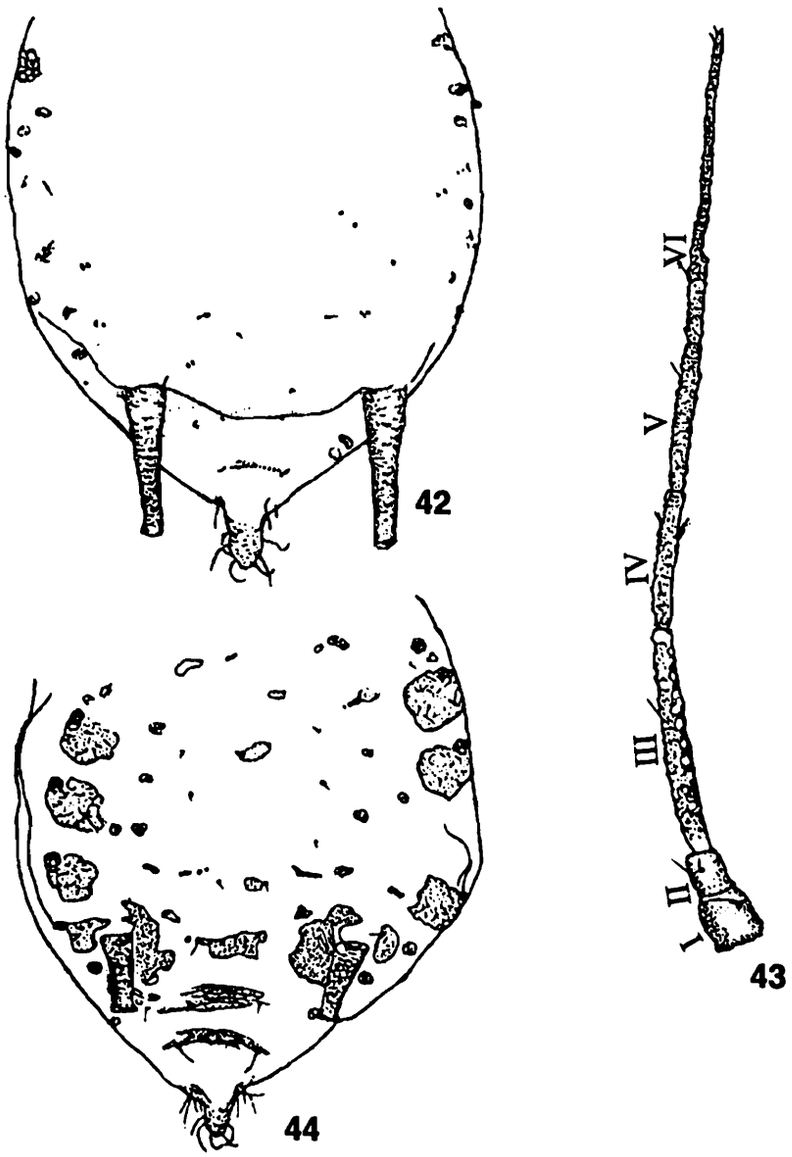
Host plants : This is the commonest species of aphid which is widely distributed throughout the world. In India, *A. gossypii* is highly polyphagous and infests more than 500 species of plants in 76 families both cultivated as well as wild. It is a potential pest of cotton, cucurbits, solanaceous vegetables, pulses, groundnuts, guava,



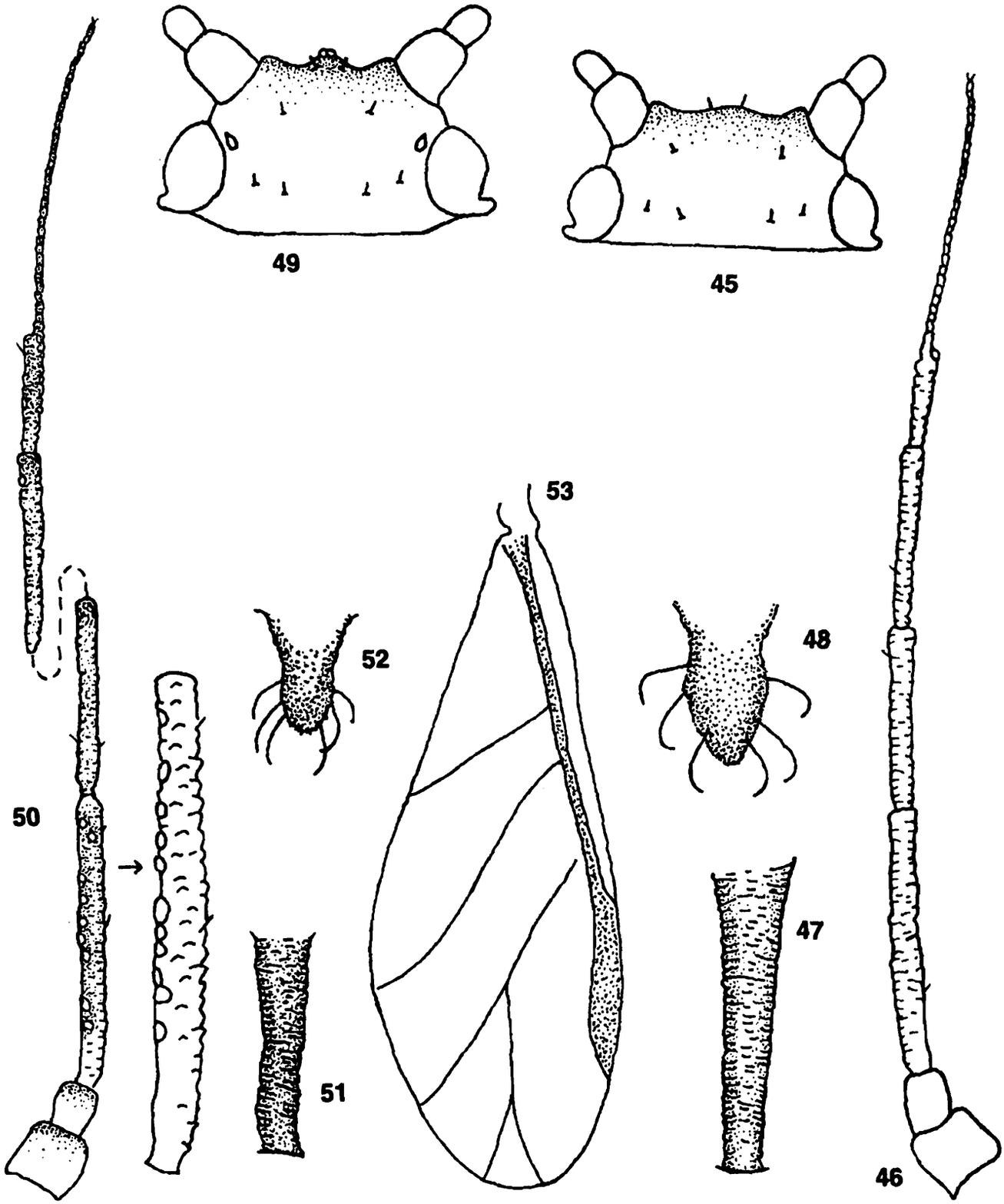
Figs. 37-41. *Aphis gossypii* Glover : Aptera. 37. Head; 38. antenna; 39. u.r.s.; 40. Siphunculus; 41. Cauda.

citrus, coffee, cocoa, peppers, okra, and many ornamental plants including *Hibiscus* spp. etc. Often the aphids are attended by ants. On cotton it inflicts appreciable damage to the crop and hence it is commonly known as cotton aphid. It exhibits great range of morphological variation even on the same plant. It's colour in life is extremely variable, greyish green to dark green, marbled with paler green and often tinged with yellow. Agarwala and Raychaudhuri, D. N. (1979) discuss on the potentiality of a weed *Gynura angutosa* as an alternative host plant of *Aphis gossypii* Glover. Kandoria and Jamwal (1988) studied comparative biology on Okra, brinjal and chilli at Ludhiana (Punjab).

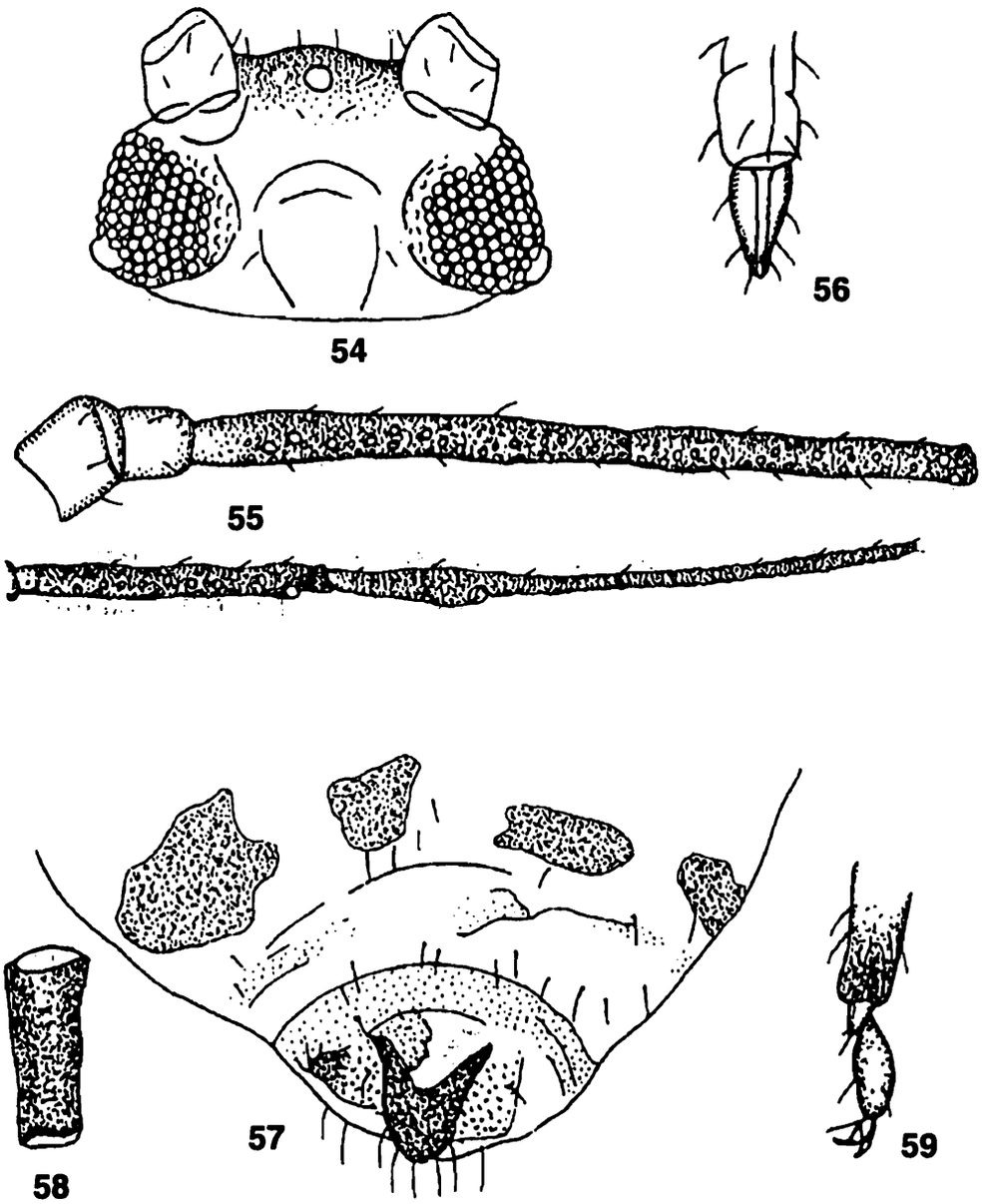
Symptom and Damage : The aphid is found in colonies of hundreds on the tender shoot and the under surface of tender leaves. In cases of severe attack in the susceptible



Figs. 42-44. *Aphis gossypii* : Aptera. 42. posterior abdominal dorsum; 43. Alata. posterior abdominal dorsum; 44. Alata. antenna.



Figs. 45-53. *Aphis gossypii* Glover : Apterous viviparous female : 45. Head; 46. Antenna; 47. Siphunculus; 48. Cauda. Alate viviparous female : 49. Head; 50. Antenna; 51. Siphunculus; 52. Cauda; 53. Wing.



Figs. 54-59. *Aphis gossypii* : Alate male : 54. Head, 55. Antenna; 56. u.r.s., 57. Posterior portion of abdomen; 58. Siphunculus; 59. Portion of hind tarsus

varieties, the leaves curl up, fade gradually and finally dry up. Black sooty mould develops on the honeydew excreted by the aphid. This falls on the leaves, bolls, lint, etc. Apart from cotton, the species is also known to be a pest of importance on brinjal, lady's finger, gingelley, chilly, guava, citrus, okra, etc.

Both adults and nymphs suck plant sap of many ornamental plants like *Hibiscus rosa-sinensis* Linn., *Cassia glauca* Linn., *Tecoma capensis* Lindl. and *Rosa* spp. from September to April in northern India. The maximum population is observed in *H. rosa-sinensis* during March-April. On *Rosa* spp., it is also observed in September-October and on *C. glauca*. In March-April. As a result of its attack, a sooty mould develops which results in a blackened look of the plants.

Life cycle : The life cycle of this cotton aphid is very complicated. It is a polymorphic and adults of both apterae and alatae are viviparous and reproduce parthenogenetically. The female deposits 80-100 nymphs (8-22 nymphs/day) which become adults in 7-9 days on cotton after passing through four moults. When the population is overcrowded, the number of winged adults increases so that they migrate from one plant to others. Both males and oviparous females have been reported from India (Ghosh 1970; Basu and Raychaudhuri 1980). The complete life-cycle is still unknown under Indian conditions. The reproductive biology of this aphid has been studied on brinjal by Kandoria and Jamwal, 1988 and chilli (Kandoria *et al.* 1990).

Natural enemies-complex :

Predators : *Brumoides suturalis* (Fabricius); *Cheilomenes sexmaculata* (Fabricius); *Catana parcesetosa* (Sicard); *Coccinella septempunctata* (Linnaeus); *C. transversalis* Fabricius; *C. undecipunctata* Linnaeus; *Coccinella* Sp.; *Coelophora bissellata* Mulsant; *Cryptogonus ariasi* (Mulsant); *C. quadriguttatus* (Weise); *Harmonia eucharis* (Mulsant); *H. dimidiata* (Fabricius); *Hippodamia variegota* (Goeze) [= *Adonia variegata* Goeze]; *Hyperaspis maindroni* Sicard; *Lemnia bissellata* (Mulsant); *Micraspis allardi* Mulsant; *M. cardoni* (Weise); *M. discolor* (Fabr.); *Micraspis vincta* (Gorham); *Nephus regularis* (Sicard); *Oenopia sauzeti* (Mulsant); *Oenopia kirbyi* Mulsant; *Oenopia quadripunctata* Kapur; *Oenopia sexareata* Mulsant; *Propylea quatuordecimpunctata* (Linn.); *P. japonica* (Thnberg); *Pullus* Sp.; *Pseudospidimerus circumflexa* (Mots.); *Scymnus castaneus* Sicard; *Scymnus giganeus* Kamiya; *Scymnus (Pullus) seritus* Weise; *Scymnus guimeti* Mulsant; *Scymnus latemaculatus* Motschulsky; *Scymnus nubilus* (Mulsant); *Scymnus pyrocheilus* Muls. [Coleoptera : Coccinellidae]; *Scymnus quadrillum* Motschulsky; *S. xerampelinus* Mulsant (= *Pullus xerampelinus*); *Thea cincta* (Fabricius); *Ischiodon scutellaris* (Fabricius); *Paragus yerburiensis* Stuckenberg; *Sphaerophoria javana*; *S. macrogaster* (Thomson); *Syrphus balteatus* De Geer; *S. confracter* Wied; *S. serarius* Wied; *Syrphus* Sp. [Diptera : Syrphidae]; *Leucopis formosana* Henn. [Diptera : Chamacmyiidae]; *Paederus fuscipes* [Coleoptera : Staphylinidae]; *Triphleps tantilus* [Hemiptera : Anthocoridae]; *Geocoris tricolor* [Hemiptera : Lygaeidae]; *Micromus timidus* Gorst; *Chrysopa* Sp. [Neuroptera]; *Lycosa pseudoannuata* (Boes & Stand); *Pardosa* Sp. [Aranae : Chelicerata]

Parasitoids : *Aphelinus flavipes* Fors; *Aphelinus gossypii* Timberlake; *Aphidius* Sp.; *Aphidius colemani* Viereck; *A. matricariae* Haliday; *Cristicaudus nepalensis* (Takata); *Diaeretiella rapae* (M'Intosh); *Ephedrus persicae* Froggatt; *E. plagiator* (Nees); *Lipolexis gracilis* Förster; *L. scutellaris* Mackauer; *Lysiphlebus tesaceipes* (Cresson); *Lysiphlebus* Sp.; *Trioxys acalephae* Marshall; *T. basicurvus* Shuja-Uddin; *T. indicus* Subba Rao and Sharma; *T. rubicola* Shuja-Uddin; *Tioxys* Sp.

Fungus : *Entomophthora fresenii* (Nowokonskii)

[*Source* : A. K. Ghosh 1974; Stary and A. K. Ghosh 1983; Omkar and Pervez 2000]

Earlier, the species was known to transmit about 4 viruses of plants (Eastop,

1958). However, in the recent years, the pest species is found to be responsible for the following viral diseases :

Achyranthes mosaic; Alfalfa mosaic; Amaranthus mosaic; Balsam mosaic; Banana mosaic; Bean common mosaic; Bittergourd mosaic; Brinjal mosaic; Calendula mosaic; Calliopsis mottle; Canna mottle; Cape gooseberry mosaic; Cardamom mosaic or katte disease; Cauliflower mosaic; Chickpea distortion mosaic; Chickpea leaf reduction; Chilli mosaic; Chilli vein banding; Chinese sarson mosaic; Citrus tristeza; Cotton anthocyanosis; Commelina mosaic; Cowpea mosaic; Cucumber mosaic; Cynodon mosaic; Datura distortion mosaic; Digitalis lanata mosaic; Eleusine mosaic; Garlic mosaic; Hyoscyamus mosaic; Launaea mosaic; Lettuce mosaic; Maize mosaic; Marigold mosaic; Muskmelon mosaic; Nasturtium ring spot; Onion yellow dwarf; Papaya mosaic; Papaya ring spot; Passion fruit mosaic; Pea mosaic; Peanut green mosaic; Pepper veinal mottle; Peristrophe bicalyculata mosaic; Peristrophe bicalyculata mosaic; Petunia mosaic; Petunia mottle; Petunia ring spot; Phlox mosaic; Pigweed mosaic; Poppy mosaic; Potato virus-M; Potato virus-Y; Primula mottle; Pumpkin mosaic; Radish mosaic; Ragi mosaic; Ridgegourd mosaic; Safflower mosaic; Snakegourd mosaic; Solanum aviculare mosaic; Solanum khasianum mosaic; Solanum torvum mosaic; Soybean mosaic; Sugarcane mosaic; Swordbean mosaic; Tree tomato mosaic; Urdbean leaf crinkle; Vegetable marrow mosaic; Vigna catjang mosaic; Watermelon mosaic; Zinnia mosaic; [Source : Muniyappa and Veeresh 1982].

Distribution : The pest species is usually distributed throughout temperate, subtropic, and tropic zones and in all cotton-producing areas of the world. In India, it is recorded not only all over the country where cotton is grown but also in non-cotton growing states where it infests a number of crop plants and weeds.

Remarks : The aphid is more serious pest of cotton, chillies, brinjal, tomato, okra and some cucurbits (Rai *et al.* 1989). Of these, *A. gossypii* is a key pest of cotton. It is also a known vector of several plant viruses. The aphid is present throughout the year in the plains. In Punjab it remains very active from 4th week of July to third week of October on okra, from first week of August to 4th week of November on brinjal and from second week of August to fourth week of December on chilli (Jamwal and Kandoria 1990). In western Uttar Pradesh it is found in early, main and late potato crops while in Bihar its population is heavy on the seed crop (Verma and Parihar 1991). In Bangalore, the population of *A. gossypii* was high from 3rd week of October to 1st week of January, and from last week of June to the last week of July, respectively. Aphids were observed more numbers in August planted cotton crop than that to March planted crop (Jalali *et al.* 2000).

Management : Monocrotophos @ 900 g ai/ha followed by phosphamidon 85 EC @ 475 a ai/ha are quite effective in reducing its population on cotton. Application of phorate 10 G @ 0.5 kg ai/ha to the soil at sowing time gives early control and reduces its attack for several weeks. The parasitoid, *Trioxys indicus* has been found to be quite effective as biocontrol agent against the cotton aphid under laboratory conditions.

At present numerous insecticidal applications are given on vegetables. The aphid can be easily controlled by the application of phosphamidon @0.03% or endosulfan @0.03%. However, insecticides should be applied only under exceptional cases on vegetables.

5. ***Aphis nasturtii*** Kaltenbach, 1843
(Figs. 60-73, 305, 408, 409, 410)

1843. *Aphis nasturtii* Kaltenbach, *Mongr. Fam. pflanz.* : 76.

1918. Das, B., *Mem. Indian Mus.*, **6**(4) : 220-222.

1963. Behura, *First Summer School of Zoology* : 25-78.

1968. Chowdhuri, Basu, R. C., Chakrabarti, and Raychaudhuri, D. N., *Sci, Cult.,* **84** : 133-134.

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1969. Chowdhuri, Basu, R. C., Chakrabarti, and Raychaudhuri, D. N., *Oriental Ins.*, **3** : 83-92.

1969. Rao, *CIBC U.S.P.L. 480 Project Final Tech. Rep.* : 1-93.

1970. Basu, R. C., Ghosh, A. K. and Raychaudhuri, D. N., *Proc. zool. Soc., Calcutta,* **23** : 83-91.

1970. Ghosh, A. K., Basu, R. C. and Raychaudhuri, D. N., *Oriental Ins.*, **4** : 64-76.

1971. Chakrabarti *et al., Proc. zool. Soc, Calcutta,* **24**(2) : 99-111.

1971. Chakrabarti, Ghosh, A. K. and Raychaudhuri, D. N., *Sci. Cult.*, **37** : 247-248.

1971. Ghosh, A. K., Banerjee, and Raychaudhuri, D. N., *Gavesana.*, **3** : 10.

1971. Ghosh, A. K., Banerjee, and Raychaudhuri, D. N., *Proc. zool. Soc., Calcutta.*, **24** : 99-111.

1972. Rao and Kulkarni, P. P., *Marathwada Univ. J. (Nat. Sci.),* **16** : 141-150.

1973. Raychaudhuri, D. N., *U. S. PL. 480 Project Tech. Report.* : 1-107.

1975. Chakrabarti, and Raychaudhuri, D. N., *Oriental Ins.*, **9** : 195-211.

1978. Mondal, Agarwala and Raychaudhuri, D. N., *Sci. Cult.*, **44** : 89-92.

1979. Kurl and Misra, *Geobios,* **6** : 286-287.

1980. Maity, Bhattacharyya, and Chakrabarti, *Sci. Cult.*, **46** : 34-312.

1980. Raychaudhuri, D. N. (*ed.*) Aphids of Northeast India and Bhutan. The Zoological Society, Calcutta : 1-521.

1981. Basu, R. C., Raychaudhuri, D. N., *Rec. zool. Surv. India, Occ. Paper,* **18** : 7-54.

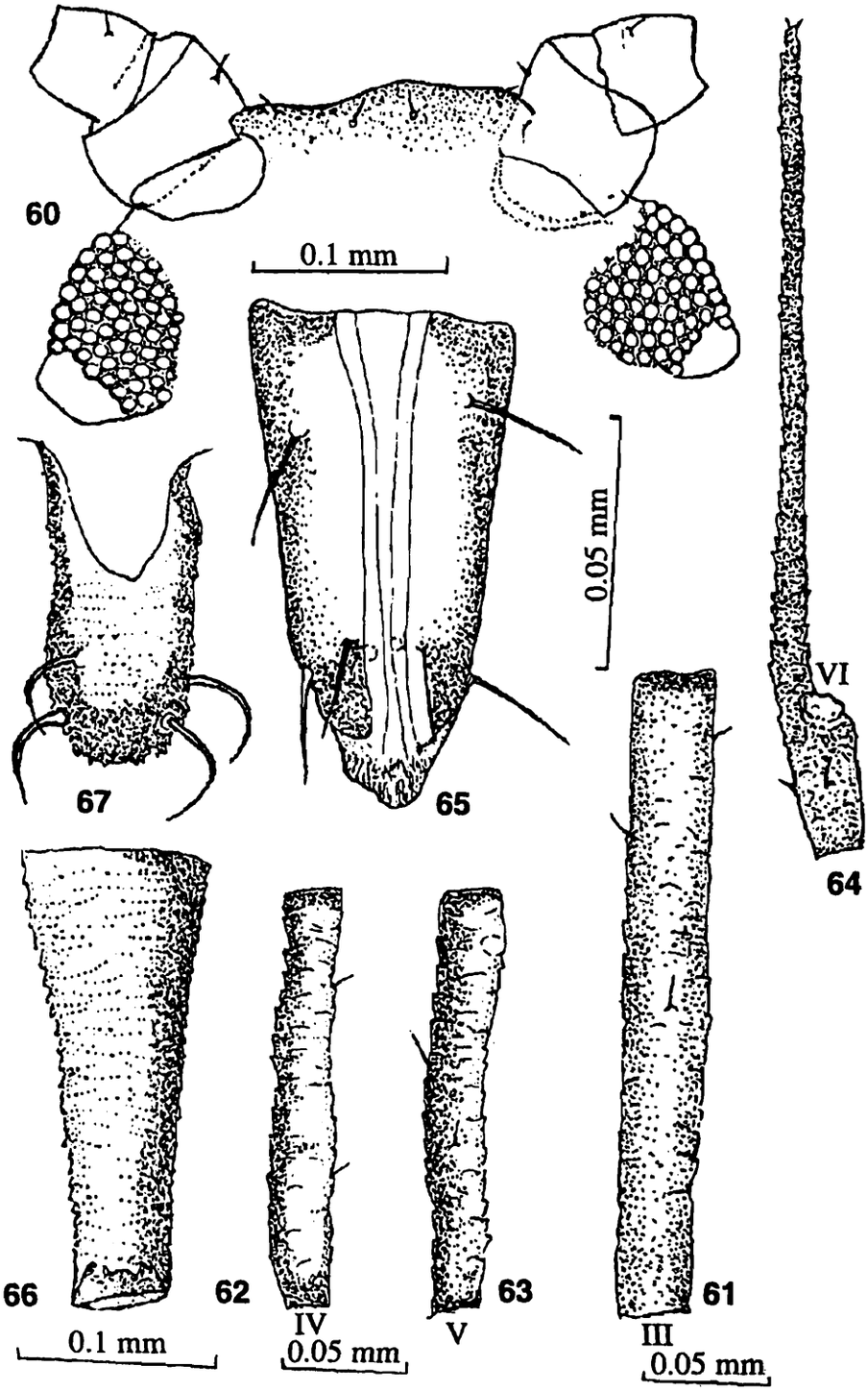
1990. Ghosh, L. K., *Mem. zool. Surv. India,* **17**(3) : 45-48.

1994. Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series*, 3(Part-5) : 159. Zool. Surv. India.

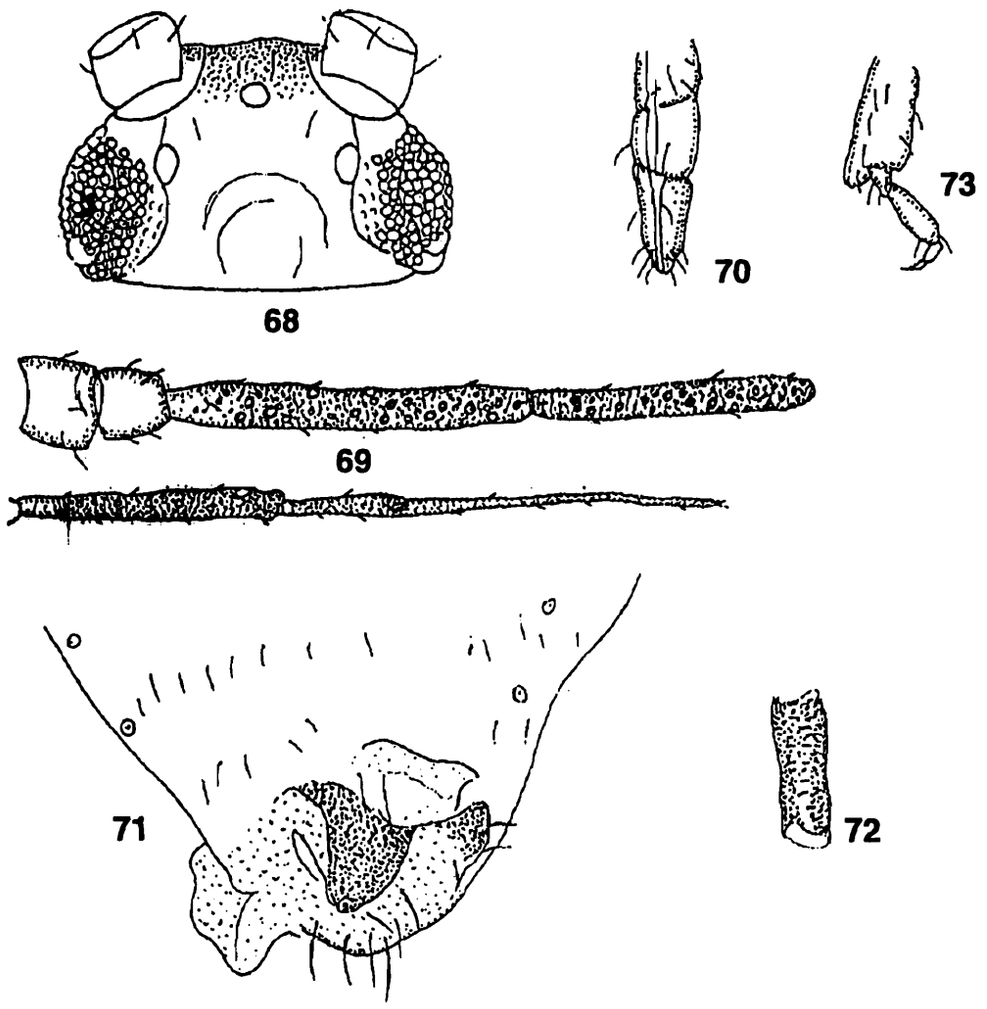
1998. Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series*, **4** : 109. Zool. Surv. India.

2000. Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7** (pt. 2) : 353. Zool. Surv. India.

Apterous viviparous female : Body pale, 0.8-1.6 mm long with 0.4-1.0 mm as its maximum width near the middle of abdomen. Antennae mostly 5-segmented sometimes may be 6-segmented, about 0.50-0.80 times as long as body; p.t. (Fig. 64) 1.8-2.4 times as long as base of a.s. VI. Rostrum reaching midcoxae, u.r.s. (Fig. 65) 1.0-1.20 times the length of ht2. Abdomen pale, without polygonal reticulation and postsiphuncular



Figs. 60-67. *Aphis nasturtii* Kaltenbach : Aptera. 60. Head; 61. a.s. III; 62. a.s. IV; 63. a.s. V; 64. a.s. VI; 65. u.r.s.; 66. Siphunculus; 67 Cauda.



Figs. 68-73. *Aphis nasturtii* Kaltenbach : Alate male. 68. Head; 69. Antenna; 70. u.r.s.; 71. posterior abdominal dorsum showing genitalia; 72. Siphunculus; 73. portion of hind tibia showing tarsal segments.

sclerite : Siphunculi (Fig. 66) 0.11-0.14 times as long as body and 1.1-1.5 times the length of cauda (Fig. 67) bearing 4-5 hairs. Tibial hairs short, longest hair on tibiae at most 0.5 times as long as mid diameter of the tibia.

Alate viviparous female : Body pale to dark brownish, 0.9-1.9 mm as its maximum width. Antennae 6-segmented, 0.6-0.7 times as long as body; p.t. 2.0-3.5 times as long as base of a.s. VI; a.s. III with 5-9, IV with 0-1 secondary rhinaria; u.r.s. 1.2-1.3 times as long as ht2. Abdominal dorsum pale with scattered brown sclerite; siphuncular sclerites distinct; longest hair on anterior tergites about as long as b.d. III. Siphunculi nearly 0.1 times as long as body and 1.4-1.7 times the length of cauda bearing 4-5 hairs. Femoral hairs nearly of equal lengths, longest one slightly longer than b.d. III; F.T.C. 3:3:2; second tarsal segments usually with three pairs of primary hairs.

Host plants : In India, the species infests nearly 74 species belonging to 64 genera under 37 plant families (L. K. Ghosh, 1990).

Symptom and Damage : The nymphs as well as adults suck the plant sap and thus deprive the plants with nutrients so that they become weak. Severe infestation results in curling of leaves, started growth and gradual drying and death of young plants.

Life cycle : It is a polymorphic species. Adults of both apterae and alatae are viviparous and reproduce by parthenogenesis. However, sexual morphs of both apterous oviparous females and alate males (Figs. 68-72) are known to occur in India. This hints at the possibility of holocyclic life cycle of the species in the Indian conditions.

Natural enemy-complex :

Predators : *Binodoxys indicus* Subba Rao and Sharma; *Lepolexis scutellaris* Mackauer [Hymenoptera] [*Source* : Omkar and Perver 2000]

Distribution : India : Arunachal Pradesh, Haryana, Himachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Uttar Pradesh, West Bengal; America; Europe; Great Britain; Middle East; Nepal; Pakistan; Taiwan; U.S.A.

Remarks : Deep yellow to brown yellow aphids infest mainly the aerial parts of the host plants. It is a minor pest of Potato. *Aphis nasturtii* is sometimes confused with *A. gossypii* but in the former the secondary tarsal segment is only with primary hairs.

Management : As in the case of *Aphis gossypii* Glover.

6. ***Aphis nerii*** Boyer de Fonscolombe, 1841
(Figs. 74-79, 411, 412, 423)

1841. *Aphis nerii* Boyer de Fanscolombe, *Annls. Soc. Ent. Fr.*, **10** : 179;

1909. Lefroy and Howlett, *Indian Insect Life* : 743-748;

1918. Das, B., *Mem. Indian Mus.*, **6**(4) : 220-222.

1919. Krishnamurti, *J. Bombay nat. Hist. Soc.*, **33** : 211-215.

1927. George, *J. Asiat. Soc. Bengal*, **23** : 1-12.

1938. Deshpande, *J. Bombay nat. Hist. Soc.*, **39** : 740-744.

1940. Ghulamullah, *Indian J. Ent.*, **2** : 13-25.

1947. Mukherjee, Behura and Basant Kumar, *J. Bombay nat. Hist. Soc.*, **47** : 774-775.

1955. Banerjee and Basu, A. N., *Curr. Sci.*, **24** : 61.

1958. David, *Indian J. Ent.*, **19** : 171-180.

1959. Ghosh, A. K. and Raychaudhuri, D. N., *J. Bombay nat. Hist. Soc.*, **56** : 660-664.

1962. Sengupta, Das, J. N. and Behura, *Prakruti Utkal Univ. J. Sci.*, **2** : 33-39.

1963. Behura, *Proc. First Summer School of Zoology*, **25** : 78.

1965. Behura, *Prakruti Utkal Univ. J. Sci.*, **3** : 40-65.

1968. Ghosh, A. K. and Raychaudhuri, D. N., *Proc. zool. Soc., Calcutta* **21** : 179-195.

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1969. Rao, *CIBC. U. S. PL. 480 Project Final Tech. Rep.* : 1-93.

1970. Dharmadhikari and Ramaseshiah, *CIBC Tech. Bull. let.,* **13** : 83-89.

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1971. Verma, *Sci. Cult.,* **37** : 248-249.

1973. Behura and Dash, *Prakruti Utkal Univ. J. Sci.,* **8** : 53-64.

1974. Basu, R. C., Ghosh, M. R. and Raychaudhuri, D. N., *Sci. Cult.* **40** : 41-43.

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1975. Chakrabarti and Raychaudhuri, D. N., *Oriental Ins.,* **9** : 195-211.

1978. Mondal, Agarwala and Raychaudhuri, D. N., *Sci. Cult.,* **44** : 89-92.

1978. Misra and Kurl, *Geobios,* **5** : 83.

1979. Kurl and Misra, *Geobios,* **6** : 286-287.

1980. Chattapadhyay and Raychaudhuri, D. N., *Sci. Cult.,* **46** : 326-328.

1980. Raychaudhuri, D. N. (*ed*), Aphids of Northeast India and Bhutan, The Zoological Society, Calcutta : 1-521.

1980. Kulkarny and Kacker, *Bull. zool. Surv. India,* **3** : 103-105.

1981. Agarwala, Raychaudhuri, D. and Raychaudhuri, D. N., *Akitu,* new series, **39** : 1-16.

1990. Ghosh, L. K., *Mem. zool. Surv. India,* **17**(3) : 48-51.

1994. Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** : 159. Zoological Survey of India.

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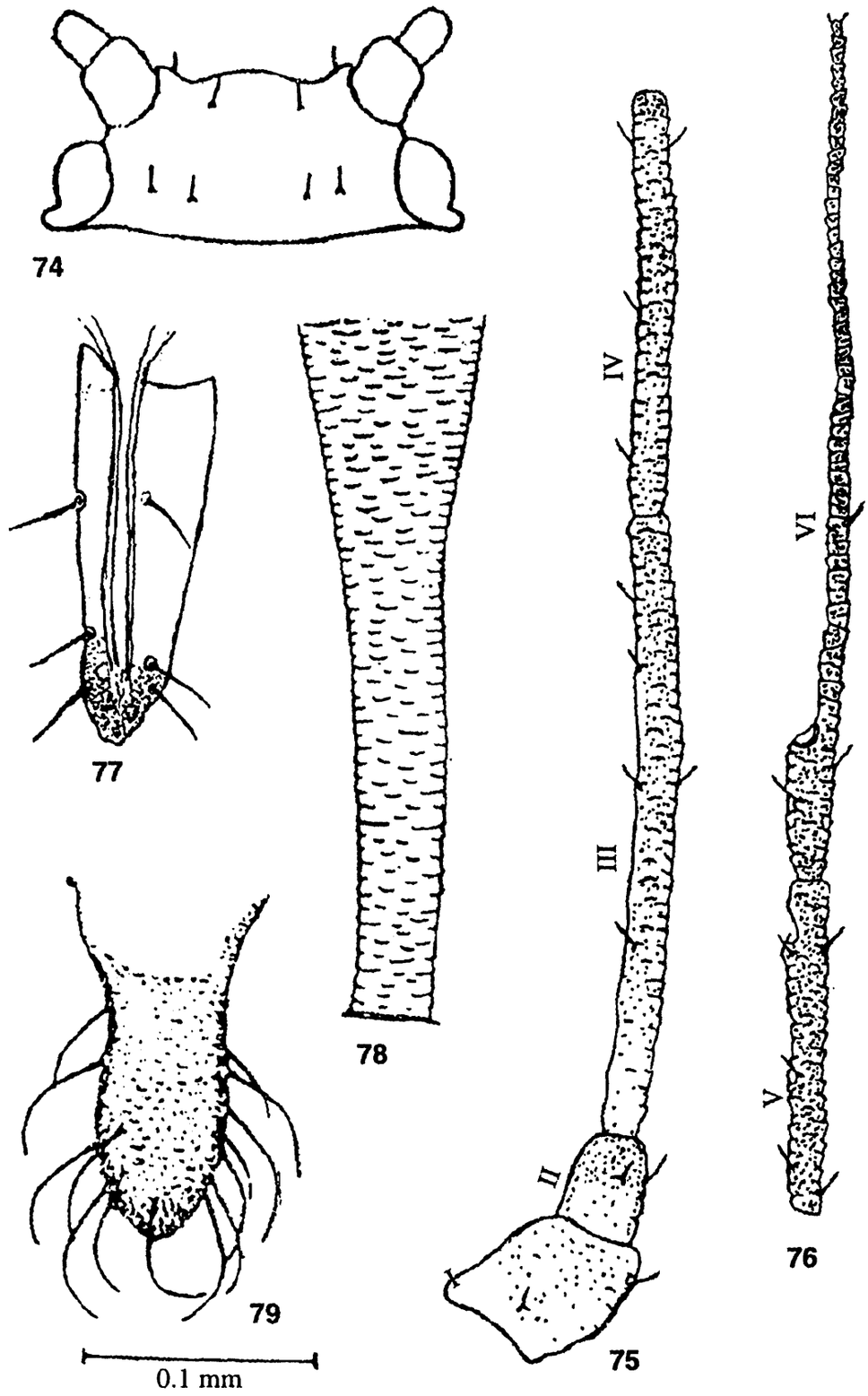
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2000. Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7** : 353. Zool Surv. India.

2001. Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 14.

2004. Basu, R. C. and Ghosh, L. K. In : Hemiptera : Aphididae, *Fauna of Manipur, State Fauna Series,* **10**(Part-2) : 185. Zoologycal Survey of India.

Diagnosis : *Apterous viviparous female* : Body bright yellow with dark siphunculi, 1.75-2.7 mm long with 0.9-1.7 mm as maximum width. Antennae 6-segmented (Figs. 75, 76), 1.0-1.8 times as long as body; p.t. 3.8-4.3 times as long as base VI. Rostrum reaches upto the hind coxae or beyond, u.r.s. (Fig. 77) 1.2-1.6 times as long as h.t.2. Abdominal dorsum with dorsal polygonal reticulations, abdominal hairs arranged in rows across the abdominal segments, longest hair on anterior abdominal tergites about 0.9-1.2 times as long as b.d. III. 8th tergite with 2 hairs. Siphunculi (Fig. 78) stout, broad, dark brown, cylindrically tapering towards apex, about twice as long as cauda (Fig. 79) bearing 9-11 hairs. F. T. C. 3 : 3 : 3. Second tarsal segment with both dorsal and ventral secondary hairs.



Figs. 74-79. *Aphis nerii* B.d.F. : Aptera viviparous female. 74. Head; 75, antennal segments I-IV; 76. a.s.V-VI; 77. ultimate rostral segment; 78. Siphunculus; 79. Cauda.

Alate viviparous female : Body 1.5-2.5 mm long with 0.6-1.0 mm as maximum width. Antennae 6-segmented, about 0.7-0.9 times as long as body, a.s. III with 6-14 secondary rhinaria distributed over entire length, a.s. IV with 0-2 secondary rhinaria, u.r.s. 1.20-1.25 times as long as b.d. III. Siphunculi stubby, cylindrical, dark brown, imbricated and about 1.7-2.0 times the length of cauda, with antesiphuncular sclerite. Cauda dark, somewhat conical, spinose, imbricated, bearing 10-11 hairs; wing venation normal.

Host plants : *Asclepias curassavica, Asclepias* sp., *Bryophyllum pinnatum, Calotropis gigantea, Calotropis procera, Calotropis* sp., *Cryptostegia grandiflora, Cucurbita moschata, Daemia extensa, Daemia* sp., **Dreca volubilis, Duranta plumieri, Duranta repens, *Gymnema sylvestre, Lyonia ovalifolia, Nerium odorum, Nerium* sp., *Tylophora asthmatica.* [*Plant of medicinal importance.]

Symptom and Damage : Both the nymphs and adults suck the plant sap. As a result, the leaves curl downwards and the plants give a very shabby look. The aphid species attacks ornamental plants (*Asclepias curassavica* etc.) and the maximum infestation is found from February to April.

Life cycle : In the Indian conditions, life cycle and detailed biology of the species is not properly known. *A. nerii* reproduces parthenogenetically in India. There is no record of occurrence of sexual morphs of the species either in the plains or in the hills. So, the species enjoys only anholocyclic life in the country.

Natural enemy-complex :

Predators : *Coccinella septempunctata* (L.) [Coleoptera : Coccinellidae]; *Adonia* sp. [Coleoptera : Coccinellidae]; *Machinus indianus* (Ric.) [Diptera : Asilidae]; *Ischiolon scutellaris* (Fabricius); *Syrphus* sp. [Diptera : Syrphidae] (*Source* : Omkar and Pervez 2000)

Parasitoids : *Aphidius colemani* (Vierecx) [Hymenoptera : Aphiidinae : Braconidae]

Vector : The species is responsible for the following virus diseases :

Bittergourd mosaic; Calotropic mosaic; Cardamom mosaic or katte disease; Cynodon mosaic; Papaya distortion ring spot; Sugarcane mosaic;

Distribution : India : all over.

Elsewhere : Cosmopolitan.

Remarks : *Aphis nerii* B.d.F. bright yellow aphid can be distinguished from both *A. craccivora* Koch and *A. gossypii* Glover in the colour and number of caudal hairs (9-11). The species is also distinguished from a close member *A. spiraecola* Patch in the length and structure of the anterior hairs of the femora, which are normal with easily observed apices, and not more than 0.75 times as long as the minimum diameter of the femora.

Management : Generally sprays of carbaryl or dimethoate are recommended.

7. *Aphis pomi* de Geer
Melon aphid
(Figs. 80-89)

1773. *Aphis pomi* de Geer, *Memores Pour Servir a Histoire des Insectes Stockholm, Aphids,* **3** : 30.

1963. Behura, *Proc. First Summer School of Zoology, Govt. of India publ.* : 25-78.

1964. Sharma and Bhalla, *Indian J. Ent.,* **26** : 318-331.

1972. Hayat, *Entomophaga,* **17** : 49-58.

1979. Rishi, additional records of Aphid fauna of J. & K., *Symp. on recent trends in aphidological studies, Bhubaneswar* : 52.

1980. Bhalla and Pawar, *A Survey of insect and noninsect pests of economic importance in H. P.,* Dept. of Entomology—Zoology, College of Agriculture, Chambaghat, Solan.

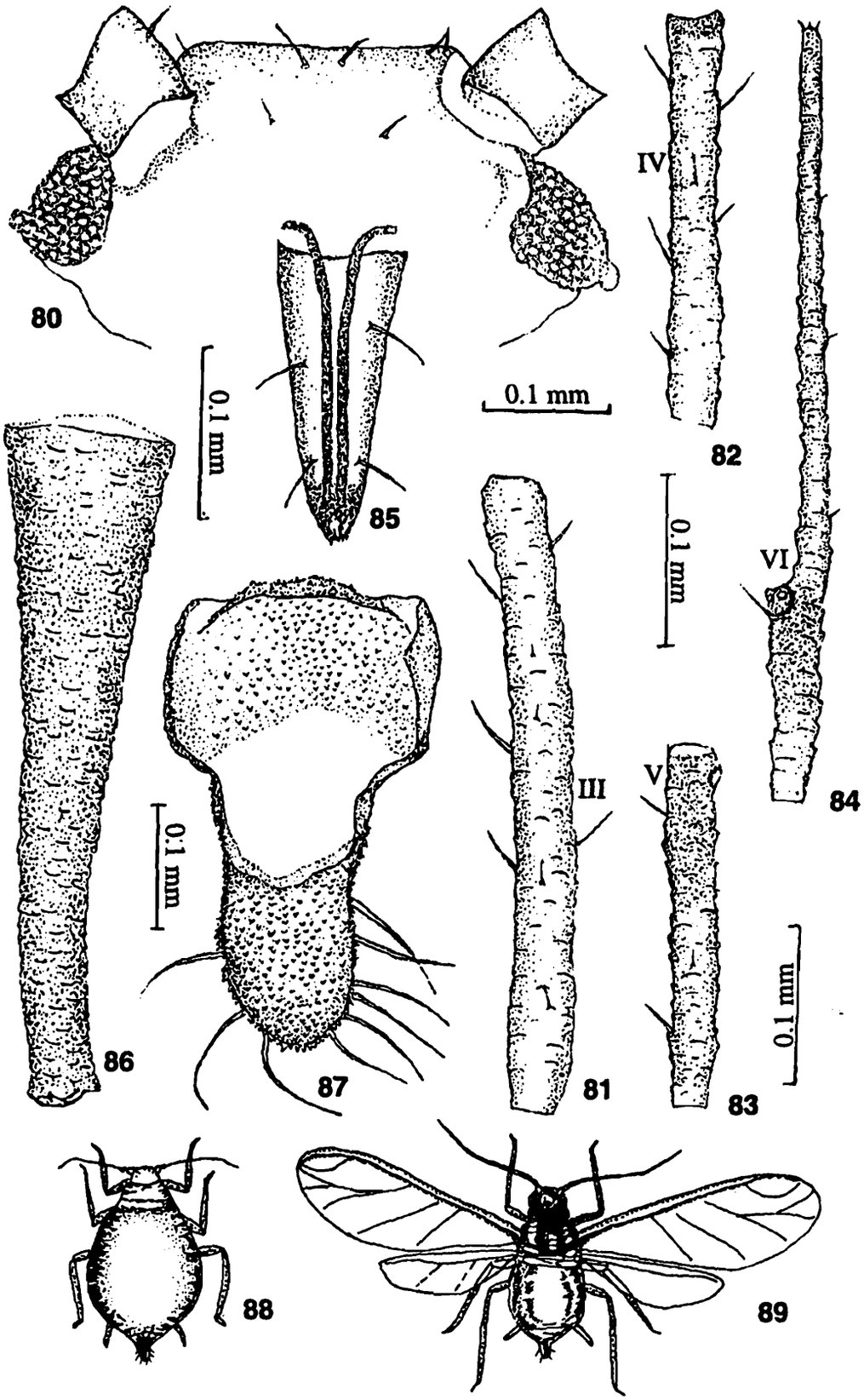
1990. Ghosh, L. K., *Mem zool. Surv. India,* **17**(3) : 56.

Diagnosis : *Apterous viviparous female* : Body 1.80-1.97 mm long. Head (Fig. 80) brown with small antennal tubercle; dorsum of head smooth, hairs on dorsum medium-sized. Antennae 6-segmented, nearly 0.75 times as long as body; flagellum (Figs. 81-84) more distinctly imbricated from base towards apex, p.t. (Fig. 85) 2-3 times as long as base VI, longest hair on a.s. III about twice as long as b.d. III, u.r.s. (Fig. 85) a little longer than to 1.5 times the length of ht2. Abdominal dorsum rather paler with reticulated pattern, hairs on anterior abdominal tergites about half as long as b.d. III. Lateral abdominal tergite with 2 hairs. Siphunculi (Fig. 86) dark, cylindrical, imbricated, tapering from base to apex, with moderately developed flanged at the tip, about 1.3 times the length of dark cauda. Cauda (Fig. 87) elongated, concolourous with siphunculi, spinose, slightly constricted near at the middle, bearing 7-12 (usually 8) hairs. F. T. C. 3:3:2; second segment of hind tarsus with both primary and secondary hairs, legs yellowish brown except the tarsi being black.

Host plant : *Malus* sp. (N.O. Rosaceae).

Symptoms & Damage : Both foliage and fruits are injured by the piercing, sucking nymphs and adults. Evidence of their activity is indicated by curled, twisted, stunted leaves, specially the tender terminal growth of new shoots, and stunted malformed clusters of fruits later in the season. Bhagat *et al.* (1988) made valuable observations on nature of damage caused by this pest species, its population density and natural enemy complex of this important succivorous pest.

Bionomics : Not much is known about the biology of this apple aphid in India. However, an idea is given below as to its life cycle usually observed in apple growing areas of North America. Here winter is passed in egg stage on twigs, usually around buds or in crevices in the bark. These begin hatching in spring just as the buds are in the green tip stage. Newly hatched nymphs are all wingless females and when



Figs. 80-89. *Aphis pomi* de Geer : Aptera. 80. Head; 81. a.s. III; 82. a.s. IV; 83. a.s.v; 84. a.s. VI; 85. u.r.s.; 86, Siphunculus; 87, cauda; 88. Apterous viviparous female; 89. Atale viviparous female.

fully grown are called stem mothers. These parthenogenetic females give birth to young with repeated generations occurring about every two weeks. Early in the summer winged forms are produced which migrate to new host plants of the same species or to plants of a different species. These alternate hosts are often called the secondary hosts. Reproduction continues throughout the summer and in autumn winged forms develop on the secondary hosts that return to the primary host. Here are born nymphs that develop into true sexual forms; these mate, the females depositing the overwintering egg. The eggs are green when first laid but soon turn shining black. [Source : Insect pests of Farm, Garden and orchard, R. H. Davidson and L. M. Peairs, John Wiley & sons, Inc. New York (1966) : 430-433. (6th Edition)].

Natural enemy-complex :

Predators : Lady bird beetles : Coleoptera : Coccinellidae; *Adalia tetraspilota* (Hope); *Adonia variegata* (Goeze); *Ballia* sp.; *Brumoides suturalis* (Rab.); *Chilocorus rubidus* Hope; *Coccinella septempunctata* Linn.; *Coccinella tibatina* Kapur; *Harmonia dimidiata* (Fab.); *Menochilus sexmaculatus* (Fab.); *Oenopia sauzeti* Mulsant; *Scymnus gracilis* Motschulsky.

Hoverflies : Diptera : Syrphidae; *Episyrphus balteatus* (de Geer); *Macrosyrphus confrater* (Weid.); *Metasyrphus corollae* (Fab.); *Scaeva pyrastri* (Linn.); *Sphaerophoria bengalensis* Macquart

Green Lacewing : Neuroptera : Chrysopidae; *Chrysoperla carnea* Steph

Brown Lacewing : Neuroptera : Hemerobidae; *Hemrobius* sp.

Spiders : Areneae : Araeidae; *Araneae* sp. [*Source* : Omkar and Pervez 2000]

Parasitoid : Hymenoptera : Aphidiidae; *Trioxys indicus* Subba Rao & Sharma

Distribution : India : Widely distributed.

Elsewhere : China; Europe; France; Middle East; Taiwan.

Remarks : *Aphis pomi* is an economically important pest of apple trees in most apple growing areas of the world wide (Oatman and Lenger 1961; Holdsworth 1970; Carroll and Hoyt 1984). Malik *et al.* (1972) reported the species infesting apple trees from Kashmir valley.

Management : In spite of association of good number of predators and parasites with apple aphid yet the population of *Aphis pomi* attains economic injury level on apple plantations. Thus, natural enemies alone are not effective to hold populations of aphids under check. It is, therefore, suggested that insecticides, chemicals having selective aphicidal action which cause least harm to these biological control agents, should be screened and recommended for their judicious and need based use for aphid control.

8. ***Aphis punicae*** Passerini
Pomegranate aphid
(Figs. 90-96)

1863. *Aphis punicae* Passerini, *Arch. Zool. Anuat. Fisiol.* (Modena), **2** : 32.

1958. Basu, A. N. and Banerjee, S. N. *Indian agric.,* **2** : 80-112.

1958. David, *Indian J. Ent.,* **19** : 121-180.

1963. Behura, *Proc. First Summer School of Zoology* : 25-78.

1969. Chowdhuri, Basu, R. C. and Raychaudhuri, D. N., *Sci. Cult.,* **35** : 334-335.

1970. Ghosh, A. K., Basu, R. C. and Raychaudhuri, D. N., *Oriental Ins.,* **4** : 64-76.

1971. Bhalla, *Himachal J. Agric. Res.,* **1** : 51-52.

1973. Raychaudhuri, D. N., *USPL 480 Project Tech. Rep.* : 1-107.

1975. Verma, Khurana and Bhanot, *Haryana agric. Univ. J. Res.,* **5** : 11-14.

1980. Raychaudhuri, D. N. (*ed.*) Aphids of Northeast India and Bhutan. The Zoological Society, Calcutta : 1-521.

1980. Bhalla and Pawar, *A Survey of insect and noninsect pests of economic importance in H. P., Dept. of Entomology, Zoology, College of agriculture, Chambaghat,* Solan.

1918. *Aphis duranti* Das, B. *Mem, Indian Mus.,* **6** : 135-274.

1990. *Aphis punicae* : Ghosh, L. K., *Mem. zool. Surv. India,* **17**(3) : 57.

1994. Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series* 3, Zool. Surv. India : 159.

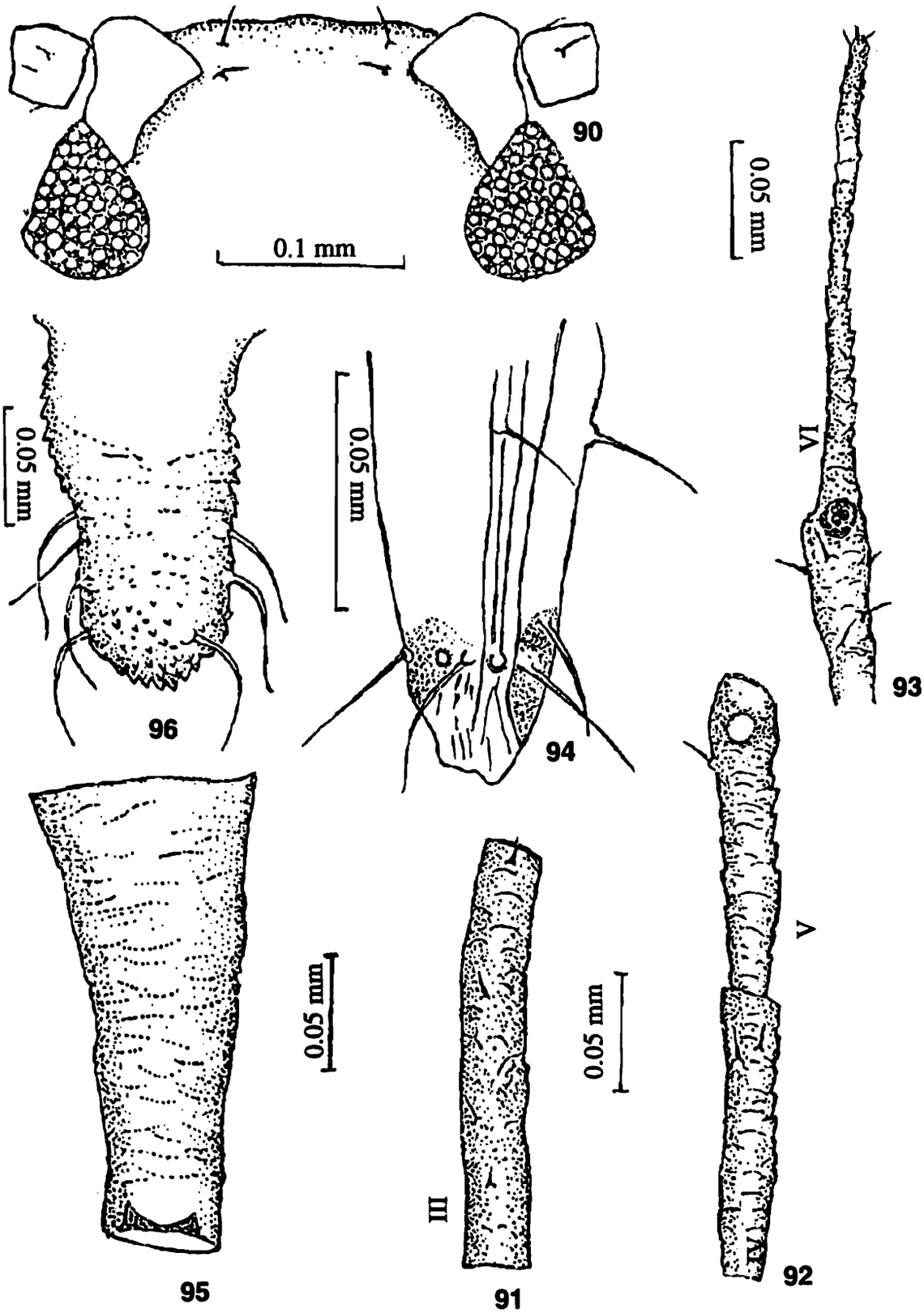
1998. Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series* 4, Zool. Surv. India : 110.

2000. Ghosh, L. K. and Basu, R. C., *Fauna of Tripura,* pt. 2, *State Fauna Series* 7, Zool. Surv. India : 353.

Apterous viviparous female : Body 1.2-1.56 mm long with 0.80-0.90 mm as the maximum width near the middle of the abdomen. Antennae pale, about half as long as the body; a.s. III (Fig. 91) subequal to or slightly longer than siphunculi; p.t. (Fig. 93) much shorter than a.s. III, about 2.5 times as long as base VI. u.r.s. (Fig. 94) as long as or a little longer than ht2, bearing 2 secondary hairs; dorsum of abdomen pale; dorsal hairs appreciable shorter that b.d. III; 8th tergite with 2 hairs. Siphunculi (Fig. 95) smooth, pale, a little dusky near the apices, distinctly imbricated, 0.10-0.15 times as long as body and 1.1-1.3 times as long as pale and blunt cauda (Fig. 96) having bulbous base and bearing 6-10 hairs. Legs pale brown with the tarsi slightly darker; femoral and tibial hairs shorter than the diameter of hind tibiae near at the middle.

Host plant : *Punica* spp. (N.O. Punicaceae)

Symptom and Damage : Both nymphs and adults of the pale green aphid infest the leaves, twigs and inflorescence of the host plant. As a result of infestation, a sooty mould on the excretion develops. This covers twigs, leaves and fruits. It interferes with assimilation and renders the fruit unfit for market.



Figs. 90-96. *Aphis punicae* Passerini : Aptera. 90. Head; 91. a.s. III; 92. a.s. IV-V; 93. a.s. VI; 94. u.r.s.; 95. Siphunculus; 96. Cauda.

Natural enemy-complex :

Scymnus castaneus (Sicard) [Coleoptera : Coccinellidae]

Distribution : India : Himachal Pradesh, Manipur, Meghalaya, West Bengal.

Elsewhere : Africa; Europe; France; Italy; Morocco; Pakistan; Switzerland; U.S.S.R.

Remarks : The species can be distinguished from *A. gossypii* Glover (which also infests *Punica*) by its pale green body with pale siphunculi.

Management : As in the case of *Aphis gossypii* Glover.

9. ***Aphis spiraecola*** Patch
(Fig. 97-108, 413, 414)

1914. *Aphis spiraecola* Patch, *Bull. Me. agric. exp. stn.*, **233** : 270.

1917. *Aphis malvoides* Das, *Mem. Indian Mus.*, **6** : 135-274.

1929. *Aphis bidentis* Theobald, *Entomologist,* **62** : 177-181.

1976. *Aphis citricola* v. d. Goot : Eastop and Hille Ris Lambers, Survey of the world's Aphids : 49.

1980. *Aphis spiraecola* Patch : Raychaudhuri, D. N. (*ed.*), Aphids of North-East India and Bhutan : 58.

1986. *Aphis citricola* v. d. Goot : Ghosh, L. K., *Tech. Mon.* No. **16**, *Zool. Surv. India* : 24.

1990. *Aphis citricola* v. d. Goot : Ghosh, L. K. *Mem. zool. Surv. India,* **17**(3) : 16.

1994. *Aphis citricola* v. d. Goot : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** : 156. Zool. Surv. India.

1997. *Aphis spiraecola* Patch : Remaudiere, G and Remaudiere, M. Catalogue of World's Aphididae : 48.

2001. *Aphis spiraecola* Patch : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 14.

Diagnosis : *Apterous viviparous female* : Body 1.5-2.5 mm long with 0.8-1.4 mm as its maximum width. Antennae 6-segmented (Figs. 98-101), about half as long as body; p.t. 2.0-2.5 times as long as base VI; u.r.s. (Fig. 102) about as long as h.t. 2. Abdominal dorsum pale, without sclerotic pigmentation; 7th tergite with 4 hairs. Siphunculi (Fig. 103) dark, tapering, 0.9-1.8 times as long as cauda being dark broad with a narrow constriction near basal 0.4 portion and with 7-14 hairs. Femoral hairs (Fig. 106) at least in part, with finely drawn out apices, longer ones about as long as to longer than minimum width of the femur near the trochantro-femoral suture; F.T.C. 3 : 3 : 2.

Alate viviparous female : Body 1.2-2.2 mm long with 0.5-1.0 mm as its maximum width. Antennae (Fig. 107) 6-segmented, about half as long as body; p.t. 2.0-2.7 times as long as base VI, a.s. III with 4-10, VI with 0-5 secondary rhinaria. U.r.s. about as long as h.t.2. Abdominal dorsum (Fig. 105) pale with segmentally arranged marginal

sclerotic patches and distinct post siphuncular sclerite. 8th abdominal segment with median sclerite between the bases of siphunculi; siphunculi (Fig. 105) dark brown, 1.1-1.4 times as long as cauda (Fig. 105) being dark, broad with a narrow constriction near basal 0.5 portion, and bearing 9-11 hairs. Wing venation normal (Fig. 108). Other characters as in Apterae viviparae.

Host plants : Highly polyphagous species infesting Acanthaceae, Amaranthaceae, Anacardiaceae, Apocynaceae, Araliaceae, Boraginaceae, Caesalpinae, Capritoliaceae, Caryophyllaceae, Chenopodiaceae, Commelinaceae, Compositae (Asteraceae), Convolvulaceae, Crassulaceae, Cruciferae (Brassicaceae), Cucurbitaceae, Ericaceae, Euphorbiaceae, Labiatae, Lauraceae, Lythraceae, Malvaceae, Melastomaceae, Moraceae, Musaceae, Myrsinaceae, Myrtaceae, Nyctaginaceae, Oleaceae, Papilionaceae, Panifloraceae, Polygonaceae, Punicaceae, Ranunculaceae, Rhamnaceae, Rosaceae, Rubiaceae, Rutaceae, Saxifragaceae, Solanaceae, Styracaceae, Ternstroemiaceae, Umbelliferae, Urticaceae, Valeriniaceae and Verbenaceae.

Symptom and Damage : The pest species usually colonises the undersurface of leaves and tender buds of the host plants chiefly *Citrus* group of fruit trees. The leaves become slightly curled as a result of heavy infestation. As soon as leaves harden in the early summer the number of the aphid population becomes greatly reduced.

Besides, the aphid also affects citrus plants by interfering the growth activity of the tender parts and resulting in malformation of leaves and fruits. Also, under heavy infestation the large amount of excreted honey dew serve as a medium for sooty fungus growth that stains the fruits and leaves. Newly planted ones are said to suffer the greatest injury.

Bionomics : The species is not host specific to *Citrus* plants, instead it has wide preference of alternate hosts. Thus, its association on citrus plants is only occasional. Emigrant alate normally initiates colony on the tender leaves and shoots during late monsoon and sizeable population is produced on apical twigs, branches and sometimes even on young fruits. Increase in population is accompanied by the production of alatae and a large part of the aphid infestation migrates to other plants. *Citrus* plants support moderate to heavy aphid population for 2-3 months and it is preceded and suceeded by poor colonization for 15-20 days respectively. Ants are often associated with this aphid.

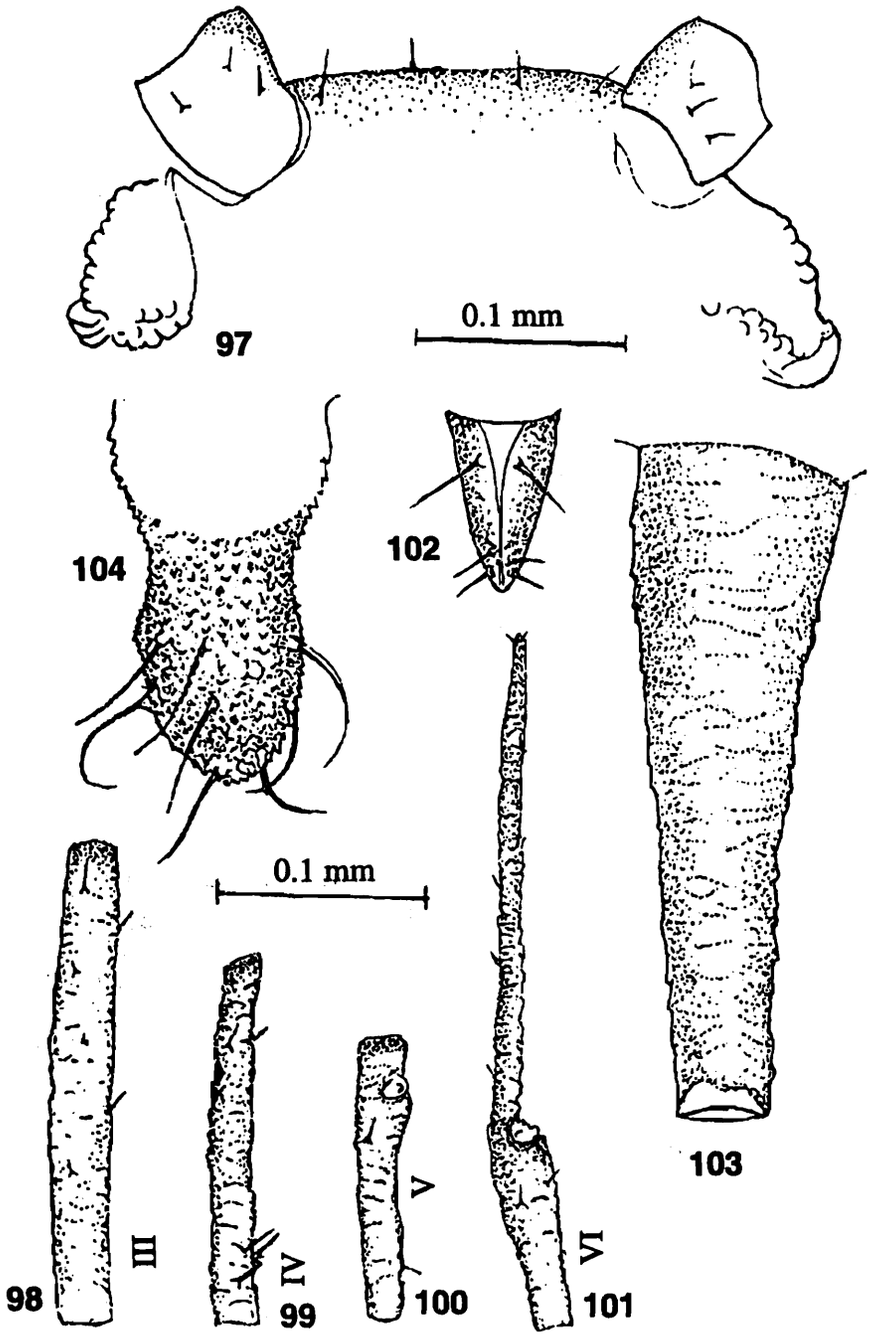
The species usually reproduces anholocyclically. However, Ghosh, A. K., Ghosh, M. R. & Raychaudhuri, D. N. (1972) reported sexual female of the species for the first time in India.

Natural enemies-complex :

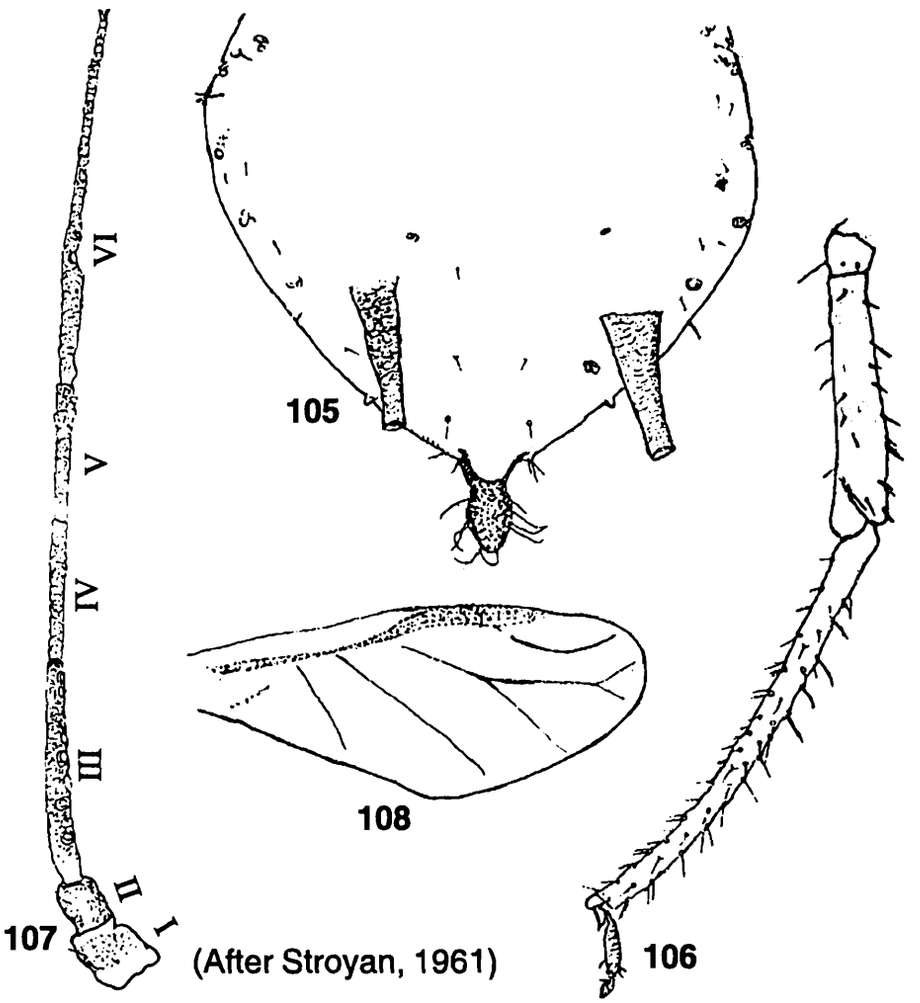
Predators : *Ischiodon scutellaris* (Fabr.); *Pragus yoserratus* (Fabr.); *P. tibialis* Fall; *P. yerburyensis* Stack; *Syrphus balteatus* (De Geer) [Diptera : Syrphidae]; *Ballia diane* Mulsant; *Cheilomenes sexmaculata* (Fabricius); *Coccinella septempunctata*

(Linnaeus); *C. transversalis* Fabricius; *Henosepilachna vigintioctopunctata* (Fabricius); *Hyperaspis maindroni* Sicard; *Lemnia bisellata* (Mulsant); *Micraspis discolor* (Fabricius); *Platynaspis* sp.; *Pseudospidimerus circumflexus* (Mots.); *Pullus pyrochellus* Mulsant; *Scymnus guimeti* (Mulsant); *S. pyrocheilus* Mulsant [Coleoptera : Coccinellidae] [*Source* : Omkar and Pervez 2000]

Parasitoid : *Aphelinus flavipes* Fors. [Hymenoptera : Aphelinidae]; *Aphidium matricariae* Haliday; *Ephedrus palgiator* (Nees); *Lipolexis scutellaris* Mackauer; *Praon*



Figs. 97-104. *Aphis spiraecola* van der Goot : Aptera. 97. Head; 98. a.s. III; 99. a.s. IV; 100. a.s. V; 101 a.s. VI; 102. u.r.s.; 103. Siphunculus; 104. Cauda.



Figs. 105-108. *Aphis spiraecola* Patch : Aptera : 105. poserior abominal dorsum; 106. hind leg showing femoral hairs; Alata. 107. Antenna showing secondary rhinaria;. 108. hindwing.

myzophagum Mackauer *Trioxys (Binodoxys) indicus* Subba Rao and Sharma [Hymenoptera : Aphidiidae] [Source : Stary and A. K. Ghosh 1983]

Fungus : *Entomopthora fresenii* (Nowakowskii); *Cephalosporium aphidicola* Petch

Vector : Citrus tristeza virus disease; Bean common mosaic, Beet mosaic, Papaw mosaic.

Distribution : India : all over.

Elsewhere : Africa; Australia Bhutan; Bermuda Is.; China; Java; Hawaii; Nepal; New Zealand; North America; Pakistan; Sri Lanka; Sumatra; Sytia; Taiwan; Thailand & Vietnam.

Remarks : The species is close to *A. pomi*. The morphological differences between these two species are difficult to evaluate. In *spiraecola*, marginal tubercles on abdominal segments 2-5 absent, also u.r.s. rather shorter. In *A. pomi* u.r.s. is about

3 times as long as wide at the base, while in *A. spiraecola* it is only twice as long as wide. Moreover, in *spiraecola*, there are less hairs on the cauda (apterae 8-15, alatae 7-14) than in *pomi* which bears 14-20 in apterae and 13-20 in alatae.

Genus 2. ***Toxoptera*** Koch

1857. *Toxoptera* Koch, *Die Pfl. Aphiden,* **3** : 253.

Type species : *Aphis aurantii* Boyer de Fonscolombe, 1841.

Head smooth without lateral frontal tubercles. Antennae 6-segmented, shorter to slightly longer (0.53-1.08) than body; flagellum gradually more distinctly imbricated from base towards apex; apterae without secondary rhinaria, alatae always with secondary rhinaria; p.t. 2.05-6.37 × base of last antennal segment; flagellar hairs short to rather long with acute, acuminate or slightly blunt apices. U.r.s. nearly as long as to 1.60 × h.t. 2, with 2 secondary hairs. Abdominal dorsum in apterae pale with polygonal reticulations and with large post-siphuncular sclerite and scattered muscleplate-like structure, alatae with large postsiphuncular patch transverse bars on 7th and 8th tergites. Dorsal abdominal hairs with acute apices. Siphunculi brown to dark brown, weakly to strongly imbricated, rather cylindrical with indistinct to distinct apical flange. Cauda elongate and constricted at middle and bears 10-46 long hairs; hindtibiae with a row of peg-like stridulatory spines. F. T. C. 3 : 3 : 3 or 3 : 3 : 2.

Key to the species of the genus *Toxoptera*

Apterous viviparous female :

Cauda with 8-16 hairs; longest hair on a.s. III shorter than b.d. III; siphunculi sparsely rather less imbricated..... *aurantii*

– Cauda with 20-35 hairs; longest hair on a.s. III longer (1.2-1.5 times) than b.d. III; siphunculi heavily imbricated, blackish ..... *citricidus*

Alate viviparous female :

Small insects (1.5-1.8 mm long); a.s. III almost rather pale; secondary rhinaria distributed : III 4-8, IV 0, V 0; longest hair on a.s. III usually not longer than b.d. III. ..... *aurantii*

– Large insects (2.2-2.5 mm long); a.s. III black except base; secondary rhinaria distributed : III 8-20, IV 0-5; longest hair on a.s. III always longer than b.d. III. ..... *citricidus*

10. ***Toxoptera aurantii*** (Boyer de Fonscolombe) (Figs. 109-113, 415, 431)

1841. *Aphis aurantii* Boyer de Fonscolombe, *Annals. Soc. ent. Fr.,* **10** : 178.

1976. *Toxoptera aurantii* (B.d.F.) : Mondal, P., Basu, R. C., and Raychaudhuri D. N., *Oriental Ins.,* **10**(4) : 535-537.

1992. *Toxoptera aurantii* : Agarwala and Bhattacharya, *Soc. Nat. Sci.*, **2** (3 & 4) : 2.

1994. *Toxoptera aurantii* : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series*, **3** : 161. Zool. Surv. India.

1998. *Toxoptera aurantii* : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series*, **4** : 111. Zool. Surv. India.

2000. *Toxoptera aurantii* : Ghosh L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series*, **7**(Part-2) : 354.

2001. *Toxoptera aurantii* : Chakrabarti and Sarkar, *J. Aphidology*, **15**(1 & 2) : 16.

Diagnosis : *Apterous viviparous female* : Body pale, 1.3-2.1 mm long. Head (Fig. 109) dusky brown. Antennae (Fig. 110) 6-segmented, about 0.70-1.08 × body. Segments I, II and apical portions of a.s. III, IV, V and base VI concolourous with head; flagellum more distinctly imbricated from base towards apex; p.t. 3.5-5.8 × base VI; flagellar hairs with acute to acuminate apices; u.r.s. 0.7-1.5 × h.t.2 and usually with 4 secondary hairs. Abdominal dorsum pale; 7th tergite with 4-6 hairs, 8th tergite with 2-3 hairs being 1.5-2.7 × basal diameter of a.s. III. Siphunculi (Fig. 111) rather cylindrical, broader near base; cauda (Fig. 112) elongated with constriction near at the middle and bears 10-21 long hairs tibiae with 10-15 peg-like structure; F. T. C. 3 : 3 : 3.

Alate viviparous female : Head (Fig. 113) brown apices of a.s. III, IV, V concolourous with head. A.s. III (Fig. 114) with 4/4 secondary rhinaria and IV with 0-3 secondary rhinaria. Dorsum of abdomen pale, with brown patches marginally; postsiphuncular sclerite well developed, dorsal hairs long, acuminate, each of 7th and 6th tergites with a narrow small transverse band; cauda (Fig. 115) shorter than in apterae. Media of forewing once or twice—branched, other veins normal. Other characters as in apterae viviparae.

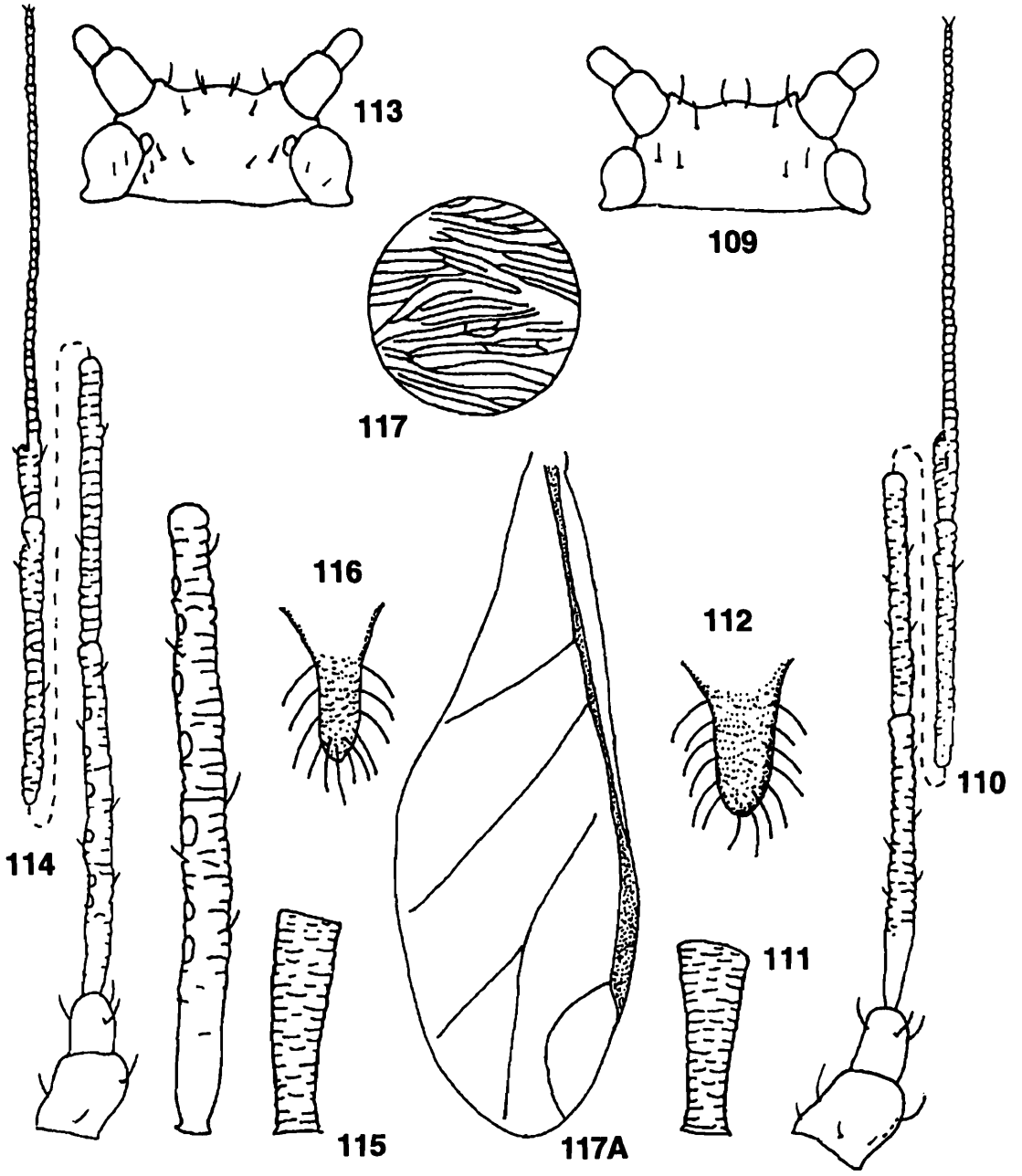
Host plants : The aphid infests a wide range of host plants under different natural orders. Among the host plants quite a few are of economic importance.

Symptom and Damage : Both adult and nymphs infest the young leaves and stems. As a result, distortion of young leaves is seen, with black sooty moulds on the upper surface of leaves and stems. There remain clusters of black and brown aphids on flush foliage. Some branches and twigs show die back symptoms. These aphids universally infest *Citrus* spp. Occasional several outbreaks occur, especially in dry weather following a rainy season.

The aphid causes "Tea rose yellow mosaic" (Ahlawat & Sardar, 1973). It always infests growing tender shoots, causing curling of the young leaves and drying up of young stems of the plant.

Life cycle : The adults are shiny black. Usually they reproduce asexually. They produce living youngs which are brown in colour. Under favourable weather conditions, a complete generation probably takes only in about seven days. Not much known about the biology of the aphid in India. In Indian condition, the pest species apparently enjoys anholocylic mode of life. So far, no sexual morph is known to the country.

Bionomics : Blackish brown insects infest almost all the aerial parts of a plant body. Normally, emigrant alate initiate colony on the apical tender leaves during late monsoon and good population is formed on the apical twigs, branches and sometimes even on young fruits. Increase in population is accopanied by the production of alatae and a large part of the aphid infestation migrates to other parts. Citrus plants support moderate to severe aphid infestation for 2-3 months. This is preceded and succeeded by poor colonisation for 15-20 days respectively.



Figs. 109-117A. *Toxoptera aurantii* (B.d.F) : Apterous viviparous female : 109. Head; 110. antenna; 111. Siphunculus; 112. Cauda. Alate viviparous female : 113. Head; 114. antenna; 115. siphunculus; 116. Cauda; 117. Reticulation at the base of siphunculi; 117A. Fore wing.

Natural enemies-complex :

Predators : *Anisolemnia dilatata* Fabricius; *Cheilomenes sexmaculata* (Fabricius); *Coccinella septempunctata* Linnaeus; *Coccinella transversalis* Fabricius; *Coccinella* sp.; *Cryptogonus orbiculus* (Gyllential); *Jauravia opaca* Mutschulsky; *Jauravia pubescens* (Fabricius); *Lemnia bisellata* (Mulsant); *Micraspis cardoni* (Weise); *Oenopia sauzeti* (Mulsant); *Psuedospidimerus circumflexa* (Motsch.); *Scymnus* sp.; *Stethorus gilvitrous* Mulsant [Coleoptera : Coccinellidae]; *Zygoballus* sp. [Spider]; Hemerobidae larvae; Syrphid larvae. [*Source* : Omkar and Pervez 2000]

Parasitoids : *Ephedrus* sp.; *Lipolexis scutellaris*; *Trioxys indicus*; *Trioxys* sp. [Hymenoptera]. [*Source* : Stary and A. KI. Ghosh 1983]

Vector : Coffee blister mosaic; Citrus tristeza (?) mosaic

Distribution : India : Throughout; *Elsewhere* : Cosmopolitan in the warmer parts of the world. It occurs in S. Europe, Africa, Asia and Australasia, Southern U.S.A., Central and S. America.

Remarks : The black to shiny black aphid is highly polyphagous. With respect to the number of host plants infested by this aphid, it can be stated that only during April and December as many as 40% plant species become infested by the aphid. The Alate viviparous female of the species can easily be recognised by the once-branched media and very dark stigma and veins of the fore wing.

Management : Same as in *T. citricidus*.

11. ***Toxoptera citricidus*** (Kirkaldy)

1907. *Myzus citricidus* Kirkaldy, *Proc. Hawaii ent. Soc.*, **1** : 100.

1980. *Toxoptera citricidus* (Kirkaldy) : Raychaudhuri, D. N. (ed.) *Taxonomy of the Aphids of North-east India and Bhutan* : 76.

1994. *Toxoptera citricidus* : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series* **3** : 161. Zool. Surv. India.

1998. *Toxoptera citricidus* : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series*, **4** : 111. Zool. Surv. India.

2000. *Toxoptera citricidus* : Ghosh L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series*, **7** : 354. Zool. Surv. India.

2001. *Toxoptera citricidus* : Chakrabarti and Sarkar, *J. Aphidology*, **15**(1 & 2) :

Diagnosis : *Apterous viviparous female* : Body 2.1-2.5 mm long with 1.2-1.5 mm as maximum width. Head brownish; antennae 0.6-0.7 times as long as body, longest hair on antennal segment III about 30μ long and 1.5-2.0 times as long as the basal diameter of the segment, p.t. 4.5-5 times as long as the base of antennal segment VI; rostrum reaches hind coxae, u.r.s. about 1.1-1.3 times as long as second joint of hind tarsus. Abdominal dorsum with polygonal reticulations besides scattered sclerites and with

distinct brownish post siphuncular sclerites; siphunculi brown, heavily imbricated, about 1.5 times as long as cauda which is thumb-shaped and bears 20-35 hairs.

Alate viviparous female : Head dark brown; antennae about 0.7-0.8 times as long as body, antennal segment III black except at very base and bears 8-20 secondary rhinaria, those on IV antennal segment 0-5, longest hair on antennal segment III always longer than the basal diameter of the segment, p.t. 4.5-5 times as long as the base of the segment VI; rostrum reaches mid coxae, u.r.s. 1.1-1.3 times as long as second joint of hind tarsus. Dorsum of abdomen with large brownish post siphuncular sclerite besides scattered small sclerites; siphunculi brown, 1.5-1.6 times as long as black cauda bearing 20-35 hairs. Media of forewing twice-branched.

Host plants : The species infests mostly the plants of N.O. Rutaceae and Urticaceae but the insects have also been noticed on other natural orders like Fagaceae, Passifloraceae and Ternstroemiseae.

Symptom and Damage : *T. citricidus* always infests growing tender shoots where it produces curling of the young leaves and drying up of young stems of the host plants. The aphid causes "Citrus mosaic" (Dakshinamurthi & Subbayya, 1981), "Citrus tristeza" (Vasudeva *et al.*, 1959; Verma *et al.*, 1960 and "Citrus vein enation" (Mali *et al.*, 1976) "Abaca mosaic" and "Citrus decline" (Mahapatra and Agarwala, 1984-85) of Citrus plants.

Natural enemies-complex :

Predator : *Cheilomenes sexmaculata* (Fabricius); *Cryptogonus bimaculatus* Kapur; *Lemnia bisellata* (Mulsant); *Micraspis cardoni* (Weise) [Coleoptera : Coccinellidae] [*Source* : Omkar and Pervez, 2000]

Parasitoid : *Lepolexis scutellaris* Mackauner; *Trioxys indicus* Subba Rao; *Trioxys* sp. [*Source* : Stary and A. K. Ghosh, 2000]

Both the predators and parasites are quite common in aphid colonies on the citrus plants.

Vector : Citrus decline; virus Citrus vein; enation Abaca mosaic

Distribution : India : all over; *Elsewhere* : Cosmopolitan except Europe, N. Africa or U.S.A. and the W. Indies.

Remarks : The dark brown large aphid is polyphagous and occurs almost throughout the year and infests quite a good number of plants of economic importance like *Citrus* spp. and *Pyrus* spp. large colonies are recorded particularly in April-May and December-January. It is much gregarious in habit and attended by ants.

Management : Control measures should only be applied in periods of flush growth, when the recommended insecticide is dimethoate as a full-cover spray in water. Dimethoate should not be used on rough lemon trees or on non-budded rough lemon stock (Hill, 1975).

Subtribe **Rhopalosiphina**

Key to the genera of subtribe Rhopalosiphina

1(2) Siphunculi short and thin, about 0.02-0.6 times as long as body and 0.4-0.6 times as long as cauda bearing 4-6 hairs ..... ***Hyalopterus***

2(1) Siphunculi longer, cylindrical or distinctly clavate, about 0.08-0.18 times as long as body 3

3(4) Abdominal dorsum of both apterae and alatae with spinules, those in apterae form distinct polygonal pattern, and each polygon encloses a few spinules. .. .. ***Rhopalosiphum***

4(3) Abdominal dorsum in apterae and alatae usually lacking spinules which, if present, never form polygons as above. 5

5(6) Alate viviparae with M in forewing once-branched, hind wing with 2 oblique veins; siphunculi and cauda either both darked or both pale ..... ***Schizaphis***

6(5) Alate viviparae with M in forewing twice-branched, hind wing with one oblique vein or both. 7

7(8) Hind wing with one oblique vein; cauda pale and with basal constriction, with 4 medial hairs ..... ***Hysteroneura***

8(7) Hind wing with both oblique veins. 9

9(10) Head with typical small inwardly directed projection from inner apex of ill-developed lateral frontal taberacle ..... ***Melanaphis***

10(9) Head without any projection; secondary rhinaria in alate not protuberant; abdominal dorsum smooth and rugose and sometimes with usual aphidine polygonal reticulations; F.T.C. 3, 3, 3 or 3, 3, 2 ..... ***Aphis***

Genus 3. ***Hyalopterus*** Koch

1854. *Hyalopterus* Koch, *Die Pflanzen Aphiden,* **1** : 16.

Type species : *Aphis pruni* Geoffroy, 1762.

Diagnosis : Head with little developed rhopalosiphine type of lateral frontal tubercle. Antennae 6-segmented, shorter than body; flagellar hairs long with acute apices; apterae without secondary rhinaria, alatae with subcircular secondary rhinaria distributed on a.s. III and IV; p.t. longer than base VI. U.r.s. shorter than h.t.2 with 2 secondary hairs. Dorsum of abdomen in both apterae and alatae pale excepting the tergites 7th and 8th, of alatae usually with pigmented bars; 8th tergite usually with 2 long and fine hairs. Siphunculi short, 0.03-0.06 times as long as body, short with sparse spinular imbrications and 0.4-0.6 times as long as cauda bearing 4-6 hairs. Wing venation normal. F.T.C 3 : 3 : 2.

12. *Hyalopterus pruni* (Geoffroy)
Mealy plum aphid

1762. *Aphis pruni* Geoffroy, *Histoire Abregea des. Ins. Environs de Paris,* **1** : 497.

1966. *Hyalopterus pruni* (Geoffroy) : Eastop, *Aust. J. Zool.,* **14** : 489.

1969. *Hyalopterus pruni* (Geoffroy) : Biswas, Chakrabarti, Basu, R. C. and Ghosh, A. K. *Sci. Cult.,* **35** : 640.

1976. *Hyalopterus pruni* (Geoffroy) : Singh, Studies on the Aphids of Manipur State (Ph.D. Thesis, Calcutta University) : 85.

1980. *Hyalopterus pruni* (Geoffroy) : Raychaudhuri, D. N. (ed.), Aphids of Northeast India and Bhutan, The Zoological Society, Calcutta : 60.

1986. *Hyalopterus pruni* (Geoffroy) : Medda, Saha and Chakrabarti, *Proc. 2nd Nat. Symp. Recent trends in Aphidological Studies,* Modinagar (ed. S. P. Kurl) : 33.

1997. *Hyalopterus pruni* (Geoffroy) : Remaudiere, G. and Remaudiere, M. *Catalogue of the World's Aphididae,* Paris : 60.

Diagnosis : *Apterous viviparous female* : Body small (1.9-2.5 mm), elongated oval. Head smooth, lateral frontal projections distinct. Antennae 6-segmented, shorter than body; flagellum faintly imbricated, but more distinctly imbricated from apical half of a.s. IV onwards; flagellar hairs 0.5-0.7 times as long as b.d. III; a.s. III without secondary rhinaria; p.t. about 3-4 times base VI; u.r.s. short, triangular, about half as long as h.t.2 and bears 2 secondary hairs. Dorsum of abdomen pale, dorsal hairs sparse, much longer than b.d. III; segments 7 and 8 with a pair of short hairs, 1.3-1.5 times as long as b.d. III. Siphunculi subcylindrical, gradually narrowing apically, about 0.04-0.06 times as long as body. Cauda dark, elongate, 0.16-0.18 mm long, bearing 5 hairs. F. T. C. 3 : 3 : 2. Mealy covered aphid in life.

Alate viviparous female : Head brown, a.s. III darker from apical half onwards; alatae with many secondary rhinaria on a.s. III arranged irregularly, a.s. IV with 0-6 simlar rhinaria; with pigmented bar on each of segments 7 and 8. Siphunculus narrow both at base and apex, brown but basally a little paler, with spinular imbrications and without flange. Legs light brown, pigmented toward proximal end of femora and tibiae. Wing venation normal, veins bordered brown. Other characters as in apterae.

Host plants : *Arundo donax* (Poaceae); *Arundo* sp. (Poaceae); *Brasicca oleracea* (Brassicaceae); *Canna orientalis* (Cannaceae); *Chenopodium album* (Chenopodiaceae); *Coriandrum sativum* (Umbelliferae); *Datura* sp. (Solanaceae); *Oenanthe stolonifera* (Umbelliferae); *Phaseolus vulgaris* (Fabaceae); *Phragmites communis* (Poaceae); *P. karka* (Poaceae); *Phragmites* sp. (Poaceae); *Poa* sp. (Poaceae); *Prunus armeniaca* (Rosaceae); *P. cerasus* (Rosaceae); *P. domesticus* (Rosaceae); *P. persica* (Rosaceae); *Prunus* spp. (Rosaceae)

Symptom and Damage : Both the nymphs and adults of these greenish aphids infest all the aerial parts showing mealy coating on both surfaces of plant parts. Under heavy attack, infestations cover leaf-petioles and the green parts of stem.

Life cycle : Not much is known about the biology of the aphid in India. However, the species is known to be holocyclic and heteroecious alternating between *Prunus* spp. and grasses, *Phragmites communis* (Palmer, 1952; Eastop, 1966), *Phragmites* sp. and *Poa* sp. (Medda *et al.* 1986; Raychaudhuri, D. N. (ed.) 1980).

Natural enemies-complex :

Predator : *Cheilomenes sexmaculata* (Fabricius); *Cryptogonus bimaculatus* Kapur; *Cryptogonus quadriguttatus* (Weise); *Jauravia binotata* Gorham; *Harmonia cucharis* (Mulsant); *Micraspis vincta* (Gorham); *Oenopia luteopustulata* Mulsant; *O. quadripunctata* Kapur; *Propylea japonica* (Thunbcrg) [Coleoptera : Coccinellidae] [*Source* : Omkar and Pervez, 2000]

Parasitoid : *Aphidius colemani* Viereck; *A. maricariae* Haliday; *Aphidius* sp. [Hymenoptera : Aphidiidae]

Vector : Celery mosaic; Cucumber mosaic; Millet red leaf; Onion mosaic

Management : Spray 500 ml. of nicotine sulphate 40 EC or 250 ml of menazon 100 EC or 800 ml of malathion 50 EC in 500 litres of water per ha is suggested. The insecticidal spray should be avoided where the parasites *Aphidius* spp. are present.

Genus 4. ***Hysteroneura*** Davis

1919. *Hysteroneura* Davis, *Canad. Ent.*, **51** : 263.

Type species : *Siphonophora setariae* Thomas, 1878.

Diagnosis : Body oval to semioval. Head smooth pale yellow having very low 'rhopalosiphine' lateral frontal projections; antennae 6-segmented, flagellum imbricated, a.s. III and sometimes also a.s. IV in apterae quite pale except their distal ends; flagellar hairs sparse, short with blunt to acuminate apices; apterae without secondary rhinaria, alatae with secondary rhinaria usually on a.s. III; p.t. about 5-7 × base VI; u.r.s. about as long as h.t.2 and bears 2 secondary hairs. Abdominal dorsum in apterae quite pale, in alatae with distinct spinular marginal patches on segments 2-4; ante and post siphuncular selerites coalesce around siphunculus; dorsum with spinular striae all over; dorsal hairs sparse, minute and blunt; siphunculi brown cigar-shaped, densely imbricated and with apical flange. Cauda elongate, quite pale and with 4 medial hairs. Femora pale at base, rest dark brown, tibiae dark brown at apex, rest pale; F. T. C. 3 : 3 : 2; 'M' in fore wing twice branched, hind wing with one oblique vein.

13. ***Hysteroneura setariae*** (Thomas)
Rusty plum Aphid
[Syn. *Carolina setariae* Thomas]
(Fig. 416)

1878. *Siphonophora setariae* Thomas, *Bull. Ill. St. Lab. nat. Hist.*, **2** : 5.

1980. *Hysteroneura setariae* (Thomas) : Raychaudhuri, D. N. (*ed.*) Taxonomy of the Aphids of Northeast India and Bhutan : 61.

1994. *Hysteroneura setariae* : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series* **3** : 163. ZSI.

1997. *Hysteroneura setariae* : Remaudiere, G. and Remaudiere, M. Catalogue of World's Aphididae, Paris : 60.

2001. *Hysteroneura setariae* : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 15.

Diagnosis : *Apterous viviparous female* : Body 1.3-1.90 mm long. Antennae 0.8-1.00 times as long as body; flagellum progressively more distinctly imbricated, a.s. VI black, rest paler, p.t. 4.3-6.4 × base VI, 1.4-2.05 × a.s. III. U.r.s. 0.77-1.1 × h.t.2. Siphunculi black, 0.17-0.22 × body 1.6-1.9 × pale yellow cauda bearing only 4 medial hairs; Antennal hairs 9-12μ long and more than half of b.d. III. Posterior dorsal cephalic hairs 9-15μ, about 0.27-0.62 × b.d. III. Hairs on 8th abdominal tergite about 15μ long.

Alate viviparous female : Body 1.37-1.95 mm long. Antennae dusky to brown with an intermittent yellowish portion, 0.8-1.10 × body. Antennal segment III with 10-16, IV with 0-4 secondary rhinaria and V usually without rhinaria. Hind wing with only one oblique vein which is the distinguishing character of the genus. Other characters as in apterous viviparous female.

Host plants : The aphid species is known to infest 82 plant species in about 40 genera mostly belonging to plant family Poaceae including Rice, Sugarcane, Corn, Wheat and other plants.

Symptom and Damage : Both nymphs and adults suck the sap from the leaves and unripened grains of rice throughout the crop season. Moderately infested grains show brown necrotic spots (Fig.). A heavy infestation turns all spiklets brown and chaffy. Apart from the physical damage, honey dew deposited by the aphids also attracts fungal development on the earheads and the leaf sheath, thus, interfares the normal physiological activities of the rice plant.

Bionomics : Basu *et al.* (1970) and Ghosh *et al.* (1971) reported the oviparous females of the species whereas Pal (1975) reported alate male. This hints at the possibility of holocyclic life cycle of the species in the Indian conditions.

Here, adult aphid reproduces asexually throughout the crop season and starts laying nymphs in a day or two after emergence. Nymphs are pink in colour and nymphal development lasts for 9-10 days through four nymphal instars. Aphid population reaches its peak in April when they congregate on the earheads and between the leaf sheaths and leaf blades. In late April, as the host plants begin to dry, the winged aphids migrate in search of host plants to other plants and even they maintain themselves on the stubbles.

Natural enemies-complex :

Predator : *Cheilomenes sexmaculata* (Fabricius); *Coccinella septempunctata* Linnaeus [Coleoptera : Coccinellidae]

Parasitoid : *Trioxys (Binodoxys) indicus* Subba Rao and Sharma [Hymenoptera : Aphidiidae]

Vector : Onion yellow dwarf; Sugarcane mosaic

Distribution : India : Widely distributed.

Elsewhere : Africa; America; China; Eastern Islands; Fiji; Japan; Korea; Malayasia; Nepal; New Guinea; Philippines; Solomon Is.; Taiwan; Thailand; Vietnam.

Remarks : The pest species is known from North and South America for a century where it infests the plum tree during the autumn and spends the summer on secondary hosts like cereals and grasses (David *et al.* 1967). *H. setariae* has been reported for the first time from India (David *et al. op. cit.*), occurring on a number of plants including the paddy, in South India. It is now widespread in India. It is attended by ants *Camponotus (Tanaemyrmex) compressus* Latr., *Solenopsis geminata* Fabricius and *Crematogaster* sp.

During May 1984 about 80% of the pots maintained at CRRI Green House at Cuttack were severely damaged by this aphid (Dani 1986).

Management : Infested plants may be sprayed by 0.04% phosphamidon or oxydemetonmethyl for effective control of this aphid.

Genus 5. ***Melanaphis*** van der Goot

1917. *Melanaphis* van der Goot, *Contr. Fauna Indes neerl.*, **1**(3) : 60.

Type species : *Aphis bambusae* Fullaway, 1910 (attributed to Kirkaldy in the original description).

Diagnosis : Head with lateral frontal tubercles not well developed and usually without apparent median frontal prominence; dorsal cephalic hairs with bluntish or finely drawn out apices. Antennae 5- or 6-segmented, weakly to strongly imbricated; p.t. about 1.42-4.50 × and 2.70-4.20 × base of last antennal segment in apterae and alatae respectively; secondary rhinaria absent in apterae but in alatae, slightly to more strongly protuberant circular secondary rhinaria present; antennal hairs in apterae like dorsal cephalic hairs in respect of lengths and apices, in alatae such hairs may have acuminate or finely drawn out apices. U.r.s. usually with at most 2 secondary hairs, usually shorter than h.t.2. lateral abdominal tubercles on segment 7 usually placed posterodorsal to spiracles of that segment; dorsal abdominal hairs short with bluntish apices. 8th tergite with 2-10 hairs. Siphunculi weakly to strongly imbricated, either wider than long or longer than wide with or without a constriction just before apex, usually shorter than cauda which is usually dark, elongate, with globular to

slightly acute apex and with a median constriction, and bears 4–21 hairs. Femora smooth dorsally but with spinulose striae ventrally; femoral hairs may be short to very long; first tarsal chaetotaxy 3, 3, 2 or 3, 3, 3. Wing-venation normal.

14. ***Melanaphis sacchari*** (Zehntner)
(Fig. 424)

1897. *Aphis sacchari* Zehntner, *Arch. Suikerind Ned. Ind.,* **5** : 551.

1958. *Longiunguis sacchari* : Eastop, Aphididae of East Africa : 81.

1974. *Melanaphis sacchari* (Zehntner) : Raychaudhuri, D. N. and Banerjee, C., *Oriental Ins.,* **8**(3) : 379.

1994. *Melanaphis sacchari* : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** : 165.

1997. *Melanaphis sacchari* : Remaudiere, G. and Remaudiere, M. Catalogue of the World's Aphididae, Paris : 61.

1998. *Melanaphis sacchari* : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series,* **4** : 115. Zool. Surv. India.

2000. *Melanaphis sacchari* : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series* **7** (Pt. 2) : 355. Zool. Surv. India.

2001. *Melanaphis sacchari* : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 15.

Diagnosis : *Apterous viviparous female* : Body 1.50-1.60 long. Head pale, with ill-developed lateral frontal tubercles and median frontal prominence, antennae 5- or 6-segmented, about 0.4-0.7 × length of body, flagellum distinctly imbricated, p.t. about 3-4 × base of the segment; flagellar hairs short and sparse with acuminate apices, longest hair on segment III about 0.2-0.7 × b.d. III. U.r.s. about 0.8 × h.t.2; and with 2 secondary hairs. Dorsum of abdomen often with irregular brown to dark brown patches in spinal and pleural areas; dorsal abdominal hairs short with acuminate apices, longest hair being about 0.5-1 × b.d. III; 8 tergite with 2 hairs. Siphunculi dark brown, subcylindrical, with distinct constriction apically, about 0.6-1 × cauda. Cauda elongated with a median constriction and bears 7-18 hairs. F. T. C. 3 : 3 : 3 or 3 : 3 : 2.

Alate viviparous female : Body 1.3-1.8 mm long; head dark brown; dorsum of head with minute stipples; longest dorsal cephalic hairs about 0.7-1.6 × b.d. III; antennae 6-segmented; segment III with 6-16 circular, somewhat protuberant secondary rhinaria, segment IV with 2-6 similar rhinaria. U.r.s. about 0.6-0.9 × h.t.2; abdominal dorsum scabrous with segmentally arranged brown transverse spinopleural bars upto segment 8; dorsal abdominal hairs 0.7-1.4 × b.d. III. Siphunculi strongly imbricated; tibiae pale with apices brown to dark brown. Wing venation normal. Other characters as in apterous viviparous female.

Host plant : *Arturaxon ciliaris, Paniculum* sp., *Pennisetum* sp., *Saccharum officinarum, Sorghum vulgare* (?) *Rubia cordifolia.*

Symptom and Damage : This species infests different poaceous plants affecting the various aerial parts including inflorescence where the infestation may be scanty to heavy. Sometimes the affected portions turn yellow.

It causes "onion yellow dwarf" (Dhingra & Nariani, 1963) & "Sorghum red stripe" (Garud & Mali, 1979) disease.

Bionomics : The species reproduces anholocyclically throughout the year in India. Not much known about the biology of the species. The sexual morph is yet to be discovered from India.

Natural enemy-complex :

Predator : *Cheilomenes sexmaculata* (Fabricius) [Coleoptera : Coccinellidae]

Parasitoid : *Aphelinus gossypii; Lysiphlebia mirzai; Lysiphlebus delhiensis, Lysiphlebus* sp., *Praon* sp.

Colour : Very variable *viz.* cream, brown, dark brown, light green and grey.

Distribution : India : all over.

Elsewhere : Worldwide.

Remarks : The concept of *M. sacchari* as given by Eastop (1958, 1961) for East & West African specimens more or less holds good for Indian specimens. The first report of this species from India was made by David (1957). Ant attendants are often noticed in association with the insects.

Management : Systematic stripping of leaves reduces the incidence of pest. Insect free setts should be used for planting. Spraying parathion or dimethoate may be useful.

Seed dressing with imidacloprid 70 WS @ 10g./100g. proves highly effective. It lowers the aphid index to 34.09% with 6.5% protection over check and records significantly more grain yield, fodder yield and 1000 grain weight. Mulching the soil with dried grass performs next to result higher grain yield (Balikai and Lingappa, 2002).

Genus 6 ***Rhopalosiphum*** Koch

1954. Koch, C.L. *Die Pflanzenlause.* Nurnberg : 23.

Type species : ***Rhopalosiphum nymphaeae*** (Linn.) Fixed by Gerstaecker, C.E.A. 1856 Arch. Naturgesch, **21** : 272.

Rhopalosiphum has been loosely used to include *Aphis*–like forms with slightly swollen siphunculi.

Diagnosis : Head with weakly developed lateral frontal tubercles having rhopalosiphine projections. Antennae 5 or 6-segmented, 0.30-0.81 times as long as body; p.t. 1.70-6.80 base of last segment; secondary rhinaria absent in apterae, in alatae segment III with 11-54, IV with 0-15 and V with 0-13 such rhinaria, hairs on

flagellum with fine to bluntish apices. Ultimate rostral segment about 0.71-1.53 times as long as h.t. 2 and with 2-4 secondary hairs. Apterae with pale abdominal dorsum, alate with pleural intersegmental pigmentation and with a dusky band on each of tergites 7 and 8, well-developed pattern of spinulose polygonal reticulation present on dorsum of apterae and each polygon encloses a group of spinules; dorsal abdominal hairs long and fine or with blunt apices; L. a.t. present on segments 1 and 7. Siphunculi about 0.05-0.25 times as long as body, often dark, cylindrical to swollen and with a well-developed flange. Cauda short, about 0.35-0.93× siphunculi and with 3-9 hairs. Legs brown. F. T. C. 3 : 3 : 3 or 3 : 3 : 2. Wing-venation normal.

Distribution : Cosmopolitan.

Key to the species of the genus *Rhopalosiphum*

Apterae :

1(2) Antennae 5-segmented; abdominal dorsum densely covered with long and fine hairs ..... *rufiabdominalis*

2(1) Antennae 6-segmented; abdominal dorsum without such hairs as above..... 3

3(4) P.t. about 2-5 times as long as base VI; body about 10-15 times as long as siphunculi ..... *maidis*

4(3) P.t. never less than 3.9 times as long as base VI; body at the best 8-5 times the siphunculi being cylindrical; dorsal abdominal-hairs with blunt apices.... *padi*

Alatae :

1(2) Antennae 5-segmented; p.t. never less than 3.0 times as long as and may be upto about 7.0 times as long as base of segment V; dorsal abdominal hairs long and fine and the longest on 7th and 8th tergites about 2.1-2.3 times as long as b.d. III ..... *rufiabdominalis*

2(1) Antennae 6-segmented 3

3(4) P.t. 1.7-2.4 times as long as base VI and always shorter than a.s. III; abdominal dorsum with blunt fine hairs ..... *maidis*

4(3) P.t. never less than 3 times as long as and upto 5.2 times as long as base VI and always longer than a.s. III; siphunculi cylindrical; cauda about half as long as siphunculi. ..... *padi*

15. ***Rhopalosiphum maidis*** (Fitch)
Corn leaf Aphid or Wheat Aphid
(Figs. 118-127, 417)

1855. *Aphis maidis* Fitch, *New York Agric. Soc. Trans.*, **16** : 551.

1931. *Aphis maidis* Hottes and Frison, *Bull. Nat. Hist. Surv.*, **29** : 205.

1952. *Rhopalosiphum maidis* : Palmer, M.A., *Thomas Say Foundation,* **5** : 217.

1953. *Rhopalosiphum maidis* : Cottier, *Bull. N.Z. Dep. Sci. Industr. Res.,* **106** : 162.

1954. *Rhopalosiphum maidis* : Eastop, *Proc. R. Ent. Soc. Lond.* (A) **29** : 84.

1957. *Rhopalosiphum maidis* : Borner, In Sorauer, *Handb. d. Pflanz.,* **5** : 98.

1980. *Rhopalosiphum maidis* : Raychaudhuri, D. N. (*ed.*) Aphids of North-east India and Bhutan, The Zoological Society, Calcutta : 69.

1997. *Rhopalosiphum maidis* : Remaudiere, G. and Remaudiere, M. Catalogue of the World's Aphididae, Homoptera : Aphidoidea, Inra, Paris : 62.

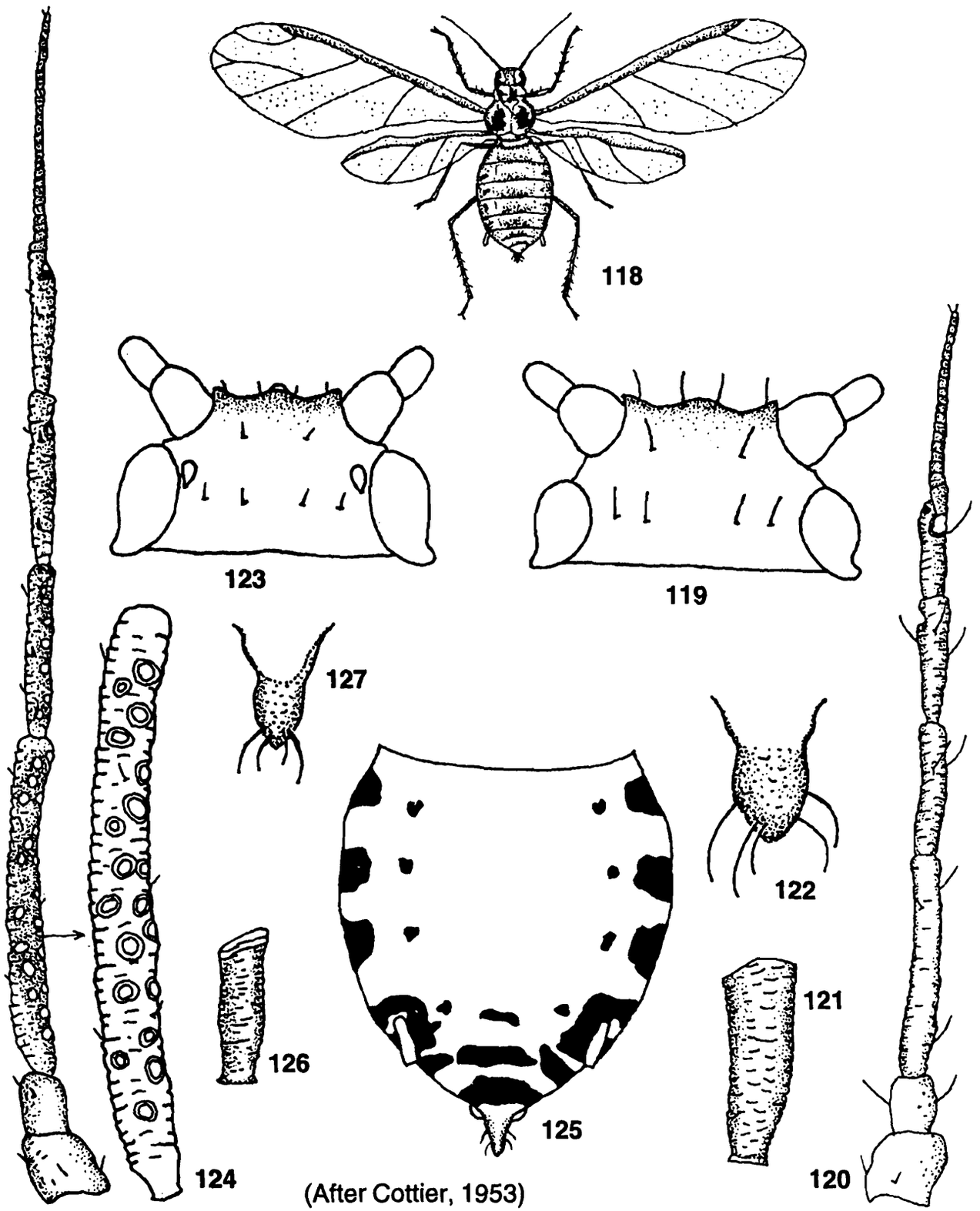
2000. *Rhopalosiphum maidis* : Ghosh L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7** : 356. Zool. Surv. India.

Synonyms : *Aphis adjusta* Zehnter, 1901; *A. maidis* Fitch, 1856 of Indian authors; *Aphis sorghi* Theobald. 1915; *Siphonaphis maidis* Fitch (of Goot, 1917).

Other References : Ayyar, 1940; Banerjee & Basu, 1955; Basu & Banerjee, 1958; Basu, R.C. and Raychaudhuri, D.N. 1980; Behura and Dash, 1986; Chona & Rafay, 1951; Chowdhury *et al.* 1969; Das, 1918; David, 1954, 1956, 1958; Deshpande, 1937; Fletcher, 1920; George, 1927; Ghosh L. K. 1969; Goot, 1917; Kapur, 1942; Krishnamurti & Usman, 1955; Krishnamurty, 1928; Lefroy, 1909; Menon and Ghai, 1969; Pal, 1954; Puttarudriah & Channa Basavanna, 1955; Rahman, 1940; Raychaudhuri, Samuel, 1940; Sengupta & Behura, 1957; Sengupta & Das, 1960; Ullah, 1940; Ghosh L. K. *et al.,* 1997; Chakrabarti and Sarkar, 2001.

Diagnosis : *Apterous viviparous Female* : Colour in life : Yellowish green usually with conspicuous dark blotches around bases of cornicles; head, antennae, legs siphunculi and cauda dark green, brown or black; slightly pulverulent.

Body spindle-shaped, 1.5-2.5 mm long with 0.7-0.9 mm as maximum width. Frontal tubercles (Fig. 119) well developed, scabrous, each with a long slender, pointed seta median tubercle well developed, hairs on disc of head slender pointed. Antennae (Fig. 120) shorter than body, five-or six-segmented; antennal hairs normally pointed, those of segments I, II, V, VI, from two to three times as long as the basal diameter on segment III; hairs on segment III-IV from 1½ times to twice the basal diameter of segment III. Rostrum reaching just beyond front coxae, ultimate rostral segment with two secondary hairs. Dorsal prothoracic hairs normally pointed, sometimes blunt or even distinctly minutely capitate. Tibial hairs erect, pointed. First tarsal segments of fore and middle legs each with three hairs; normally only two hairs on first tarsal segment of hind leg. Hairs on abdominal terga normally pointed. Abdomen largely membranous except for pigmented spiracular sclerites. Siphunculi (Fig. 121) sometimes roughly cylindrical, usually tapering towards attentuation just proximad of flange, often roughly elliptical with the base and attentuated part narrower than swollen middle portion; with strongly spiculose imbrications; cauda (Fig. 122) elongate, strongly spiculose, slightly constricted at middle, with two or three, slender curved hairs on each side.



Figs. 118-127. *Rhopalosiphum maidis* (Fitch) : 118. Alate viviparous female. Aptera. 119. Head; 120. antenna; 121. Siphunculus; 122. Cauda. Alate viviparous female : 123. Head; 124. antenna; 125. posterior abdominal dorsum showing pigmentation; 126. Siphunculus; 127. Cauda.

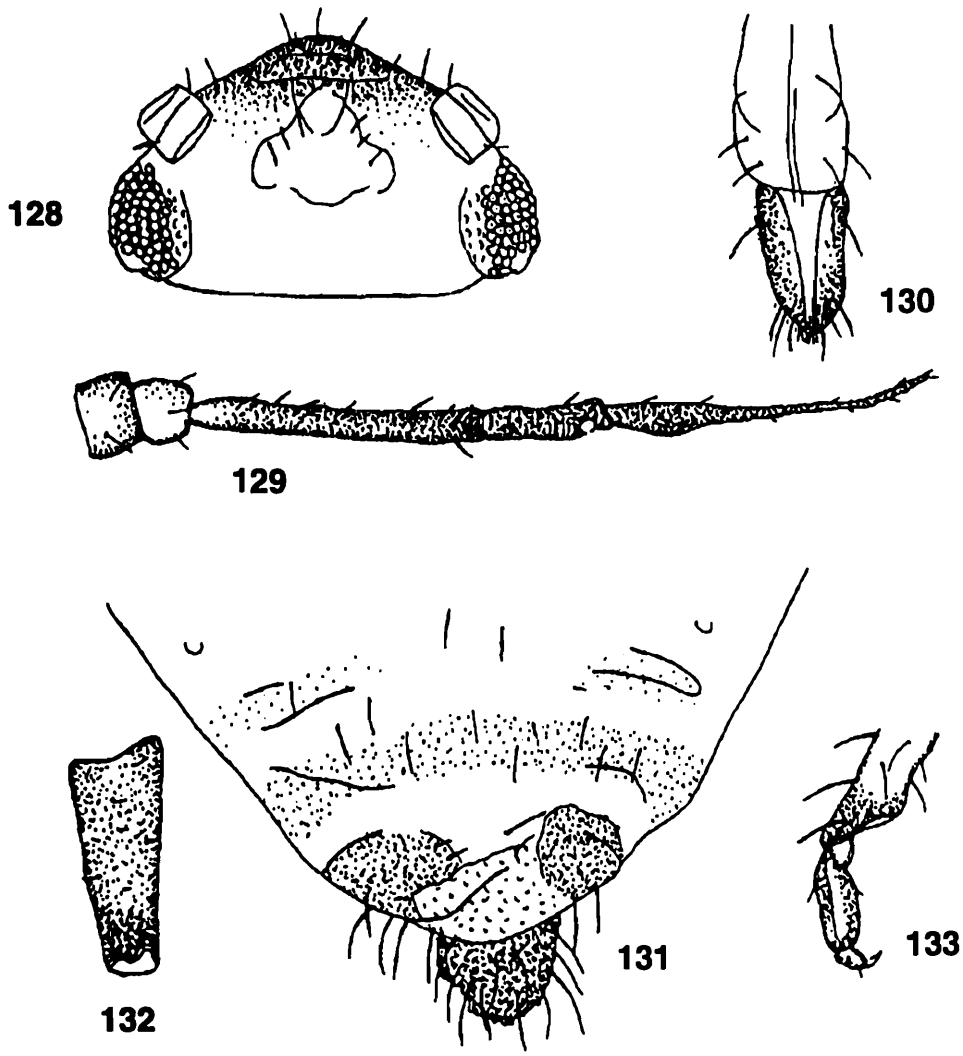
Alate viviparous female : Colour in life : Head, antennae, thorax, rostrum, legs abdominal intersegmental and lateral sclerities, cauda and anal plate black; abdomen largely light to dark green.

Body (Fig. 118) 1.5-2.5 mm. Frontal tubercles (Fig. 123) well developed, scabrous, each with a pointed hair that is equal to or longer than basal diameter of antennal segment III; hairs on disc of head pointed, distinctly longer than basal diameter of antennal segment III. Antennae (Fig. 124) 6-segmented, segment III with 12-23, IV with 0-10, V and with 0-4 rhinaria. Hairs on antennal segment normally pointed, those on segments I and II up to twice as long as the basal diameter of segment III, those on IV-VI usually about equal to basal diameter, those on segment III normally shorter than basal diameter of III. Prothorax with well developed lateral tubercles. Wings hyaline; media of forewings usually two-branched. Hairs on tibia normally pointed and mostly shorter than apical diameter of tibia. First tarsal segments of fore and middle tibia each normally with three hairs, first segment of hind tarsus normally with two hairs; abdomen (Fig. 125) membranous except for intersegmental sclerities, lateral selerites, pigmented sclerotic bars on tergites VI-VIII, VI-VIII normally pointed, normally at least 1½ times the diameter of siphunculi just proximad of flange. Siphunculi (Fig. 126) usually elliptical, narrower at base and apically attentuated portion than in middle; normally with strongly spiculose imbrications; Cauda (Fig. 127) elongate, normally constricted at middle, with two or three slender, curved, pointed hairs on each side, strongly spiculose. Dorsum of abdomen weakly reticulate. Anal plate strongly spiculose.

Host plant-aphid association : Association of aphid with host plants plays vital role in holocycly of aphid. Consideration of host plant association at plant family level indicates that plants belonging to about 60 species in 36 genera under 10 families are infested by *R. maidis* (Fitch). Of these, the corn aphid infests maximum number of 36 species belonging to Poaceae and minimum species each of the families Abismatceae, Caryophyllaceae, Combetaceae, Commelinaceae, Cupressceae, Polygonaceae, Portaliaceae, Rosaceae and Solanceae, The most favoured hosts for this aphid are, therefore, poaceous plants. Thus,. *R maidis* is impressively host specific on its primary host. Now, whether a plant or plants (other than poaceous) will or will not be successfully colonised by this aphid may depend on ecological or physiological conditions of both aphids and host plants.

Host plants : *Andropogon bicolor* (Poaceae); *Andropogon durr* (Poaceae); *Andropogon halepense* (Poaceae); *Andropogon vulgare* (Poaceae); *Andropogon* spp. (Poaceae); *Avena sativa* (Poaceae); *Bromus uniloides* (Poaceae); *Cajanus cajan* (Fabaceae); *Capsicum frutescence* (Solanaceae); *Cenchrus ciliaris* (Poaceae); *Coix lachyma-jobi* (Poaceae); *Cynodom dactylon* (Poaceae); *Cyperus rotendus* (Cyperaceae); *Dactyloctenium aegypticum* (Poaceae); *Dichanthium* sp. (Poaceae); *Digitaria* sp. (Poaceae); *Echinochloa colonum* (Poaceae); *Echinochloa cerus-qalli* (Poaceae); *Echinochloa* sp. (Poaceae); *Eleusine coracana* (Poaceae); *Eleusine aegyptiaca* (Poaceae); *Eleusine indica* (Poaceae);

Gizolia abyssinica (Commelinaceae); *Hordeam vulgare* (Poaceae); *Lycopersicon esculentum* (Solanaceae); *Nicotiana tabacum* (Solanaceae); *Oryza sativum* (Poaceae); *Panicum atidotae* (Poaceae); *Panicum javanicum* (Poaceae); *Panicum miliaceum* (Poaceae); *Panicum* sp. (Poaceae); *Paspalum scroiculatum* (Poaceae); *Pennisetum glaucum* (Poaceae); *Pennisetum typhoideum* (Poaceae); *Pennisetum* sp. (Poaceae); *Poa* spp. (Poaceae); *Polygonum runcinatum* (Polygonaceae); *Potalia* sp. (Portaliaceae); *Pyrus communis* (Rosaceae); *Prunus puddum* (Rosaceae); *Saccharum officinarum* (Poaceae); *Saccharum* sp. (Poaceae); *Sagittaria saggittifolia* (Alismataceae); *Setaria italica* (Poaceae); *Setaria verticillata* (Poaceae); *Setaria* spp. (Poaceae); *Silene conoides* (Caryophyllaceae); *Solanum nigrum* (Solanaceae); *Solanum vulgare* (Solanaceae); *Solanum tuberosum* (Solanaceae); *Sorghum buclor* (Poaceae); *Sorghum vulgare* (Poaceae); *Terminalia arjuna* (Combretaceae); *Triticum aestivum* (Poaceae); *Triticum vulgare* (Poaceae); *Triticum* spp. (Poaceae); *Zea mays* (Poaceae).



Figs. 128-133. *Rhopalosiphum maidis* (Fitch) : Apterous viviparous female : 128. Head; 129. antenna; 130. u.r.s.; 131. posterior abdominal dorsum; 132. siphunculus; 133. hind tarsus (Posterior part)

Symptom and Damage : The nymphs and adults of the species suck the sap from leaves as a result of which they turn yellow and ultimately get dried. The infested plants remain stunted in growth. In case of severe injury yellowish patches on leaves appear and the main shoot dries up resulting in the production of late tillars bearing earheads devoid of grains. The losses in grain yield vary from 3-63% in some promising and commercial varieties. The pest also causes much decrease in fodder yield varying from 7-43% (Bhatia and Singh, 1977). This aphid species in fact is a pest of maize and wheat but also occasionally infests paddy crop in certain areas, where rice crop is grown after maize or wheat in northern India. It's nature of damage is similar to *Hysteroneura setariae* (Thomas) in rice and considerable loss in yield takes place if infestation is in large population.

Biology : The aphid is green to dark yellowish in colour. Both apterous and alate viviparous females together with nymphs constitute a colony where winged adults relatively few in number in a population. The adult larviposits 1-5 per day and 24-47 in its life span. The nymphal period is 9-10 days. The adult gives birth to nymphs for 10-25 days and lives for another 3 days. It usually takes 19-35 days to complete a life cycle.

Life cycle : The corn leaf aphid like most other aphids is remarkable for its polymorphism and complicated life cycle. In temperate regions, aphids commonly lead holocyclic mode of life cycle but in tropical areas these insects usually enjoy anholocyclic life cycle throughout the year. It has both anholocyclic i.e., parthenogenetic reproduction and holocyclic i.e., sexual life cycles it produces five or six morphs *viz.* male, female, fundatrix, apterous and alate parthenogenetic forms, apterous and alate gynoparae giving rise to sexual females or oviparae and males.

In Indian conditions, aphid is predominantly anholocyclic, producing apterous and alate parthenogenetic viviparous females. The immature nymphs laid by them moult four times to attain adult state. Regarding sexuales alate males were recorded from Lahore (now in Pakistan) by Das (1918) Alate males of the species were also recorded from Kenya (Africa) by Eastop (1954). Apterous oviparous females of the species are known from Delhi and Netarhat (Bihar) during the colder part of the year (Menon and Ghai 1969, Ghosh, L. K. 1971.)

The cornleaf aphid thus apparently enjoys anholocyclic as well as holocyclic life both in the plains and hills of India. The species presumably overwinters and spends the summer on grasses, sedges and some semiaquatic plants. The picture about complete life cycle of this aphid would be clear only when if it is ascertained the capability of the oviparae to produce viable eggs although available information in respect of at least of a few species suggests that viable eggs are laid in tropical ecosystem of India and fundatrices are produced on primary host.

Although production of sexual forms is treated as an indicator of possible holocyclic reproduction, true sexual reproduction in this species can only be speculated. In that case, complex holocyclic life cycle is yet to be established in India.

Natural enemy complex : A number of parasites and predators are associated with *R. maidis* (Fitch), Among the parasites *Aphidencyrtus* spp; *Aphidius colemani, Aphidius uzbekistanicus, A. transcaspicus* Telengg, *Ephedrus* sp., *Lipolexis scutellaris* [*Toxares deltiger*], *Toxares macrosiphophagum* [*Toxares shigai*], *Lysiphlebia delhiensis, Aphidenervtus* sp. are important.

Predator : *Cheilomenes sexmaculata* (Fabr.); *Coccinella septempunclata* Linnaeus; *C. transversalis* Fabr.; *Nephus regularis* (Sicard); *Oenopid aexareata* Mulsant; *Scymnus castaneus* (Sicard); *Scymnus quadrillum* Motsch [Coleoptera : Coccinellidae]; *Ischiodon scutellaris* (Fabr.); *Syrphus balteatus* (Dee Geer) [Diptera : Syrphidae] [*Source* : Omkar and Pervez, 2000]

Parasitoid : *Aphidius transcaspicus* Telenga; *Aphidenervatus* sp.; *Sysiphlebia mirzai* Shuja Uddin; *Lysiphlebus delhiensis* Subba Rao and Sharma [Hymenoptera] [*Source* : Stary and A. K. Ghosh, 1983]

Vector : The corn aphid acts as a potential vector of the virus causing the following mosaic diseases :

Bajra mosaic; Barley mosaic; Barley yellow dwarf; Broadbean mosaic; Canna mottle; Cucumber mosaic; Cynodon mosaic; Eleusine mosaic; Large cardamom streak mosaic; Maize mosaic; Millet red leaf; Mulberry mosaic; Onion yellow dwarf; Panicum crusgalli mosaic; Pea mosaic; Pumpkin mosaic; Ragi mosaic; Sorghum red stripe; Sugarcane mosaic.

The aphid also transmits *Chirke* virus of large cardamom and certain wheat varieties.

Remarks : *Rhopalosiphum maidis* (Fitch), commonly known as corn-leaf-aphid or wheat aphid, attacks cultivated and wild graminaceous plants from all over tropical and temperate parts of the world. It is a well known pest of several cereal crops in India and the commonest aphid species on Maize. It causes appreciable injury by attacking the inflorescence. This aphid has been known to cause economic losses in maize, sorghum, barley, oats, wheat and jawar. Barley which is grown for fodder and grain, surfers losses upto 25% by this aphid (Bhatia *et al.* 1971). It appears on cereal crops early in spring and remains in large numbers long after fall migrations of other species are well advanced. The species is also a serious pest of barley crop.

Management : Spray with 40% nicotine (1 : 800) or 0.02% phosphamidon or 0.03% dimethoate or diazinon is effective for controlling this aphid. It is not recommended to spray the insecticides if the flowers are in bloom. To prevent the occurrence of aphids it is recommended to mix thoroughly with the soil around the plants addrcarb 5%, earbofuran 3% or phorate 10% granules @ 2 to 3g. per plant. This will also control the other sap sucking pests, if any.

For its biocontrol, two parasitoid species *Lysiphlebia mirzai* Shuja-uddin and *Lysiphlebus delhinesis* Subba Rao & Sharma (Hymenoptera : Braconidae) were evaluated by Tripathi & Singh (1995) and Mishra & Singh (1990) respectively.

16. ***Rhopalosiphum padi*** (Linnaeus)
(Figs. 134-159)

1758. *Aphis padi* Linnaeus, *Syst. Nat.* (10 ed.), **1** : 451.

1953. *Rhopalosiphum padi* (Linn.) : Cottier, Aphids of New Zealand : 155.

1980. *Rhopalosiphum padi* (Linn.) : Raychaudhuri, D. N. (*ed.*), Aphids of North-East India and Bhutan.

1960. *Rhopalosiphum padi* (Linn.) : Richards, *Canad. Ent.,* Supply **13** : 29-35.

1997. *Rhopalosiphum padi* (Linn.) : Remaudiere, G. and Remaudiere, M. Catalogue of the World's Aphididae : 62.

1998. *Rhopalosiphum padi* (Linn.) : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series,* **4** (pt. 4) : 117. Zool. Surv. India.

2000. *Rhopalosiphum padi* (Linn.) : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7** : 356. Zool. Surv. India.

2001. *Rhopalosiphum padi* (Linn.) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(2) : 16.

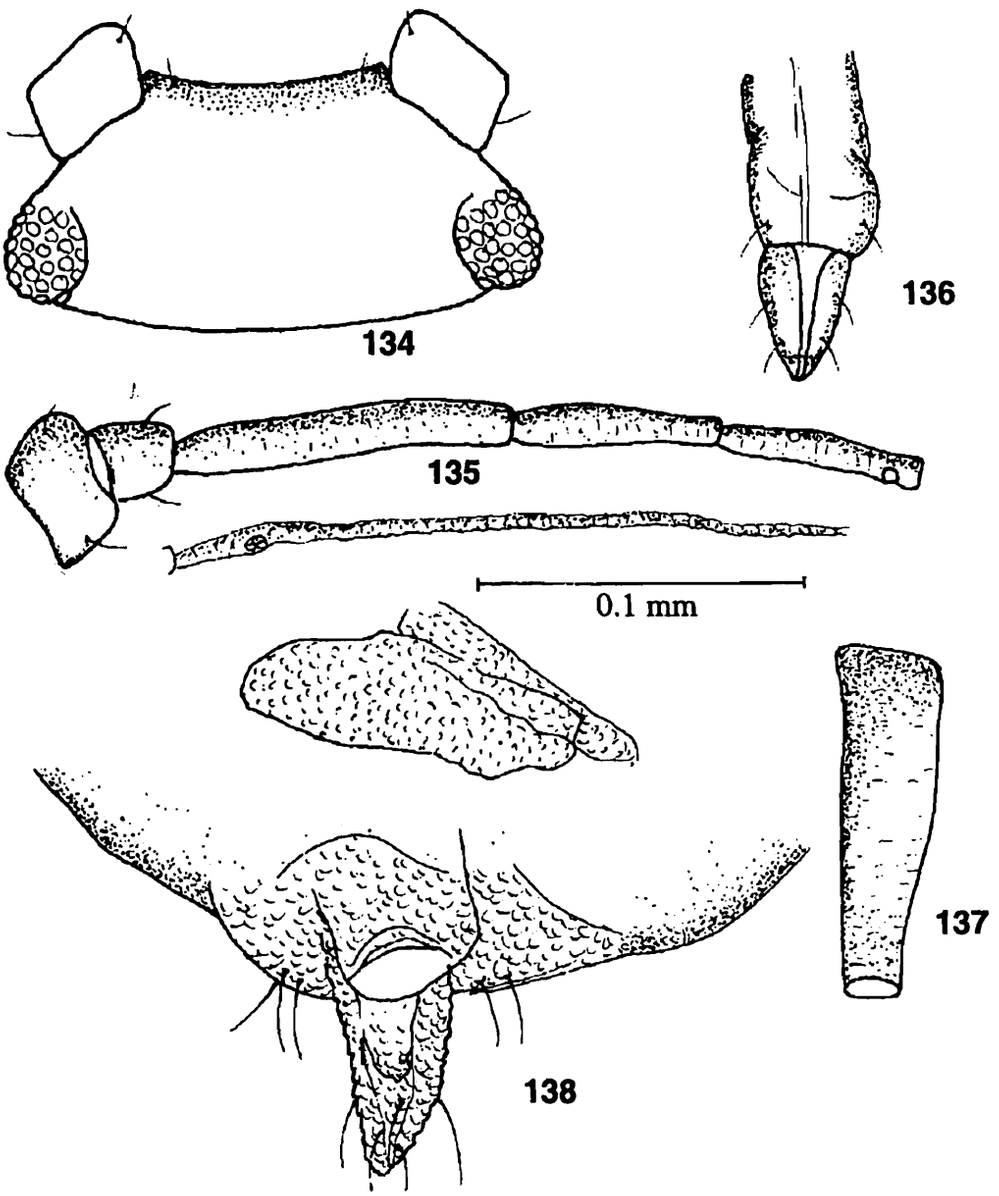
Diagnosis : *Apterous viviparous female* : Body 1.5-1.8 mm long. Head (Fig. 134) with distinct but small tubercles. Dorsal surface roughened in patches, vertex slightly produced anteriorly. Dorsum of head with medium–sized hairs. Antennae (Fig. 134) 0.8-0.9 times the body. Rostrum extends upto 2nd coxae; u.r.s. (Fig. 136) about as long as h.t. 2. Antennae without secondary rhinaria; p.t. about 4-6 times as long as base VI. Abdominal dorsum (Fig. 138) with reticulated pattern; dorsal abdominal hairs with blunt apices. Siphunculi (Fig. 137) cylindrical, about 0.15-0.20 times as long as body with well developed apical flange, with a few imbrications, a little more than 1.5 times as long as cauda and 0.15-0.20 times as long as body. Cauda (Fig. 138) spinose, tapering towards apex with 4-6 hairs yellowish green to blackish green.

Alate viviparous female : Body about 1.80 mm long. Head (Fig. 139) with distinct but small antennal tubercles not extending beyond vertex. Dorsum smooth; hair medium–sized. Antennae (Fig. 140) 6-segmented, secondary rhinaria distributed : III 10-20, IV 2-8, V 0-2; a.s. I and II rather smooth with some imbrications on ventral and inner sides, rest of antennae imbricated. Siphunculi (Fig. 142) cylindrical with distinct apical flange, often slightly swollen appearence before apex, about 1.6 times as long as cauda. Cauda (Fig. 143) spinose, rather thin on apical half with 4-5 hairs. Wing venation normal.

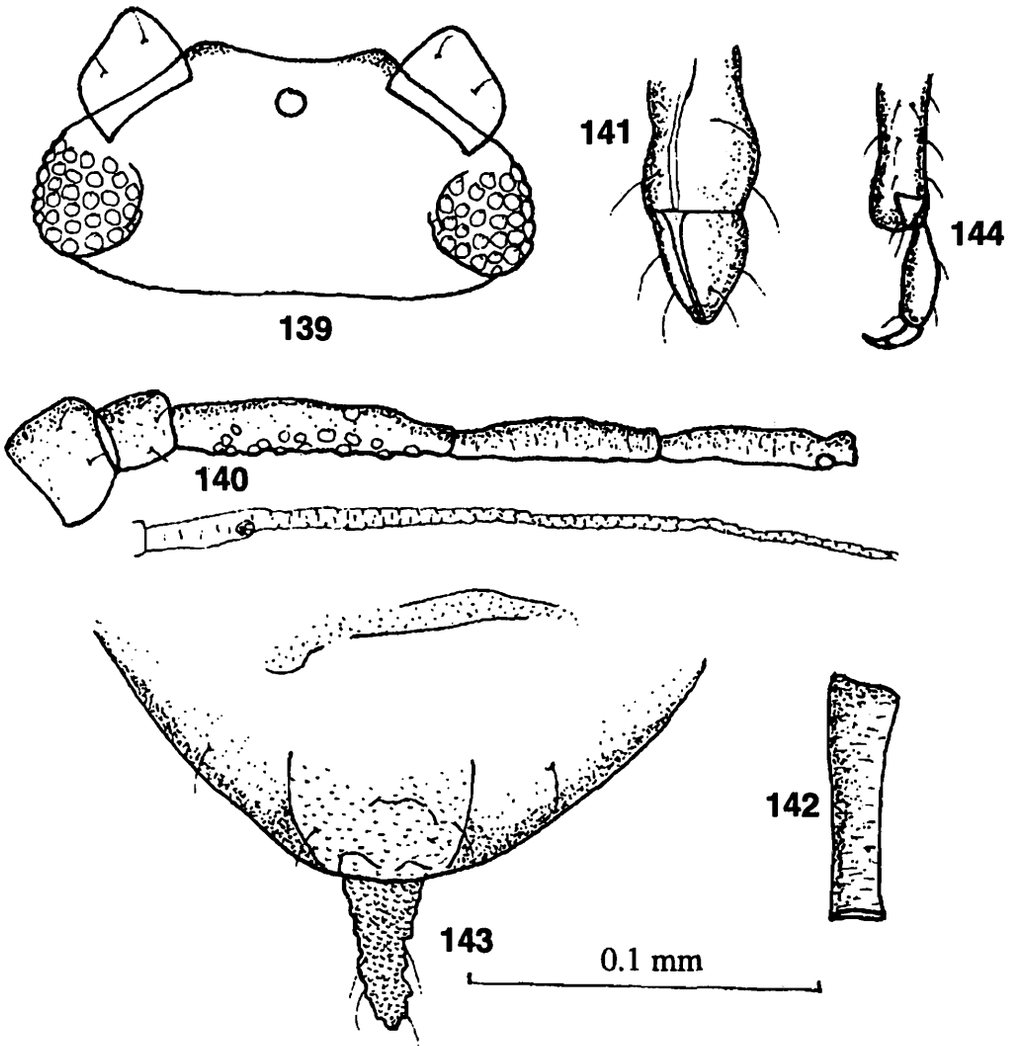
Host plans : In India the species is known to infest about 30 species of plants belonging to N.O. Acanthaceae, Canaceae, Cyperaceae, Poaceae, Oxalidaceae and Polygonaceae.

Symptom and Damage : In the field the species may be very injurious. Severe infestation is observed in the poaceous plants (November-March). From centres of infestation, it spreads in ever-widening circles. As a result, plants turn yellow and become stunted. Heavy infestation causes yellowish patches on leaves and ultimate drying of the leaves. It is commonly found on maize, but does not appear to cause noticeable injury. The aphid is responsible for Barley yellow dwarf (Nagaich and Vashisth, 1963) and Wheat streak mosaic (Raychaudhuri and Ganguli, 1968).

Bionomics : The life cycle of these greenish blue aphids does not differ materially from those of other species. The species apparently reproduces parthenogenetically throughout the year in India. However, oviparae of this species are recorded from India (Raychaudhuri, D. N. (ed.), 1980). This hints at the possibility that it may have



Figs. 134-138. *Rhopalosiphum padi* (L) : 134. head; 135. antenna; 136. u.r.s.; 137. siphunculus; 138. portion of abdomen.



Figs. 139-144. *Rhopalosiphum padi* (L) : Alate viviparous female : 139. head; 140. antenna; 141. u.r.s.; 142. siphunculus; 143. portion of posterior abdominal dorsum.

sexual life cycle in the altitudinal areas where day length is short and temperature is low which may initiate the production of the sexuales. According to Richards (1960) the number of generations of alienicolae produced is unknown, but certainly several are produced. Fall migrants alate viviparous females resemble spring migrants but are produced by Alienicolae) and sexuales occur on the winter host from the middle of September to the end of October.

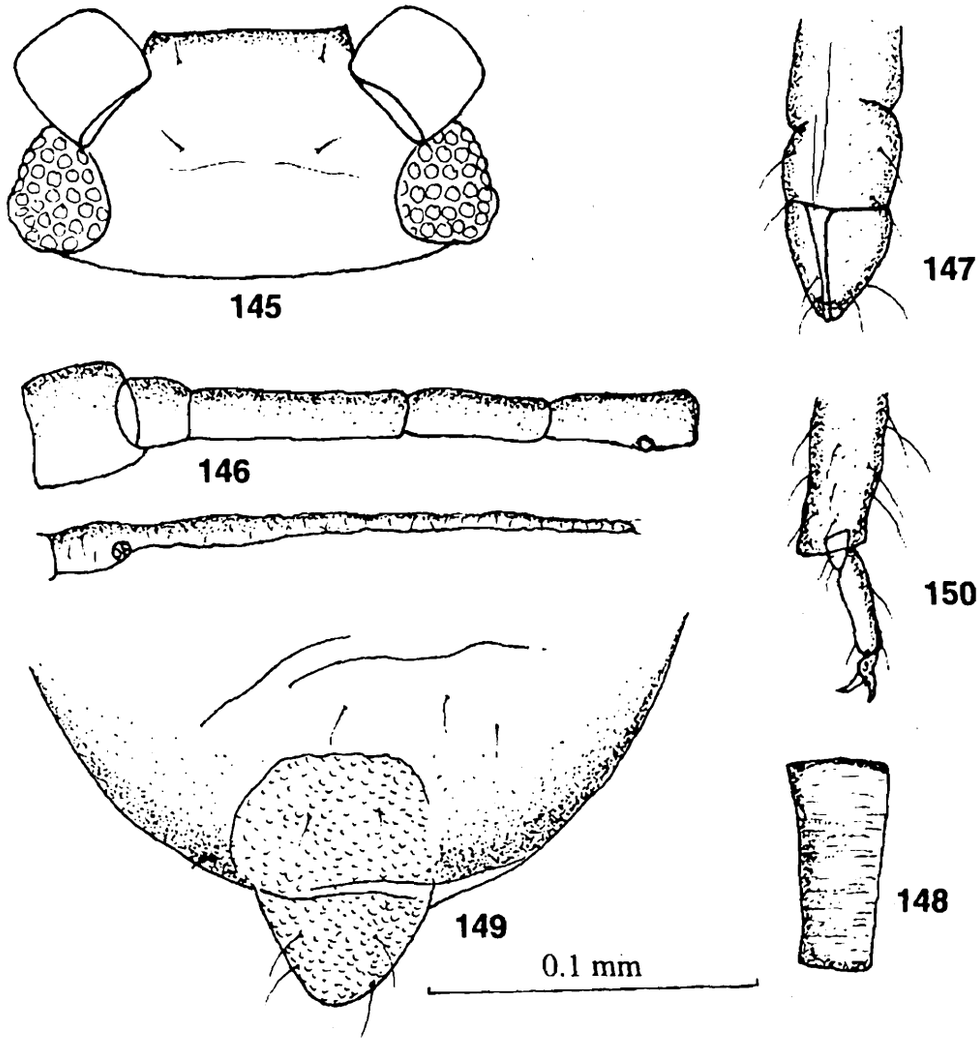
Natural enemy-complex :

Predator : *Syrphus* sp. (Diptera)

Parasitoid : *Aphidius colemani; Ephedrus* sp. [Hymenoptera]

Vector : Barley yellow dwarf, Maize leaf fleck, Oat yellow leaf, Onion yellow dwarf (Kennedy *et al.* 1962).

Distribution : India : Throughout.



Figs. 145-150. *Rhopalosiphum padi* (L) : nymph : 145. head; 146. antenna; 147. u.r.s.; 148. siphunculus; 149. portion of abdomen; 150. portion of hind tibia showing tarsal segments.

Elsewhere : Cosmopolitan.

Management : As in *Rhopalosiphum maidis* (Fitch).

17. ***Rhopalosiphum rufiabdominalis*** (Sasaki)
Rice-root aphid
(Figs. 151-159)

1899. *Toxoptera rufiabdominalis* Sasaki, *Rept. Hokkaido Agr. Expt. Sta.* **17** : 202.

1986. *Rhopalosiphum rufiabdominalis* (Sasaki) : Ghosh, L. K. *Tech. Mongr.* **16** : Zoological Survey of India : 38.

1988. *Rhopalosiphum rufiabdominalis* : Verma, *J. Indian Potato Assoc. Shimla,* **15** : 192.

1990. *Rhopalosiphum rufiabdominalis* : Bhattacharya, *J. Aphidology,* **4**(1&2) : 11.

1994. *Rhopalosiphum rufiabdominalis* (Sasaki) : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** (Part-) : 167. Zool. Surv. India.

1997. *Rhopalosiphum rufiabdominalis* : Verma and Ghosh, L. K., *J. Aphidology,* **11**(2) : 189.

2000. *Rhopalosiphum rufiabdominalis* : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7**(Part-2) : 356. Zool. Surv. India.

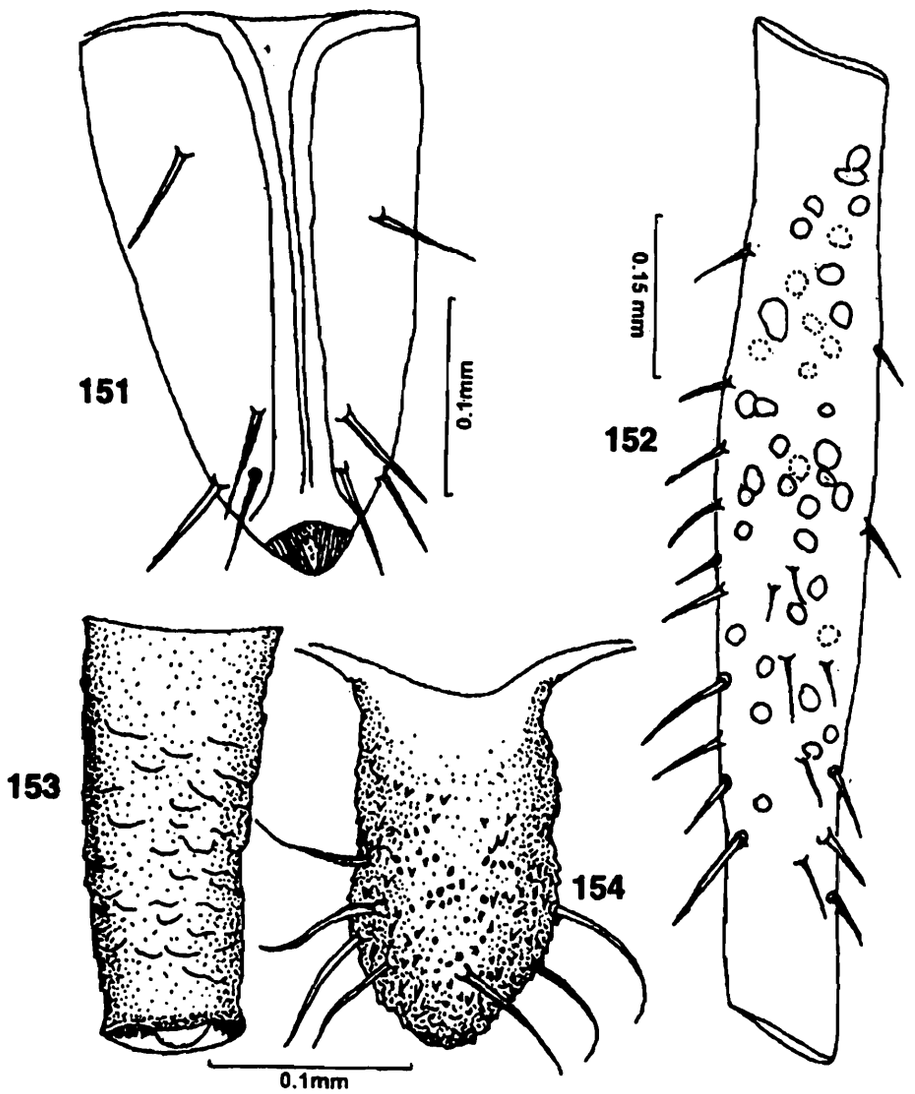
2001. *Rhopalosiphum rufiabdominalis* : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 16.

Diagnosis : *Apterous viviparous female* : Body oval, 1.42-1.89 mm long with 0.85-0.90 mm as maximum width head with well developed lateral frontal tubercles and bears rhopalosiphine projection; antennae normally 5-segmented, about half as long as body, p.t. at least 5 times as long as base VI; longest hair on a.s. III 3-4 × b.d III; u.r.s. 0.8-0.9 × h.t. 2; 8th tergite with 4-8 hairs; siphunculi dark, cylindrical, only slightly attenuated just proximad to flange heavily imbricated, 0.10-0.13 × body and about twice as long as elongate cauda which is slightly constricted and bears 4 hairs, abdominal dorsum densely covered with long and fine hairs. Apterae often subterranean. Head and part of abdomen green in life, posterior half brown.

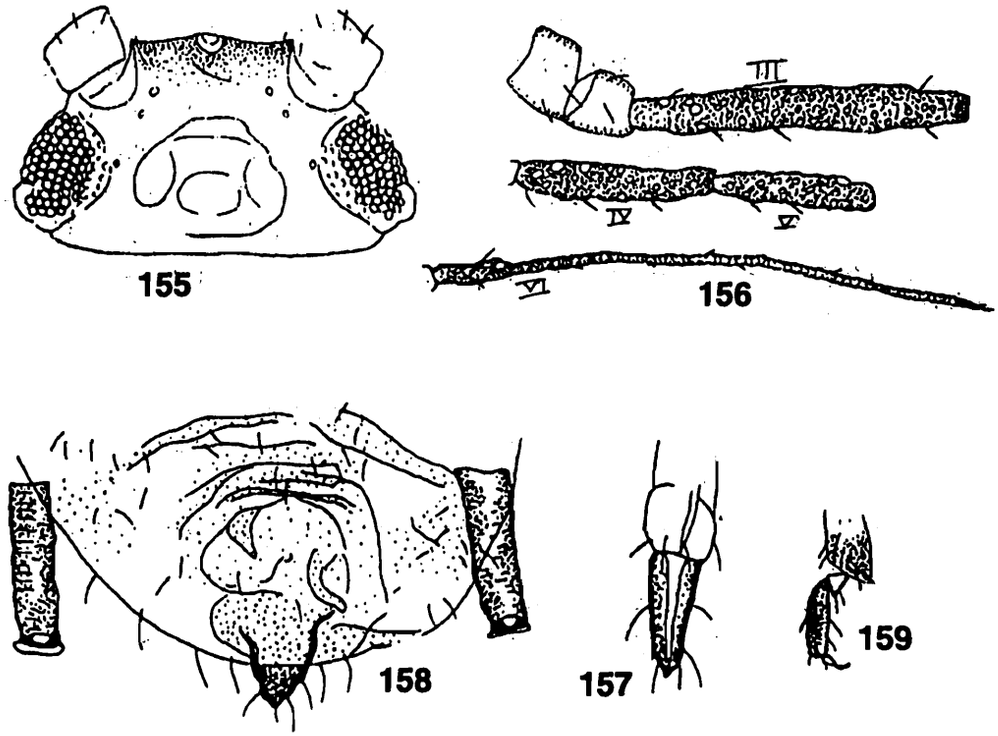
Alate viviparous female : Body semioval, about 1.60-2.20 mm long. Head with weakly developed lateral frontal tubercles having rhopalosiphine projections. Antennae 5-segmented; p.t. never less then 3 times and may be upto 7 times base V and 1.03-1.50 times as long as a.s. III; a.s. III with 11-54, IV with 0-15 and V with 0-13 secondary rhinaria, flagellar hairs with fine to bluntish apices. U.r.s. 0.7-1.5 times as long as h.t. 2 and with 2-4 secondary hairs. Abdominal dorsum with pleural intersegmental pigmentation and with a dusky band on each of tergites 7 and 8. Dorsal abdominal hairs long and fine and longest of these on 7th and 8th tergites about 2.1-2.3 times and 2.2-3.8 times as long as b.d. III respectively; body about 7-9 times as long as siphuncali being slightly swollen apically and with a well developed flange at the tip. Cauda short, about 0.6 times as long as siphunculi and with 4-9 hairs. Legs brown to dark brown; coxae and femora partly imbricated. F. T. C. 3 : 3 : 2. Wing venation normal.

Apterous oviparous female (151-154) : Body oblong, 1.70–1.80 mm long, 0.9–1.0 mm. wide. Antennae 5-segmonted, about 0.3 times as long body; longest hair on a.s. III about 3 times as long as b.d. III, p.t. 3.0–3.5 times as long as base V. Rostrum reaches hind coxae; u.r.s. (Fig. 151) 1.8–2.0 times as long as h.t. 2 with 2 secondary hairs. Hind tibiae (Fig. 152) about 0.3 times as long as body, swollen, about twice as thick as mid tibia, maximum diameter at middle 1.21-1.25 times as thick as minimum diameter at apex, with 29-40 roundish seudosensoria distributed along its whole length, diameter of hind tibiae. Siphunculi (Fig. 153) cylindrical, imbricated, about as long as cauda. Cauda (Fig. 154) nearly tongue-shaped, imbricated, about as long as siphunculus, with 6-7 hairs. Abdomen with terga membranous and smooth; 8th tergite with 6 hairs being about twice as long as b.d. III; F.T.C. 3, 3, 2.

Alate male : Body spindle-shaped, measuring 1.25 mm and having the maximum width 0.55 mm. Head sclecrotic bark brown 0.37 mm broad across the eyes, front smooth concave, bearing 4 hairs being about as long as the flageller hairs. Eyes with distinct triommatidia visible from above. Thorax dark brown, sclerotic. Abdomen pale membranous with small marginal sclerities on tergites II-IV, each bearing a few hairs and spinular striae; post-siphuncular scleric well developed; tergites VII and VIII wih transverse hears. Doral hairs similar than those in alate viviparous female with more or less acute apices, upto about 33μ, longest hair about 1.5 times as long as b.d. III, VIIII abdominal tergite with 5 moderately long hairs. The longest one measuring about 43μ. Antennae 6-segmented uniformly brownish, imbricated, 0.88 times as long as long as body, the longest hair on segment III about as long as b.d. of segment. Segment III with 28-40, partly tuberculate circular rhinaria scattered irregularly along is entire lenght except the very base; segment IV with upto 18 and segment V



Figs. 151-154. *Rhopalosiphum rufiabdominalis* (Sasaki) : Apterous oviparous female : 151. u.r.s.; 152. hind tibia showing pseudosensoria; 153. siphunculus; 154. cauda.



Figs. 155-159. *Rhopalosiphum rufiabdominalis* : Alate ♀ : 155. head; 156. antenna; 157. u.r.s.; 158. posterior portion of abdomen; 159. portion of hind tarsus.

with 15 to 16 rhinaria, arranged irregularly along their entire lengh, while the base of a.s. VI with 1 to 2 moderately large circular rhinaria the middle; p.t. 6.2 to 6.6 times as long as the base of the segment VI, 1.8 times as long as long a.s. III; rostrum extends upto 2nd coxae; siphunculi sclerotic, about 0.14 times as long as the body, imbricated with a few transvere striae and cylindrical with a little expansion near the distal half followed by a faint constriction before small but distinct flange at the tip. Cauda dark, imbricated broadly oval, rather tongue-shaped, about 0.37 times as long as siphunculus and with 5 hairs. Anal and sub-genital plates dark sclerotic. Legs moderately long, pale, except the femora and the apices of the hind tibiae which are dark. First tarsal tarsel chaetotaxy 3, 3, 2.

Symptom and Damage : Both adults and nymphs attack both the aerial parts and roots of Potato. However, a large population has been found on the roots. The species also attacks roots of paddy, maize, jowar, weeds etc. Due to infestation the plant suffers stunted growth resulting yield loss.

Host plants : The aphid species is known to infest about 55 plant species belonging to N.O. Apocynaceae, Aroidae, Canaceae, Ericaceae, Fagaceae, Poaceae, Liliaceae, Malaceae, Papilionaceae, Rosaceae, Solanaceae etc.

Life cycle : The adults reproduce parthenogenetically and produce nymphs throughout the year. The alate forms that are produced after 2-3 generations of the apterous forms are responsible for dispersal of this aphid. They are carried to the potato fields by wind and subsequently nymphs are produced on the leaves, which move towards the roots at soil level. The adults are minute dark green with reddish

blotches around bases of siphunculi. In India, alate male (Figs. 155-159) was reported and described for the first time from snow at Nainipeak (*Ca.* 8, 563') in Uttar Pradesh by L. K. Ghosh (1969). Later, Verma (1988) reported apterous oviparous females collected on Peach in U.P. Thus, the finding of both sexual male and female (Fig. 151-154) from the same geographical range hints at the possibility that the species breeds holocyclically at least in the northern part of India.

Natural enemy-complex :

Predator : *Scymnus* sp. [Coleoptera : Coccinellidae)

Vector : The aphid transmits barley yellow dwarf virus; Ragi mosaic (Subbayya & Raychaudhuri, 1970).

Distribution : India : Delhi, all over.

Elsewhere : Africa; Japan; Malayasia; Netherlands; Middle East; Nepal and Taiwan.

Remarks : The species is readily recognised by the relatively long antennal and body hairs and also the presence of usually 4 hairs on abdominal tergum VIII.

Young *et al.* (1971) reported the species from roots and underground stems in Barley at Delhi from the first time in India. According to them the aphid colonies were present on the crop from the 1st week & January to the end of February. In India, yield losses in potato crop upto 80% have been reported due to aphids of which *R. rufiabdominalis* also plays an important role.

Management : Mixing crude oil emulsion in irrigated water or drenching the soil with 0.05% carbaryl or 0.04% phospamidon @ 2000 litres/ha can effectively control infestation of this aphid.

Genus 7. ***Schizaphis*** Börner

1931. *Schizaphis Börner,* 1931. *Anz. Schädlingsk.,* **7** : 10.

Type species : *Aphis graminum* Rondani, 1847.

Head smooth with low but distinct lateral frontal tubercles and a slightly scabrous low median frontal prominence. Antennae 6-segmented, about 0.77-0.86 × body, imbricated on flagellum; apterae without secondary rhinaria, alatae with circular secondary rhinaria usually on segment III; p.t. long, up to about 5.0 × base of segment VI. U.r.s. short, usually shorter but may be a little longer than h.t. 2 and bears 2-3 secondary hairs. Abdominal dorsum in apterae with usual 'aphidine' reticulation, pale, but 8th tergite with a narrow sclerotic band; in alate also with marginal pigmented areas and transverse pigmented bands on tergites 7 and 8, hairs on 7th and 8th tergites usually fine and may be just longer to much longer than anterior tergal hairs on tergite 8. Siphunculi either completely pale or pale only basally or dark, imbricated, without flange. Cauda pale to dark, about less than 0.70 × siphunculi and bears 5-7 hairs. Media in forewing once-branched; hindwing usually with two oblique veins. F. T. C. 3 : 3 : 2.

18. *Schizaphis graminum* (Rondani)
Wheat aphid
(Figs. 160-166)

1852. *Aphis graminum* Rondani, *Nouv. Ann. Sci. Nat. Bologna,* **6**(3) : 10.

1976. *Schizaphis graminum* (Rondani) : Nayer *et al., General and applied Entomology* : 202.

1980. *Schizaphis graminum* (Rondani) : Raychaudhuri, D. N. *et al., In* : Aphids of N.E. India and Bhutan : 72.

1992. *Schizaphis graminum* (Rondani) : Agarwala and Bhattacharya, *Soc. Nat. Sci.,* **2**(3 &4) : 2.

1994. *Schizaphis graminum* (Rondani) : Ghosh, L. K. and Basu, R. C., *In* : *Fauna of West Bengal, State Fauna Series* **3** : 168. Zool. Surv. India.

1998. *Schizaphis graminum* (Rondani) : Ghosh, L. K. and Basu, R. C., *In* : *Fauna of Meghalaya, State Fauna Series,* **4** : 118. Zool. Surv. India.

2000. *Schizaphis graminum* (Rondani) : Ghosh, L. K. and Basu, R. C., *In* : *Fauna of Tripura, State Fauna Series,* **7**(pt. 2) : 357.

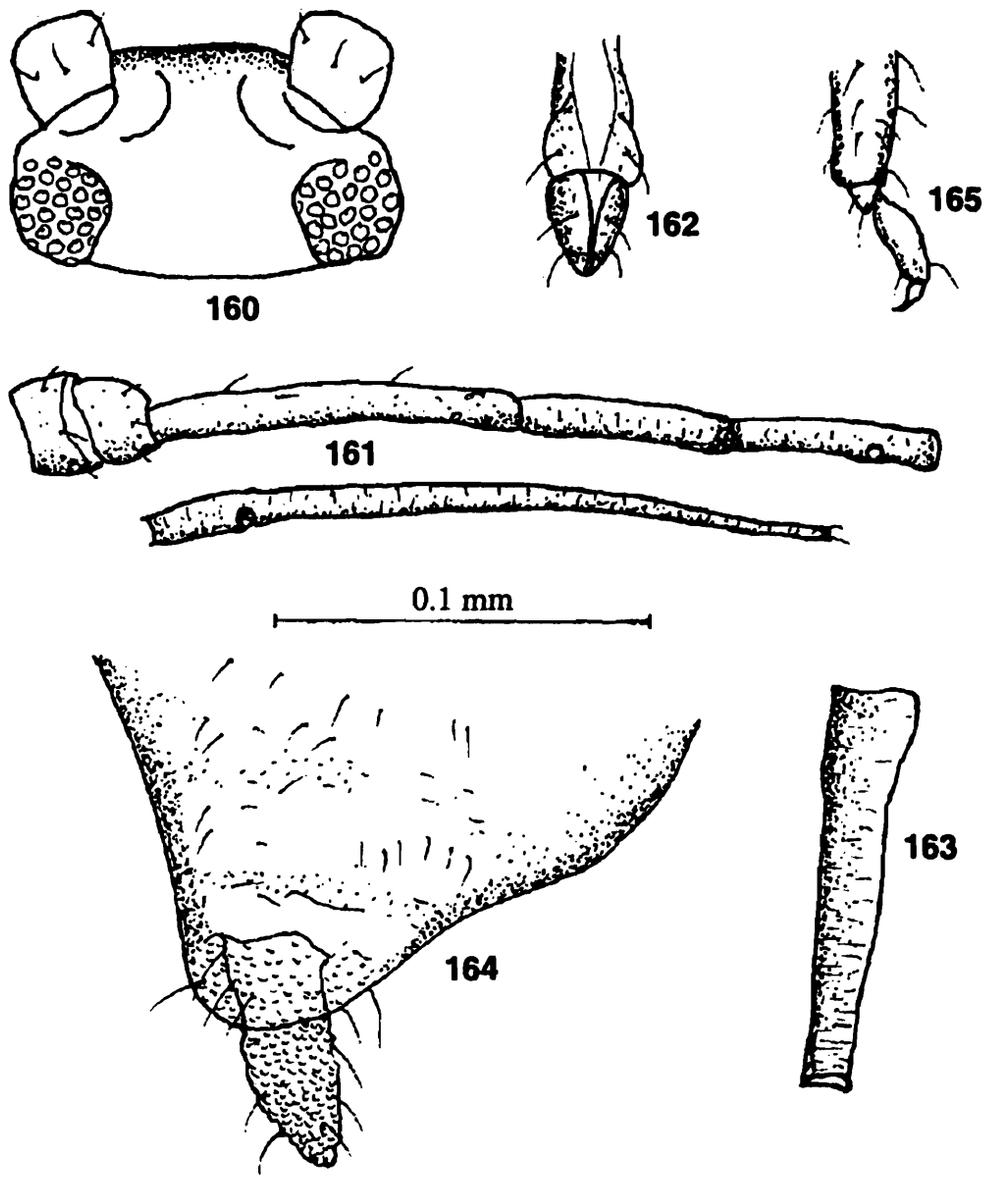
2001. *Schizaphis graminum* (Rondani) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 16.

Diagnosis : *Apterous viviparous female* : Body elongate, about 1.45-2.0 mm long with about 0.80 mm as maximum width. Antennae (Fig. 161) 6-segmented about 0.9 times as long as body, flagellum imbricated a.s. III without secondary rhinaria; flagellar hairs short; p.t. long, nearly 5 times as long as base VI. U.r.s. (Fig. 162) either a little shorter or to about as long as h.t. 2, bearing 2-3 secondary hairs. Dorsum of abdomen (Fig. 164) pale, with usual "aphidine" reticulation, 8th abdominal tergite with a narrow sclerotic band; dorsal hairs on anterior tergites moderately long, hairs on 7th and 8th abdominal tergite fine. Siphunculi (Fig. 163) pale or dusky, 0.13-0.16 times as long as body, without well developed flange and nearly smooth on distal half. Cauda (Fig. 164) somewhat pale, about 0.6 times as long as siphunculi, bearing 5-7 hairs. F. T. C. 3 : 3 : 3.

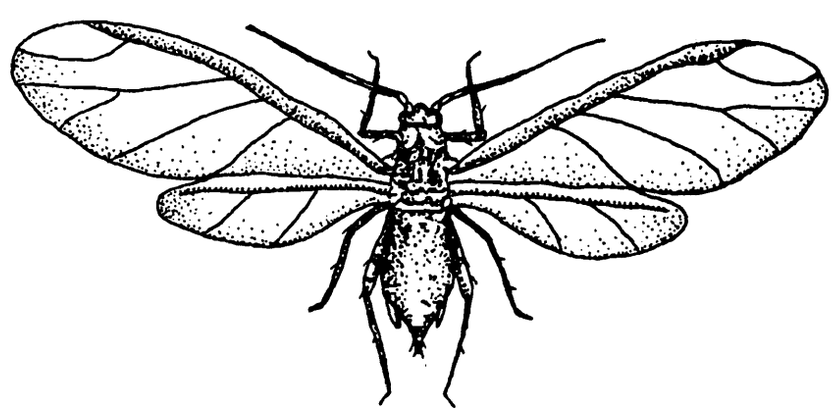
Alate viviparous female : Body much elongate, about 2 mm long with about 0.85 mm as maximum width near the middle of abdomen. U.r.s. about 0.7 times as long as h.t. 2. Abdominal dorsum with marginal pigmented areas and transverse pigmented bands on tergites 7 and 8. Cauda pale, more than 0.6 times as long as siphunculi; antennal segment III with 7-10 secondary rhinaria, a.s. IV and V without such rhinaria. Media of forewings once-branched, hind wings with two oblique veins.

Host plants : The species is known to infest 19 species of plants belonging to N.O. Poaceae (Gramineae).

Symptom and Damage : This aphid is often present in very large and dense colonies on stems, leaves and the inflorescence of the host plant. Its feeding causes yellow patches and in cases of severe attack leaf becomes yellowish brown. Honeydew excretion favours sooty mould development. There can be much grain deformation.



Figs. 160-165. *Schizaphis graminum* (Rondani) : Apterous viviparous female : 160. head; 161. antenna; 162. u.r.s.; 163. siphunculus; 164. posterior abdominal dorsum; 165. portion of tibia showing tarsal segments.



Figs. 166. *Schizaphis graminum* (Rondani) : Alate viviparous female.

Biology : The species usually reproduces parthenogenetically in the Indian conditions and it is very rapid in its effect. Breeding is continuous almost throughout the country. Both apterous and alate viviparous females are present. The nymphs are deposited on the leaf blade in a single row which afterwards migrate to another leaf. Nymphal period involves 7-13 days. Its life span is 26-39 days. During this period an alate viviparous female gives birth to 55-79 nymphs at one to eight per day. Both winged and nonwinged adults multiply at fast rate during cold weather and reach the height of their population in February-March. At the advent of summer the species migrates to other plants. These aphids have many generations in a year.

Natural enemies-complex :

Predator : *Cheilomenes sexmaculata* (Fabricius); *Coccinella* sp. [Coleoptera : Coccinellidae]

Parasitoid : *Aphelinus gossypii* Timberlake; *Aphidius colemani* Viereck; *Aphidius* sp.; *Diaeretiella rapae* (M' Intosh); *Ephedrus* sp.; *Lysiphlebus delhiensis* Subba Rao and Sharma; *Lysiphlebis mirzai* Shuja-Uddin; *Lysiphlebus* sp.; *Parapraon pakistanum* (Kirkland); *Praon* sp. [*Source* : Stary and A. K. Ghosh, 1983]

Fungus : *Entomophthora aphidis* Hoffman

Vector : Barley yellow dwarf; Millet red leaf; Sugarcane mosaic; Wheat mosaic; Radish mosaic.

Distribution : India : all over.

Elsewhere : very widely distributed in Europe, Asia, eastern and southern Africa, Middle East, S. China, Japan, Philippines and Australia.

Management : Spraying of monocrotophos (0.036%), Oxydemetonmethyl or phosphamidon (0.025%) is most effective.

Tribe MACROSIPHINI

Genus 8 ***Acyrthosiphon*** Mordvilko

1914. *Acyrthosiphon* Mordvilko, *Faune Russie,* **1** : 75.

Type species : *Aphis pisi* Kaltenbach, 1843 (= *Aphis pisum* Harris, 1776).

Head usually smooth, sometimes with a very few indistinct spinules ventrally near base of antennal sockets; lateral frontal tubercles well developed, frontal sinus, at least in apterae, usually V-shaped, in alate middle of frontal sinus might be slightly raised and head provided with a pair of small somewhat pleurally placed tubercles just inner to eyes; dorsal cephalic hairs short with bluntish to incrassate apices. Antennae 6-segmented; segment III in apterae with a few secondary rhinaria near base, in alatae number may be about 3.0-5.0 × base of segment, shorter than h.t.2. Abdominal dorsum in apterae pale and smooth, in alatae only with faint spinulose

marginal sclerities; dorsal hairs also like dorsal cephalic hair. Siphunculi cylindrical with a wide base, imbricated, sometimes with a few interconnecting preapical striae. Cauda elongated with pointed to bluntish apices, about 0.50-0.65 × siphunculi; wing venation normal. F.T.C. 3,3,3.

19. *Acrythosiphon pisum* (Harris)
Pea aphid
(Figs. 167-168)

1776. *Aphis pisum* Harris, *Exposit English Insects* : 66.

1947. *Acyrthosiphon pisum* (Harris) : Hille Ris Lambers, *Temminckia* **7** : 247.

1958. *Acyrthosiphon pisum* (Harris) : Basu, A. N. and Banerjee, S. N. *Indian agriculturist,* **2** : 89.

1980. *Acyrthosiphon pisum* (Harris) : Raychaudhuri, D. N. (ed), Aphids of N. E. India and Bhutan : 91.

1994. *Acyrthosiphon pisum* (Harris) : Ghosh, L. K. and Basu, R. C. *Fauna of West Bengal, State Fauna Series,* **3** : 176. Zool. Surv. India.

1998. *Acyrthosiphon pisum* (Harris) : Ghosh L. K. and Basu, R. C. *Fauna of Meghalaya, State Fauna Series,* **4** : 124. Zool. Surv. India.

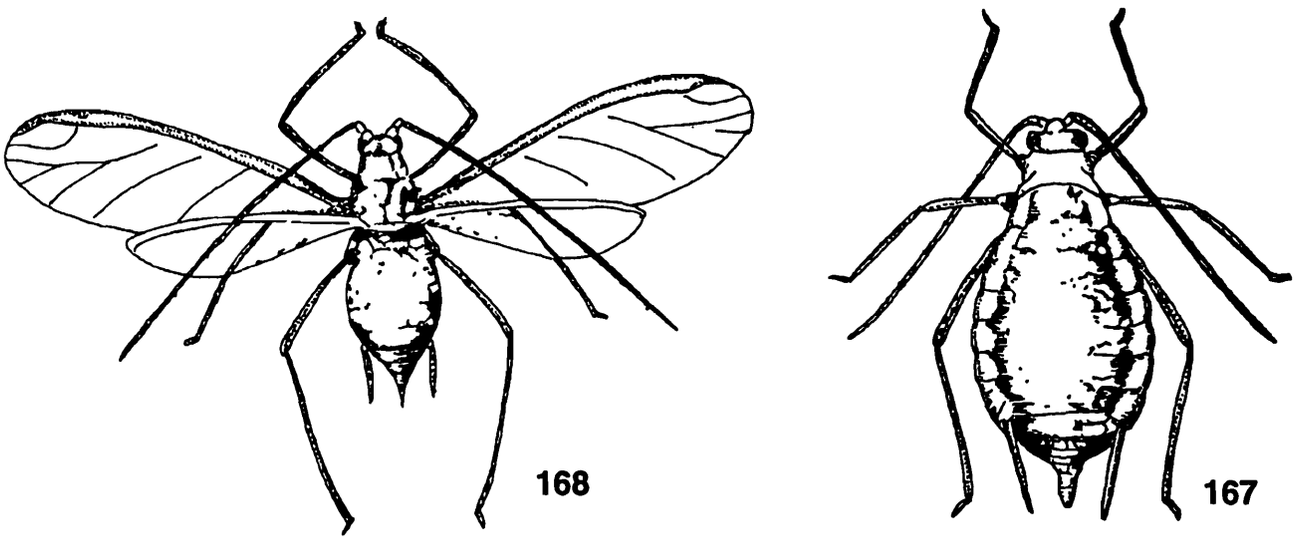
2000. *Acyrthosiphon pisum* (Harris) : Ghosh L. K. and Basu, R. C. *Fauna of Tripura, State Fauna Series,* **7** : 358. Zool. Surv. India.

2001. *Acyrthosiphon pisum* (Harris) : Chakrabarti and Sarkar, *J. Aphidology,* **15** (1 & 2) : 17.

Apterous viviparous female (Fig. 167) *:* Body pale green, elongate, 3.2–4.5 mm long with 1.3–2.5 mm as maximum width near at the middle; head smooth, lateral frontal tubercle well developed, frontal sinus usually V-shaped, dorsal cephalic hairs short with bluntish to incrassate apices. Antennae 6-segmented, subequal to body, a.s. III with a few (1-4) secondary rhinaria near base, p.t. 3–5 times as long as base VI, flagellar hairs like dorsal cephalic hairs; rostrum reaches mid coxae, u.r.s. 0.6–0.7 times as long as h.t.2. Abdominal dorsum pale and smooth; dorsal hairs about 0.5 times as long as b.d. III. Siphunculi slender, 0.20-0.25 times as long as body, distinctly flanged, imbricated, sometimes with a few interconnecting striae. Cauda elongate, not constricted basally, about 0.5–0.6 times as long as siphunculi, bearing 7–12 hairs; F.T.C. 3,3,3.

Alate viviparous female (Fig. 168) : Head usually smooth, sometimes with a very few indistinct spinules ventrally near base of antennal sockets; a.s. III 8-25 secondary rhinaria distributed on basal 0.75 portion; dorsum of abdomen with faint spinulose marginal sclerites. Wing venation normal. Other characters as in apterous viviparous female.

Host plants : Alhagi camelorum; Chenopodium album; Cicer arietenum; Dianthus dampieri; Dolichos lablab; Glycenemax Lathyrus odoratum; L. sativus; Lens esculenta;



Figs. 167-168. *Acyrthosiphon pisum* (Harris) : 167. Apterous viviparous female; 168. Alate viviparous female.

Lens culinaris; Medicago denticulata; M. falcatum; M. lupulina; M. sativa; Melilotus alba; Peganum harmala; Pisum sativum; Pisum spp., *Prinsepia utilis; Pyrus communis; Sesbania grandiflora; Solanum tuberosum; Trifolium alekandrium; Trigonella foenum-graecum; Vicia taba.* [Source : Raychaudhuri, D. N. (ed.) 1983 and Chakrabarti and Sarkar, 2002].

Symptom and Damage : Both nymphs and adult aphids suck the plant sap. As a result, the leaves are often cupped or otherwise distorted, colony of green or pink aphids are found round the stems, young shoots and the underside of leaves, they drop to the ground at the slight disturbance. A sporadically serious pest of peas.

Biology : The large green, yellow or pink aphids are with long subcylindrical siphunculi. Not much known about the biology of the aphid in India where both adult apterous and alate viviparous females reproduce parthenogenetically. One generation apparently takes about a week from completion.

Distribution : India : widespread.

Elsewhere : Cosmopolitan in both Palaearctic and Nearctic regions, extending into the highland areas of Africa, Java; Tasmania.

Management : Spraying of dimethoate, formothion, demeton-s-methyl, menazon, diazinon and pyrethrum proves effective.

Natural enemy-complex :

Predator : *Cheilomenes sexmaculata* (Fab.); *Sphaerophoria scutellaris* (Fab.).

Harmonia : *Coccinella septempunctata Linn. dimidiata* (Fab.); *Harmonia octamaculata* (Fab.); *Coccinella transversalis* (Fab.) [Coleoptera : Coccinellidae].

Parasitoid : *Aphidius* sp.; *Aphidius smithi* Sharma and Subba Rao; *Ephedrus plagiator* (Nees); *Lysiphlebus fabarum* (Marshall); *Praon myzophagum* Mackauer; *Praon volucre* (Haliday) [Aphidiidae : Hymenoptera]; *Allograpta javana* (Wiedmann) [Syrphidae : Diptera]; *Macrosyrphus confrator* (Wiedmann) [Syrphidae : Diptera].

Transmission of Virus : *Acyrthosiphon pisum* (Harris) happens to be potential vector of more than 30 viruses (Misra 2002). Some important are : Bean common mosaic; Beet mosaic; Cabage ring spot; Cauliflower mosaic; Pea mosaic; Pea leaf roll; Radish mosaic; Potato virus-Y; Cardamom mosaic.

Genus 9 ***Aulacorthum*** Mordvilko

1914. *Aulacorthum* Mordivilko, Faune Russie, **1** : 68.

Type species : *Aphis solani* Kaltenach, 1843.

Diagnosis : Head spinulose on under surface, spinulosity rather sprase dorsally; lateral frontal tubercles scabrous with parallel inner margin and diverging apically, median frontal tubercles low; dorsal cephalic hairs "myzine" type. Antennae 6-segmented, basal 2-segments scacbrous; apterae usually with 0-4 secondary rhinaria, in alatae such rhinaria present only on a.s. III; p.t. about 5-6 times as long as base of a.s. VI; u.r.s. with 4-8 secondary hairs. Dorsum of adomen in apterae sometimes smoky middorsally and marginally on segments 2-4, in alatae with segmentally arranged spinal, pleural and marginal patches. Siphunculi much longer than canda, usually cylindrical, flanged. Canda elongate bearing 4-8 hairs. Second tarsal segment with normal imbrication. F.T.C. 4 : 4 : 4 or 3 : 3 : 3.

20. ***Aulacorthum solani*** (Kaltenach)
Potato aphid
(Fig. 169-177)

1843. *Aphis solani* Kaltenbach, *Mon. der. Fam. Pflanzen.* : 15.

1969. *Aulacorthum solani* (Kaltenach) : Basu, A. N. *Oriental Ins.* **3**(4) : 357.

1980. *Aulacorthum solani* (Kalt.) : Raychaudhuri, D. N. (ed.) Aphids of N. E. India and Bhutan : 105.

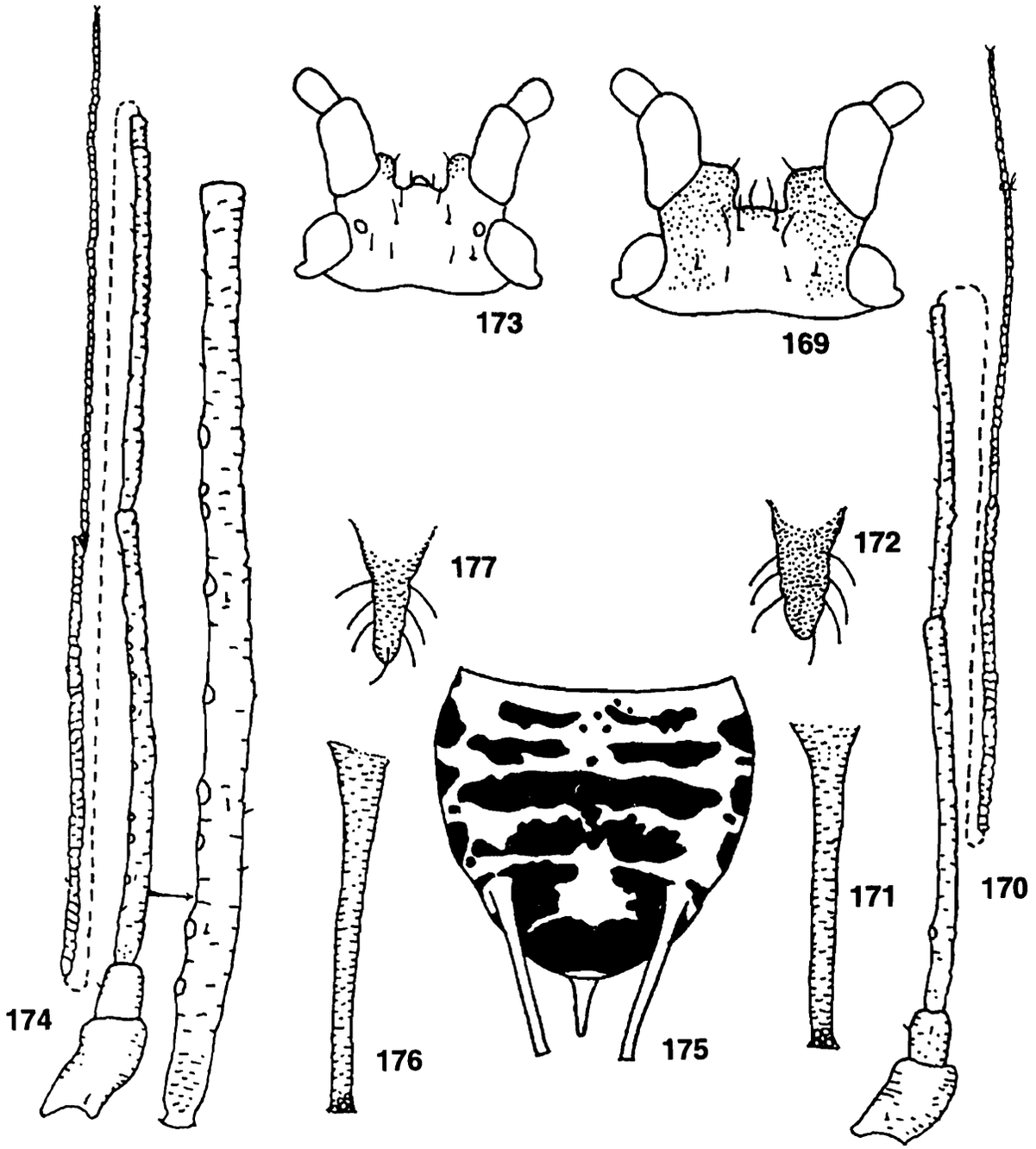
1986. *Aulacorthum solani* (Kalt.) : Ghosh, L. K., *Tech. Monogr. No.* **16,** Zoological Survey of India : 59.

1994. *Aulacorthum solani* (Kalt.) : Ghosh L. K and Basu, R. C., *Fauna of West Bengal, State Fauna series,* **3** : 180. Zool. Surv. India.

1998. *Aulacorthum solani* (Kalt.) : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series,* **4** : 128. Zool. Surv. India.

2001. *Aulacorthum solani* (Kaltenbach) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 17.

Diagnosis : Body elongate, dorsum of head with spinules (Fig. 169), such spinules spread all over or at least near bases of lateral frontal tubercles and inner margins of eyes. Antennae (Fig. 170) 6-segmented, longer than body, basal 2 segments scabrous, flagellum imbricated progressively from base towards apex; apterae usually with a few circular nonprotuberant secondary rhinaria near base of a.s. III, in alatae such rhinaria present on a.s. III distributed almost throughout its length, p.t. much longer than base VI (Fig. 174). U.r.s. shorter to longer than h.t. 2, bearing 4-8 secondary hairs besides 3 preapical pairs.



Figs. 169-177. *Aulacorthum solani* : Apterous viviparous female : 169. Head; 170. Antenna; 171. Siphunculus; 172. Cauda. Alate viviparous female : 173. Head; 174. Antenna; 175. posterior abdominal dorsum; 176. Siphunculus; 177. Cauda.

Dorsum of abdomen in apterae pale, sometimes smoky middorsally and marginally on segments 2–4, in alatae with segmentally arranged spinal, pleural and marignal patches (Fig. 175). Siphunculi dark cylindrical, imrbicated, flanged and with a few preapical interconnecting striae which may form a few transversely elongate cells (Fig. 176). Cauda dark elongate, about half as long as siphunculi bearing 4–8 hairs (Fig. 177). Femora sparsely to densely imbricated, tibiae smooth, 2nd tarsal segment with normal imbrications. wing venation normal. F.T.C. 3 : 3 : 3.

Host plants : The species infests nearly 40 species belonging to 21 plant families. The important families are Asteraceae (Compositae) Brassicaceae (Leguminasae), Poaceae (Gramineae) Polygonaceae, Solanaceae etc.

Symptom and Damage : The brownish aphids suck the plant sap with the help of piercing and sucking type of mouth parts. They usually infest young shoots and the undersides of young leaves of the host plants. As a result, leaves are cupped or otherwise distorted and become yellowish. Drops of sticky honey dew or patches of sooty mould on the upper sides of leaves.

Life history : In Indian Conditions, this aphid reproduces parthenogenetically throughout the year. Several generations are completed in a year. One generation takes about two weeks in favourable conditions. The biology of the species is not properly known.

Vector : The species is known to transmit chrysanthemum aspermay disease (Gupta and Singh 1981). According to Misra (2002) this aphid is a vector of more than 30 viruses.

Distribution : India : Widespread.

Elsewhere : Widespread in Europe; Africa; Japan; Middle East; Sri Lanka, Newzealand; Australia; North America; Peru; Hawaii; Fiji.

Remarks : The species is characterised in the alatae with broken transverse blackish spots (or bands) on the abdomen which sometimes fuse and appear as an irregular black patch.

Management : Spray of dimethoate, formothion, demeton-s-methyl, menazon, diazinon and pyrethrum are recommended. (Hill, 1975).

Genus 10. ***Brachycaudus*** van der Goot

1913. *Brachycaudus* van der Goot. *Tijdschr. Ent.*, **56** : 97.

Type species : *Aphis myosotidis* Koch, 1854.

Diagnosis : Head rugose and lateral frontal tubercles ill developed; frons convex; dorsal cephalic hairs with blunt to incrassate apices. Antennae usually 6-segmented, apterae without secondary rhinaria, alatae with round protuberant secondary rhinaria on segments III and IV; flagellar hairs sparse, short with blunt apices; p.t. about 2.0-

4.0 × base of segment VI; u.r.s normal, as long as to nearly 2.0 × h.t.2 and with 3 pairs of secondary hairs. Abdominal dorsum in apterae often with pigmented middorsal patch; in alatae abdominal dorsum with middorsal pigmented patch on segments 3 to 6, spinopleural bars on segments 7 and 8 median patch may coalesce with marignal patches on posterior segments; dorsal hairs thick with blunt apices, those on anterior tergites at most 2.0 × b.d. III. Siphunculi short, subcylindrical, pigmented, smooth, with well developed apical flange and subapical annular circumcision. Cauda short, dusky, subpentagonal, about half as long as siphunculi and with 4 to 6 hairs. Spiracular openings large, more or less circular, distance between spiracular apertures on segments 5 and 6 closer than that between those on segments 6 and 7. Wing-venation normal. Nymphs with hind tibiae smooth, F.T.C. 3, 3, 3 or 3, 3, 2.

21. ***Brachycaudus helichrysi*** (Kaltenbach)
Leaf-curl plum aphid or Peachleaf curling aphid
(Figs. 178-188)

1843. *Aphis helichrysi* Kaltenbach *Mon der Fam. Pflanzen.* : 102.

1913. *Brachycaudus helichrysi* (Kaltenach) : van der Goot, *Tidschr. Ent.* **56** : 97 (in Cottier, 1953)

1972. *Brachycaudus helichrysi* (Kaltenbach) : Ghosh, A. K. *et al., Oriental Ins.,* **6**(3) : 336.

1975. *Brachycaudus helichrysi* (Kaltenbach) : David and Hameed, *Oriental Ins.* **9**(2) : 216.

1980. *Brachycaudus helichrysi* (Kaltenbach) : Raychaudhuri, D. N. (ed), Aphids of N. E. India and Bhutan : 107.

1986. *Brachycaudus helichrysi* (Kaltenach) : Ghosh, L. K., *Tech. Manogr.* No. **16** : 62. Zool. Surv. India.

1986. *Brachycaudus helichrysi* (Kaltenbach) : Medda, Saha and Chakrabarti, *Proc. 2nd Nat Symp., Recent Trends in Aphidological Studies,* Modinagar : 31.

1994. *Brachycaudus helichrysi* (Keltencbach) : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** : 180. Zool. Surv. India.

1998. *Brachycaudus helichrysi* (Kaltenbach) : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series,* **4** : 128. Zool. Surv. India.

2002. *Brachycaudus helichrysi* (Kaltenbach) : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7** : 358. Zool. Surv. India.

2001. *Brachycaudus helichrysi* (Kaltenbach) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 17.

Diagnosis : Apterous viviparous female : Body somewhat elongated; head (Fig. 178) with lateral frontal tubercles not indicated; frons convex. Antennae (Fig. 180) 6-segmented about half as long as body; flagellum imbricated, aptera without secondary rhinaria, flagellar hairs sparse, short with blunt apices; p.t. about twice as long as base VI. U.r.s. as long as or a little longer than h.t.2, bearing 3 pairs of short secondary

hairs. Dorsum of abdomen often with pigmented middorsal patch; dorsal hairs thick with blunt apices, posterior hairs being longer than anterior ones, about twice as long as b.d. III. Siphunculi (Fig. 181) short, subcylindrical, pigmented, smooth with distinct apical flange and subapical annular circumcision, cauda (Fig. 183) short, subpentagonal, about half as long as siphunculi, bearing 4-6 hairs. Spiracular openings large, distance between spiracular apertures on segments 5 and 6 closer than between those on segments 6 and 7. F.T.C. 3 : 3 : 3.

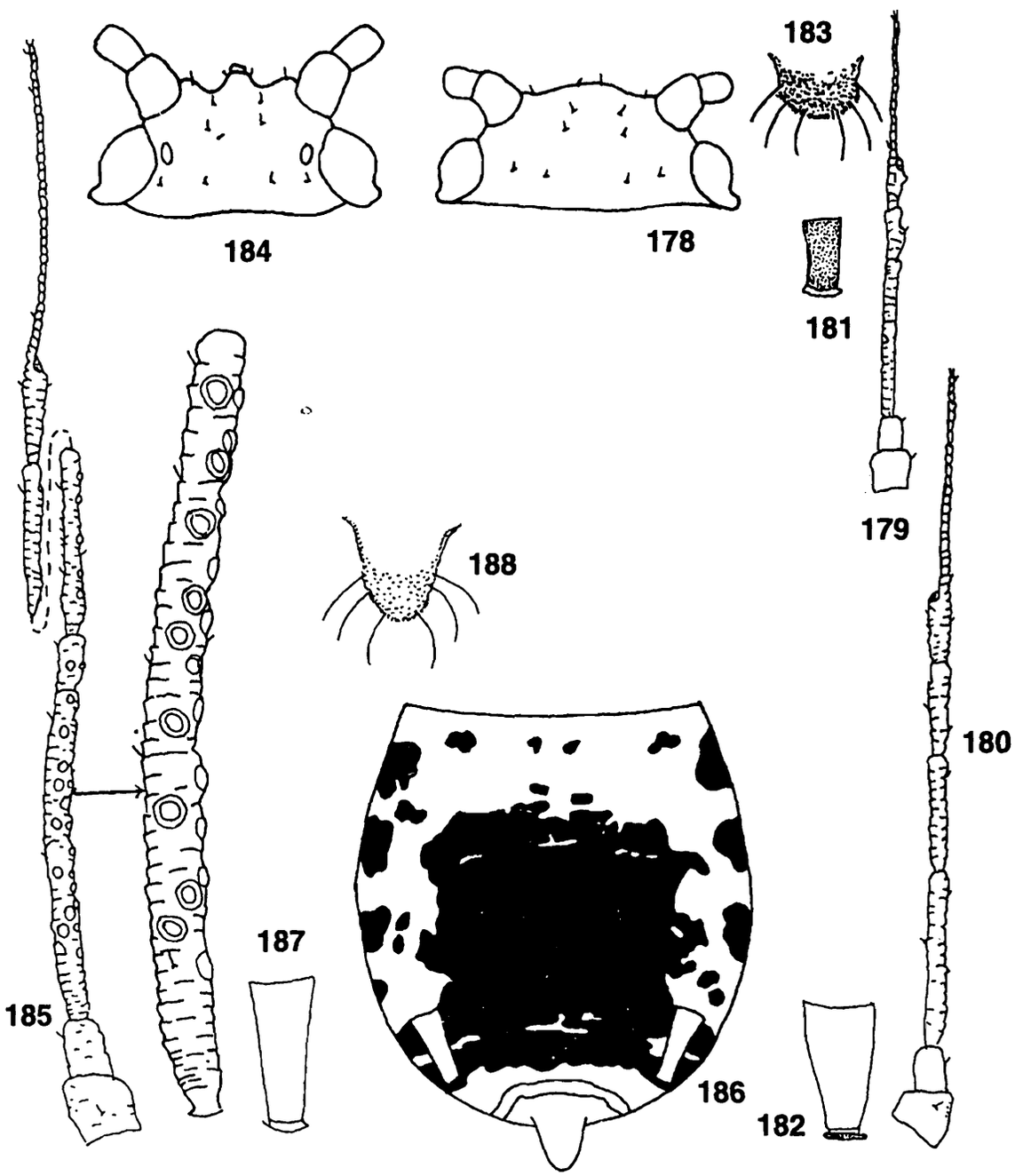
Alate viviparous female : A.s. III and IV with round protuberant secondary rhinaria (Fig. 185); abdominal dorsum (Fig. 186) with middorsal pigmented patch on segments 3-6, spinopleural bars on segments 7 and 8 in addition to similar patches on each of segments 2-6, median patch may coalesce with marginal patches on posterior segments. Wings venation normal. Other characters as in apterous viviparous female.

Host plants : The species is extremely polyphagous, infesting nearly 185 species belonging to 115 genera under 49 plant families including mainly Amaranthacease, Apocynaceae, Asteraceae (Compositae), Boraginaceae, Brassicaceae (Cruciferae), Capparidaceae, Caprifoliaceae, Caryophyllceae, Chenopodiaceae, Cucurbitaceae, Enphoriaceae, Fagaceae, Labiatae, Logniaceae, Malvaceae, Myrsinaceae, Oxalidaceae, Papilionaceae, Passifloraceae, Polygonaceae, Punicaceae, Rosaceae, Rubiaceae, Saxifrogaceae, Scrophulariaceae, Solanaceae, Slyraceae, Ternstroemiaceae, Verenaceae.

Symptom and Damage : The damage is caused by nymphs and females (apterous and alate) which are confined to the growing shoots and leaves, from where they suck the cell sap. It also sucks the sap from buds, blossoms, petioles, tender fruits and leaves. Excess feeding causes ventral curling of peach leaves which adversely affects the yield. On sprouting the leaves emerge curled while the fruits either do not set or fall off prematurely. The infestation starts with the commencement of bud swelling and continues during and after flowering. The curling of leaves in peach caused by these pest species is often confused with the leaf curl caused by the fungus *Taphrina deformans* Berk & Tul, in which a curled leaf becomes thickened near the midrib. The severely attached plants have only small crumpled or twisted leaves and bear very little fruit.

Life cycle : The pest species is active from February to March on temperate fruits. During the winter, it is found only in the egg stage at the base of the buds. During spring the eggs hatch and nymphs move on to the young leaves. Here they start sucking the plant sap. In about 4 weeks the nymphs become apterous viviparous female adults. The viviparaous females give birth to young ones. Each viviparous female produces about 50 nymphs in her short life time of nearly 2 weeks. 3 or 4 generations are completed on the fruit plants. With the warming up winged females and probably males are also produced. They migrate to other alternative host plants such as golden-rod and start reproducing parthenogenetically again. 4 or 5 generations are completed on the said plant from June to October. Early in November, the alate viviparous females are produced again. They migrate back to peach, plum and other

fruit trees. Later, the females lay eggs at the base of the buds. Egg laying is completed by the middle of December. In Kumaon hills, this peach leaf curl aphid infests peach, plum and almond from November to May and from May to October it spends on an alternate host *Erigeron canadensis*. On both the fruit trees and *E. canadenses* reproduction is normally through parthenogenesis. However, in winter one generation of sexual form is produced. The female (oviparous) lays eggs on the primary hosts. The egg is laid singly. The eggs overwinter and hatch in spring. The nymphs pass



Figs. 178-188. *Brachycaudus helichrysi* (Kalt.) : Apterous viviparous female : 178. Head; 179. Antenna; 180. Antenna enlarged; 181. Siphunculus; 182. Siphunculus enlarged; 183. Cauda. Alate viviparous female : 184. Head; 185. Antenna; 186. Posterior abdominal dorsum showing sclerotization; 187. Siphusculus; 188. Cauda.

through-3 or 4 asexual generations. In the last generation alate forms develop which migrate to golden-rod plants and pass 4 or 5 generations parthenogenetically. Afterwards alate forms appear and migrate to fruit trees on which they lay eggs.

As so in the Himachal Pradesh of N. W. Himalaya apterous oviparous female lays eggs in the axils and bases of buds at the time of leaf fall. They overwnter. The eggs hatch in spring (about middle of February) at higher altitudes and about the end of Jaunary at lower altitudes. The nymphs hatch 3 or 4 weeks before flowering. By the time flowering starts its population increases.

The species is known to migrate to *Prunus* spp. in October–November in the hills. Mating takes place in December. Hatching of eggs goes upto middle of January. After a few generations on these primary host *(Prunus* spp.) it migrates to secondary host plant which mainly belongs to plant family Asteraceae.

In the plains however, it is found to breed parthenogenetically from January to March on *Prunus persica* (Rosaceae).

Basu *et al.* (1970) reported ovipara from *Prunus* sp. and alate males at Shillong. Alate males were also recorded (A. K. Ghosh *et al.* 1971) from *Prunus* sp. at Kalimpong (N-E Himalaya) (Ghosh, L. K. 1986) reported both oviparous female and alate males from N.W. Himalaya which confirms that the species enjoys both anholocylic and holocylic mode of life in Indian conditions besides its usual parthenogemetic reproduction. Thus, it is a holocyclic and heteroecious species alternating between *Prunus* spp. (primary host) and a number of heterogenous secondary host plants including *Anaphalis* sp., *Ageratus conyzydes, Chrysanthemum* sp. (Raychaudhuri *et al.,* 1980). *Eupatorium* sp. (Maity and Chakrabarti, 1979) *Erigeron canadensis* (Lal & Siddique). The overwintered eggs hatch into apterous fundatrices on *Prunus* during February. These constitute colonies of apterous fundatrigeniae afterwords. Upto May, several generations are continued. Later, alatae emigrate to the secondary hosts, A number of generations are continued on the secondary hosts. During Octoer to November the alatae migrate back to their primary host and produce young individuals which susequently develop into apterous oviparae. Alate males being developed on secondary hosts unite with the apterous oviparous females and males. The fertilized eggs laid by oviparae on the buds overwinter till Jaunary. The sexual females lay eggs on the buds in the primary host. The eggs overwinter till January.

Natural enemies-Complex :

Predator : *Adalia bipunctata* (Linnaeus); *A. tetraspilota* (Hope), *A. variegata* (Geoze); *Ballia brantimne* Mulsant, *B. eucharis* Mulsant; *Brunus suturalis* (Fabr.); *Clovia puncta* (Mulsant); *Cheilomenes sexmaculata* (Fabricius); *Coccinella septempuncata* (Linnaeus), *C. transversalis* Faricius, *C. z-punctata; Harmonia eucharis* (Mulsant); *Hippaodamia variegata* (Goeze); *Illes* sp.; *Jauravia binotata* Gorham, *Oenopia luteopustulata* Mulsant; *O. sauzeti* (Mulsant); *O. sexareata* Mulsant; *Scymnus* sp. [Coleoptera]; *Chrysopa* sp. (Neuroptera); *Betasyrphus serarius; Sphaerophoria scripta; Metasyrphus carollae* (Fabr.) and also several syrphidae. [*Source* : Omkar and Pervez, 2000]

Parasitoid : *Aphelinus gossypii* Timberlake, *Aphelinus* sp.; *Aphidius matricariae* Haliday, *Aphidius* sp; *Coccidencyrtus kumaonensis* Bhat.; *Copidosoma* sp., *Diaertiella rapae* M. Intosh; *Ephedrus plagiator* Nees; *Goniogaster* sp., *Lysiphlebus* sp.; *Pachycrepipoides indicus* Fabricius; *Pachyneuron ferrierei* Mani; *Praon* sp., *Taxares macrosiphophagum* Shuja-Uddin; *Tetrastichus* sp.; *Torymus chaubattiensis* Bhat.; *Trioxys (Binodoxys) indicus* Suba Rao & Sharma; *Trioxys* sp. [Hymenoptera]. [*Source* : Stary and A. K. Ghosh, 1083]

Vector : Cardamom mosaic or Katte disease (Rao & Naidu 1974); Large Cardamom streak mosaic (Raychoudhuri and Chatterjee, 1964, 1965); Cucumber mosaic; Dahlia mosaic and Radish yellow (Kennedy, Day and Eastop 1962).

Distribution : India : widely distributed in North India, South India including Nilgiris and Coimbatore and also Eastern India including Assam, Meghalaya, Manipur, Sikkim and West Bengal.

Remarks : *Brachycaudus helichrysi* (Kaltenbach), popularly known as "the leaf-curl plum Aphid" on "the Peach leaf curling aphid" is a major pest of peach and apricot and a minor pest of plum and almond in tropical and temperate regions of India. However, it was observed to infest almond plants in serious proportions under dry temperate conditions of Kinnaur district in Himachal Pradesh [Bhardwaj, 1991, 1995]. The aphid sucks the plant sap from buds, blossoms, petioles, leaves and tender fruits. This world-wide aphid is very destructive to other fruits. This pest species occurs both in the plains and in the mountainous areas of India, even beyond the altitude of ca 2500 metres. The infested plants show curling of new leaves. The development of fruits is very low and due to the lack of nutrition, they fall prematurely. The species is subject to colour variation (the light green or greenish yellow) depending upon the physiological conditions of the host plants.

Management : Removal of weeds which act as secondary hosts of this aphid is essential. Also, spraying of 190 ml of phosphamidon 100EC or 625 ml of dimethoate 30 EC or 500 ml of monocrotophos 40 EC or 190 ml of dichloruos 100 EC in 625 litres of water per ha. One pre-bloom and a post-bloom spray at 10 day interval should be given. (Atwal and Dhaliwal 1997). Diazinon is also effective against the pest species (Nayar *et al.* 1976). It can be managed through predators on almonds, especially by *Anthocoris confuses*. Also coccinellid predators have been effective in bringing down the population of this aphid in dry temperate region of Kinnaur in Himachal Pradesh.

Genus 11. ***Brevicoryne*** van der Goot

1915. *Brevicoryne* van der Goot, *Beitr. Kennt. Holland. Blattläuse,* 245

Type species : *Aphis brassicae* Linnaeus, 1758.

Diagnosis : Head usually smooth pigmented; lateral frontal tubercles very low and medium frontal elevation well developed; dorsal cephalic hairs long with acute to

subacute apices. Antennae 6-segmented, about 0.45-0.65 × body; flagellum strongly imbricated; apterae without secondary rhinaria, alatae with numerous distinctly protuberant rhinaria scattered irregularly all over segment III; flagellar hairs sparse and short; p.t. 2.0-4.0 × base of segment VI. Ultimate rostral segment much shorter than h.t. 2 and with 4 secondary hairs. Prothorax in apterae with marginal brown patches and in alatae with a transverse pigmented band; meso- and metathorax in apterae with such marignal patches in addition to scattered pigmented patches and muscle-plates arranged pleurally; Abdominal dorsum in apterae with pleural pigmented irregular-shaped wrinkled patches; segment 8 with a spinoplueral band and scattered muscle-plates on antesiphuncular segments, alatae with spinopleural segmental bars on each segment. Marginal spinular pigmented patches on segments 2-5 along with muscle-plates; dorsal hairs of moderate size, thick with blunt apices in apterae and with acuminate apices in alatae. Siphunculi in apterae barrel-shaped, in alatae basal portion much constricted and wrinkled, faintly imbricated. Cauda dark, triangular, about 1.10-1.30 × siphunculi, bearing 5-7 hairs. Legs smooth. Wing venation normal; F.T.C. 3, 3, 3 or 3, 3, 2.

22. ***Brevicoryne brassicae*** (Linnaeus)
Cabbageaphid
(Figs. 189-201, 425)

1758. *Aphis brassicae* Linnaeus, *Syst. Nat.* **10** : 452.

1918. *Brevicoryne brassicae* (Linnaeus) : Das, B. *Men. Indian Mus.*, **6**(4) : 187.

1958. *Brevicoryne brassicae* (L.) : David, *J. Bombay nat. Hist. Soc.*, **55**(1) : 115.

1940. *Brevicaryne brassicae* (L.) : Ullah, *Indian J. Ent.*, **2**(1) : 13.

1969. *Brevicoryne brassicae* (L.) : Ghosh A. K. *et al., Oriental Ins.*, **3**(4) : 330.

1974. *Brevicoryne brassicae* (L.) : Ghosh, A. K. *Indian Agric.*, **18**(2) : 97.

1980. *Brevicoryne brassicae* (L.) : Raychaudhuri, D. N. (ed.), Aphids of Northeast India and Bhutan : 111.

1980. *Brevicoryne brassicae* (L.) : Ghosh, L. K. *Bull. zool. Surv. India*, **3**(1 & 2) : 67.

1986. *Brevicoryne brassicae* (L.) : Ghosh, L. K., *Tech Monogr.* **16** : 65. Zoological Survey of India.

1994. *Brevicoryne brassicae* (L.) : Ghosh, L. K. and Basu R. C., *Fauna of West Bengal, State Fauna Series*, **3** : 181. Zool. Surv. India.

1997. *Brevicoryne brassicae* (L.) : Ghosh L. K. *et al., Fauna of Delhi, State Fauna Series*, **6** : 227. Zool. Surv. India.

2001. *Brevicoryne brassicae* (L.) Chakrabarti and Sarkar, *J. Aphidology*, **15** : 18.

Diagnosis : Apterous viviparous female : Body (Fig. 189) elongated oval, about 2.5 mm long with 1.45 mm as maximum width. Head (Figs. 193, 194) rather smooth. Frons with ill—developed lateral frontal tubercles; Median frontal prominence distinct.

Antennae (Fig. 195) 6-segmented, shorter than body, flagellum strongly imbricated, a.s. III without secondary rhinaria, flagellar hairs sparse, short with acute to acuminate apices; p.t. longer (about thrice) than base VI. U.r.s. shorter (0.8 times) than h.t.2, bearing 4 secondary hairs. Prothorax with marignal brown patches; meso-and metathorax with such marignal patches in addition to the scattered pigmented pitches and muscle-plates arranged pleweally. Dorsum of abdomen (Fig. 190) with pigmented irregular-shaped wrinkled patches pleurally, on segments 1-7 and segment 8 with a spinopleural band besides scattered muscle-plates on the antesiphuncular segments; dorsal hairs thick and blunt. Siphunculi (Fig. 196) usually barrel-shaped, at most upto 0.14 times as long as body. Cauda (Fig. 197) dark triangular, shorter (about 0.8 times) than siphunculi and with 5-7 hairs. F.T.C. 3,3,3 or 3,3,2. Nymphs with hind tibiae smooth.

Alate viviparous female : Alatae with numerous circular protuberant secondary rhinaria distributed irregularly on a.s. III, a.s. IV with 7-15, V with 5-19 and VI with 0-2 secondary rhinaria (Fig. 199), each abdominal segment with spinopleural segmental bars, sometimes these on anterior segments broken; besides marignal spinular sigmented patches occur on segments 2-5 along with muscle plates, dorsal hairs with acuminate apices placed slightly on raised bases. Siphunculi (Fig. 200) with basal portion much constricted and wrinkled, fairly imbricated, almost without apical flange. Wing venation normal. Other characters as in apterous viviparous female.

Host plants : The following host plants are known to be infested by the pest species :

Atropa belladonna, Beta vulgaris, Brassica campestris, Brassica dichotoma, Brassica juncea, Brassica napus, Brassica nigra, Brassica, oleracea, Brassica oleracea var botrytis, Brassica oleracea var. capitata, Brassica oleracea var. gongylodes, Brassica rapa, Brassica spp., *Cajanus cajan, Capsella burga-pastoris, Cardamine hirsuta, Cardamine impatiens, Ficus* sp., *Guttarda incana, Iberis* sp. *Lycopersicon esculentum, Nasturtium, officinale, Petunia violacea, Raphanus sativus, Scutellaria scandens, Solanum tuberosum, Solanum xanthocarpum, Veronica agrestris, Zea mays* and other indet plants of Brassicaceae.

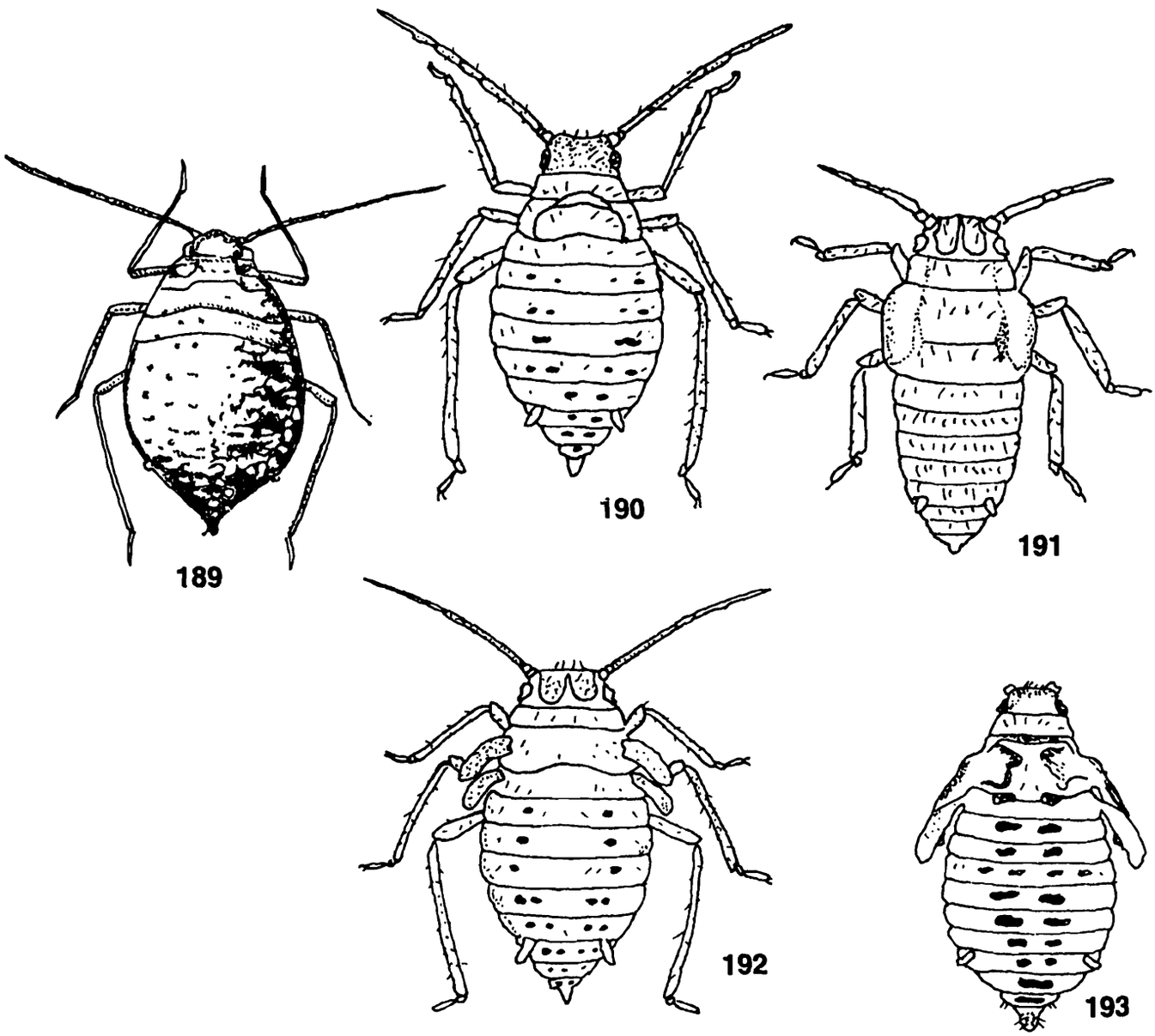
Symptoms and Damage : Colony of soft mealy-grey consisting of nymphs and apterous viviparous females are found feeding in clusters on leaves, stems and flowers. Infested seedlings may be stunted and distorted. While cast skins and drops of sticky honey-dew and /or sooty mould growing on the honey-dew are often noticed on the leaves. These affect the proper photosynthesis. As a result, the general health of the plants is affected, causing yield loss.

Bionomics : The adults are either apterous or alate viviparous females besides sexuales (apterous oviparous females and alate males). These are medium—sized, but are always covered with a fine gray, mealy powdery wax covering the basic green colour of the aphid pest. In most of the cases, the aphid reproduces parthenogenetically

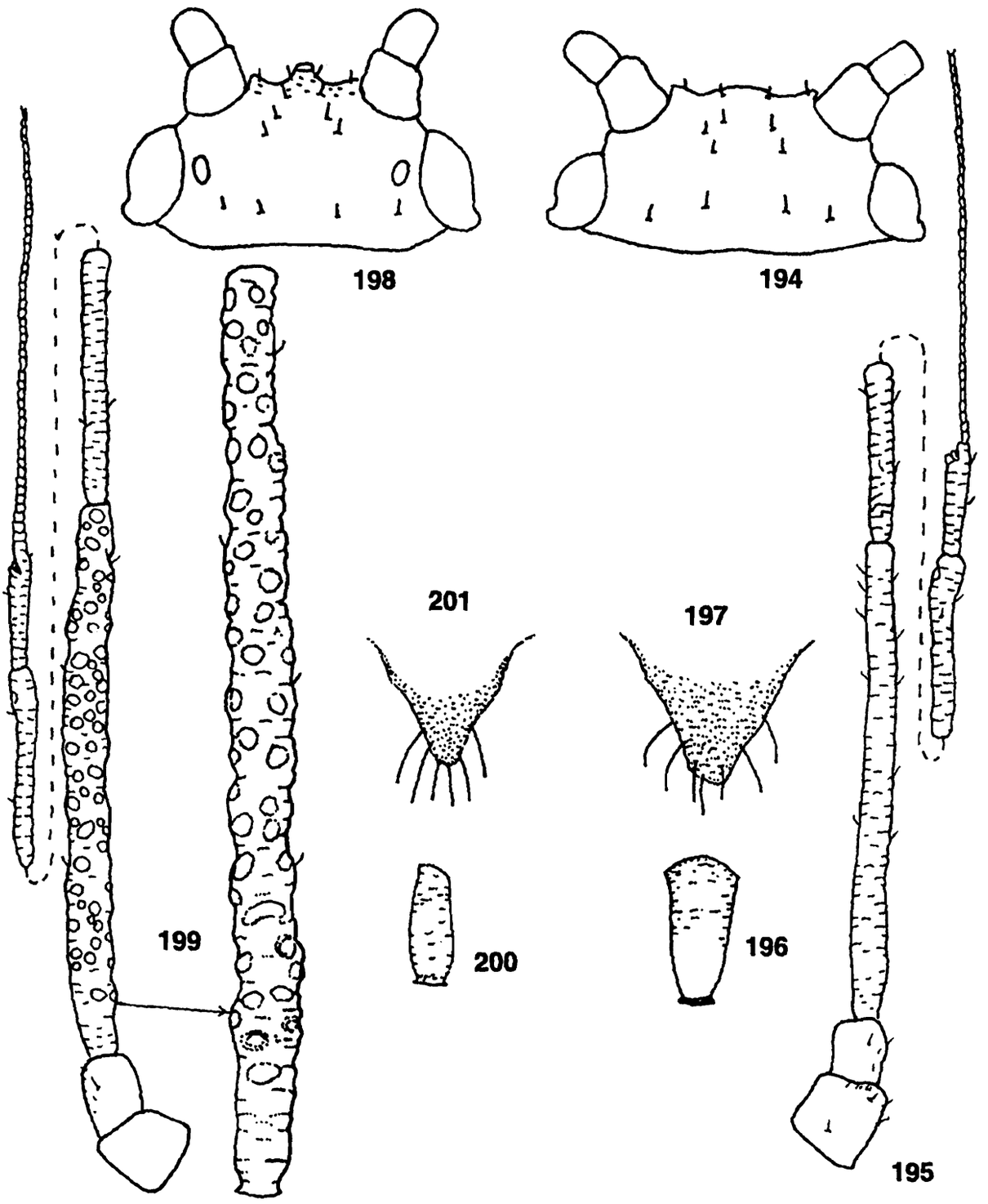
both in the plains and altitudes. The species has 4 instars, total nymphal period is 1-15 days. The adult longevity on cabbage is about 40 days while on mustard it is about 16 days (Debraj *et al.* 1995).

It is known that the species is more common above *C.* 3,000 feet in Indian conditions where there is a chance of overlapping of mustard aphid *Lipaphis erysini* (Kaltenbach) and cabbage aphid *Brevicoryne brassicae* (L.)

Although asexual reproduction (anholocyclic) takes place in most of the cases of this aphid, sexual play significant role in the biology of the aphid occurring usually at the higher elevations where cold climate prevails and day length is short. David



Figs. 189-193. *Brevicoryne brassicae* (L.) : 189. Apterous viviparous female. 190. Apterous viviparous female; 191-193. Stages of intermediates, alate viviparous female nymph (From Bonnemaison).



Figs. 194-201. *Brevicoryne brassicae* (Linn.) : Apterous viviparous female : 194. Head; 195. Antenna; 196. Siphunculus; 197. Cauda. Alate viviparous female : 198. Head; 199. Antenna; 200. Siphusculus; 201. Cauda.

(1958) reported the occurrence of only apterous oviparous females on *Brassica oleracea* from simla. Banerjee *et al.* (1969) reported males (alate) from Kuti valley (Uttar Pradesh) and Ghosh, A. K. *et al.* (1969) reported alate male on *B. oleracea* in colony with viviparae at Simla (Himachal Pradesh). All the above records of the aphid are from the plants of Brassicaceae growing at an elevation of above *c* 5,000 feet in the Western Himalaya. This suggests that *Brevicoryne brassicae* (L.) reproduces both anholocyclically and holocyclically at higher elevations. This observation also accounts for the presence of this species at higher altitudes.

Natural enemies complex :

Predators : *Adalia tetraspilota* (Hope), *Adonia* sp.; *Cheilomenes sexmaculata* (Fabricius); *Coccinella septempunctata* Linnaeus; *Coccinella repanada* Fabricius; *Ischiodon scutellaris* Fabricius; *Harmonia dimidiata* (Faricius); *Hippodamia tredecipunctata* (Linnaeus); *Hippodamia variegata* Goeze; *Micraspis allardi* (Mulsant); *Micraspis cardoni* (Weise); *Micraspis discolor* (Fabricius); *Micraspis vincta* (Gorham); *Nephus regularis* (Sicard); *Oenopia kirby* Mulsant; *Oenopia sauzeti* (Mulsant); *Oenopia sexareata* Mulsant; *Propylia quatuordecipunctata; Propylia japonica* (Thunberg); *Rodolia ruficollis* Mulsant; *Scymnus xerampelinus* Mulsant; *Xanthogramma scutellarae* [Coleoptera : Coccinelidae]; *Metasyrphus confrater* (Wied.) [Diptera : Syrphidae]. [*Source* : Omkar and Pervez, 2000]

Parasitoids : *Aphelinus* sp. nr. *flavipes* Kurd, *Aphidius colemani* viereck, *Aphidius matricariae* Haliday, *Aphidius* sp., *Ephedrus* sp., *Diaeretiella rapae* (M'Lntosh). [*Source* : Stary and A. K. Ghosh, 1983]

Vector : Anemae mosaic, Bean common mosaic, Beet yellow, Bittergourd mosaic, Cabbage black ring spot, Cauliflower mosaic, Celary mosaic, Chinese sarson mosaic, Onion yellow dwarf, Nasturtium ring spot, Primula mosaic, Radish mosaic, Ridgegourd mosaic, Vegetable narrow mosiac, [*Source* : Kennedy *et al.* 1962; Muniyappa and Veeresh 1986; Misra 2002].

Distribution : Holarctic or Palaearctic in origin but virtually cosmopolitan including India where the species is mostly spread in higher altitudes. In India, the species is usually found in Delhi, Himachal Pradesh, Nagaland, Punjab, Uttar Pradesh, West Bengal and South India.

Remarks : The Cabbage aphid, *Brevicoryne brassicae* (Linn.) is one of the most serious pests of crops of Brassicaceae (Cruciferae). It is a cosmopolitan species available in different agroclimatic conditions of the world. The aphid attacks different parts of the plant, but mainly underside of the leaves as well as inner leaves of the head in cabbage and all the inter-spaces in the curd in cauliflower. In flowering plants including Turnip, Radish etc. the main shoots are attacked which later turn pale and succumb quickly, even the mature seeds obtained are shrivelled and become unfit for sowing. Moreover, in oil-seed rape, heavy infestation caused reduction in seed yield and subsequently death of the young plants (Batra 1960). In addition to the losses that

the aphid causes by direct feeding, the crops also suffer damage through virus diseases mentioned under Natural enemies-complex. Under inadequate or total absence of plant protection measures over 70% infestation of plants has been reported by Prasad (1963) while Sachan and Srivastava (1972) assert that the percent infested varied from 76 to 84. Such severe infestation seriously affect the yield of head and seed of cauliflower.

Management : Due to waxy covering on the body of the aphids, it is particularly difficult to wet directly with the usual aphidicides; if contact sprays are to be used then extra wetter should be used. However, systemic poisons are generally more effective. The following insecticides are recommended : demephion, demeton-s-methyl, dichlorves, dimethoate, disulfoton, malathion, menazon, mevinphos, phorate and thiometon (Hill, 1975).

Genus 12. ***Hyadaphis*** Kirkaldy

1904. *Hyadaphis* Kirkaldy, *Entomologist*, **37** : 279.

Type species : *Aphis xylostie* Schrank, 1801 (= *Siphocoryne foeniculi* Passerini, 1860).

Head smooth or somewhat wrinkled, dorsal cepahalic hairs short, hardly as long as b.d.III, rather fine. Antennae 6-segmented, much shorter than body; basal 2 segments scabrous; flagellum gradually more distinctly imbricated from base towards apex; flagellar hairs short with acute apices; secondary rhinaria absent in apterae but in alatae circular non-protuberant ones present, always on segment III, p.t. longer than base of segment VI. Ultimate rostral segment, shorter to as long as h.t.2 and with a pair of secondary hairs, Dorsum of abdomen in apterae pale with brownish transverse bands on segments 7 and 8, with a faint net-like pattern which is prominent on posterior segments and appear somewhat spinulose, in alatae also pale with spinulose brownish marignal patches on segments 2-6 and transverse spinulose transverse brownish bands on segments 7 and 8; dorsal hairs short, with acute apices. Siphunculi distinctly clavate, shorter to as long as cauda, imbricated and with a pre-apical circumcision. Cauda elongated, broad basally, slightly constricted near at the middle, with 5-11 hairs including a pre-apical one. F.T.C. 3,3,3 or 3,3,2. Wing-venation normal.

23. ***Hyadaphis coriandri*** (Das)
Coriander Aphid

1918. *Brevicoryne coriandri* Das, B. *Mem. Indian Mus,* **6**(4) : 180.

1958. *Hyadaphis coriandri* (Das) : Eastop, A study of the Aphididae (Homoptera) of East Africa : 40.

1970. *Hyadaphis coriandri* (Das) : Ghosh, A.K., Basu, R.C. and Raychaudhuri, D.N., *Oriental Ins,* **4**(1) : 72.

1974. *Hyadaphis coriandri* (Das) : Hameed, Sud and Giamzo, *Indian J. Ent.,* **37**(2) : 205.

1980. *Hyadaphis coriandri* (Das) : Raychaudhuri, D. N. (ed.), Aphid of N.E. India and Bhutan : 143.

1986. *Hyadaphis coriandri* (Das) : Ghosh, L. K., *Tech. Monogr.* No. **16** : 83. Zool. Surv. India.

1992. *Hyadaphis coriandri* (Das) : Agarwala and Bhattacharya, *Soc. Nat. Sci.,* **2**(3&4) : 2.

1994. *Hyadaphis coriandri* (Das) : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** : 189. Zool. Surv. India.

1998. *Hyadaphis coriandri* (Das) : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series,* **4** : 139. Zool. Surv. India.

2000. *Hyadaphis coriandri* (Das) : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7** : 358. Zool. Surv. India

2001. *Hyadaphis coriandri* (Das) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 20.

2002. *Hyadaphis coriandri* (Das) : Medda and Chakrabarti, Abstract : *Nat. Seminar on Ecology and Diversity of aphid and aphidological complex,* Tripura University (May 4-5, 2002) : 11.

Diagnosis : Apterous viviparous female : Body elongated, 1.97-2.25 mm long with 1.2-1.3 mm as width near the middle of abdomen. Head smooth; dorsal cephalic hairs short, usually shorter than b.d.III. Antennae 6-segmented, 0.3-0.5 times as long as body, without secondary rhinaria. U.r.s. shorter than h.t.2 and with 2 secondary hairs. Dorsum of abdomen pale with brownish transverse bands on segments 7 and 8; longest hair on anterior abdominal tergites 0.33-0.38 mm long. Siphunculi distinctly clavate, less than 2.5 times as long as their greatest width. Cauda elongated, broad basally, slightly constricted medially, about as long as to 1.5 times as long as siphunculi and bearing 5-11 hairs.

Body in life mealy covered, dirty greenish with green spots.

Alate viviparous female : Body rather shorter than apterae, measuring 1.5-2.0 mm with 0.55-0.90 mm as maximum width. Antennae 6-segmented, about 0.6 times as long as body, a.s. III with many (35-44), IV with 7-11 and V with 0-1 secondary rhinaria; segments 2-6 with spinulose brownish marginal patches and transverse brownish spinulose bands on segments 7 and 8; dorsal hairs longer, acute, 0.40-0.50 mm long. Siphunculi shorter, 0.11-0.15 mm long. Cauda about 1.4 times as long as siphunculi. Wing venation normal. Other characters as in apterae.

Host plants : *Anethum graveolens* (Apiaceae), *Atriplex hortensis* (Chenopodiaceae), *Carum carraway* (Apiaceae), *C. copticum* (Apiaceae), *Cariandrum sativum* (Apiaceae), *Coriandrum* spp. (Apiaceae), *Cuminum sativum* (Apiaceae), *Daucus carota* (Apiaceae), *Daucus carota var. sativa* (Apiaceae), *Foeniculum vulgare* (Apiaceae), *Helianthus annuns* (Asteraceae), *Leycesteria formosa* (Caprifoliaceae), *Peucedanum gravelens* (Apiaceae), *Rubus fruticosus* (Rosaceae), *Trifolium alexantrium* (Fabaceae).

Symptom and Damage : Both nymphs and adults have been reported to suck the sap of Coriander plants and exude copious quantity of honey dew giving the plants

glistening appearence. Due to severe infestation most of the leaves get twisted. This symptom is regularly found throughout the year in the coriander growing areas.

Biology : The yellowish green aphid usually appears grey because of the blue-white powdery matter covering the body which is more or less pear-shaped. The aphid reproduces parthenogenetically thoughout the year. A single apterous viviparous female gives birth to 40-50 young ones which take 8-12 days to become adult. These young ones are apterous viviparous females. Among and shortage of food source together with low humidity and high temperature. Normally, life cycle is completed in two-three weeks during summer. The duration may last for 6 weeks in winter. The species was so far known from its secondary host (Umbelliferae). Its primary host was unknown. Although *H. kirkaldy* is known to alternate between plants of Caprifoliaceae and Umelliferae, but other species are monoecius on either the former or the later (Medda and Chakrabarti, 2002).

Natural enemies-complex :

Predator : *Coccinella septempunctata* Linnaeus, *Menochilus sexmaculatus* (Fabricius), *Propylea japonica* (Thunberg) (Coccinellidae), *Psyllobora bbisoctonotata* (Mulsant), *Allograpta javana* (Wiedmann), *Betasyrphus isaci* (Bhatia) [Syrphidae]. [*Source* : Omkar and Pervez, 2000]

Fungus : *Urophlyctis coriandri,*

Distribution : India : Bihar, Jammu and Kashmir, Himachal Pradesh, Manipur, Meghalaya, Sikkim, South India, Uttar Pradesh, West Bengal.

Elsewhere : Middle East, Pakistan, South Africa.

Remarks : The species resembles *B. brassicae* and *L. erysini* in a nature of siphunculi but differs from *B. brassicae* in not having triangular cauda. It differs from *L. erysini* in having rather distinctly clavate siphunculi and elongated cauda with a median constriction. Again, *Hydaphis* differs from both the above species in the host plant association i.e. it infests plants of Caprifoliaceae and Apiaceae whereas the other two infest mostly cruciferous plants.

According to Eastop (1966), *Hyadaphis* and *Brevicoryne* are difficult to separate from *Lipaphis* when the world fauna is considered and both the genera *Brevicoryne* and *Lipaphis* can at best be treated as sub genera of *Hydaphis* Kirkaldy which is oldest of 3 genera. However, only transfer experiment can prove Eastop's contention.

Management : Same as in *Lipaphis erysimi* (Kaltenbach).

Genus 13 ***Lipaphis*** Mordvilko

1928. *Lipaphis* Mordvilko, *Key for the identification of Insects of European Russia* (in Russian) : 200.

Type species : *Aphis erysimi* Kaltenbach, 1843.

Diagnosis : Body broadly oval. Head smooth with lateral frontal tubercles and distinct median frontal prominence as high as lateral frontal tubercles. Antennae 6-segmented, shorter than to about half as long as body; flagellum imbricated, flagellar hairs minute; p.t. about 2-3 times as long as base VI; apterae without secondary rhinaria on a.s. III, alatae with such rhinaria on a.s. III and sometimes also on IV and V. U.r.s. with 2 secondary hairs, 0.6 times to slightly longer than h.t.2. Dorsum of abdomen in apterae pale, in alate with scattered brown patches and transverse brown bands on segments 7 and 8 besides a few "muskel-platten"—like structure. Siphunculi weakly clavate, imbricated and about as long as cauda bearing 5-6 hairs. F.T.C. 3 : 3 : 2 or 3 : 3 : 3. Wing venation normal.

24. ***Lipaphis erysimi*** (Kaltenbach)
The Mustard Aphid
(Figs. 202-212, 213, 426, 427)

1843. *Aphis erysimi* Kaltenbach, *Mon. Fam. Pflanzen.* : 99.

1928. *Lipaphis erysimi* (Kaltenbach) : Mordvilko, *Keys for the identification of Insects of European Russia* : 200.

1969. *Lipaphis erysimi* (Kaltenbach) : Chowdhuri *et al.*, *Sci. & Cult.*, **35** : 337.

1980. *Lipaphis erysimi* (Kaltenbach) : Raychaudhuri, D. N. (ed.), *Aphids of N.E. India and Bhutan,* Zoological Society, Calcutta : 161.

1986. *Lipaphis erysimi* (Kaltenbach) : Ghosh, L. K., *Tech. Monogr.* No. **16** : 96. Zool. Surv. India.

1992. *Lipaphis erysimi* (Kaltenbach) : Agarwala and Bhattacharya, *Soc. Nat. Sci.,* **2** (3&4) : 2.

1994. *Lipaphis erysimi* (Kaltenbach) : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** : 191. Zool. Surv. India.

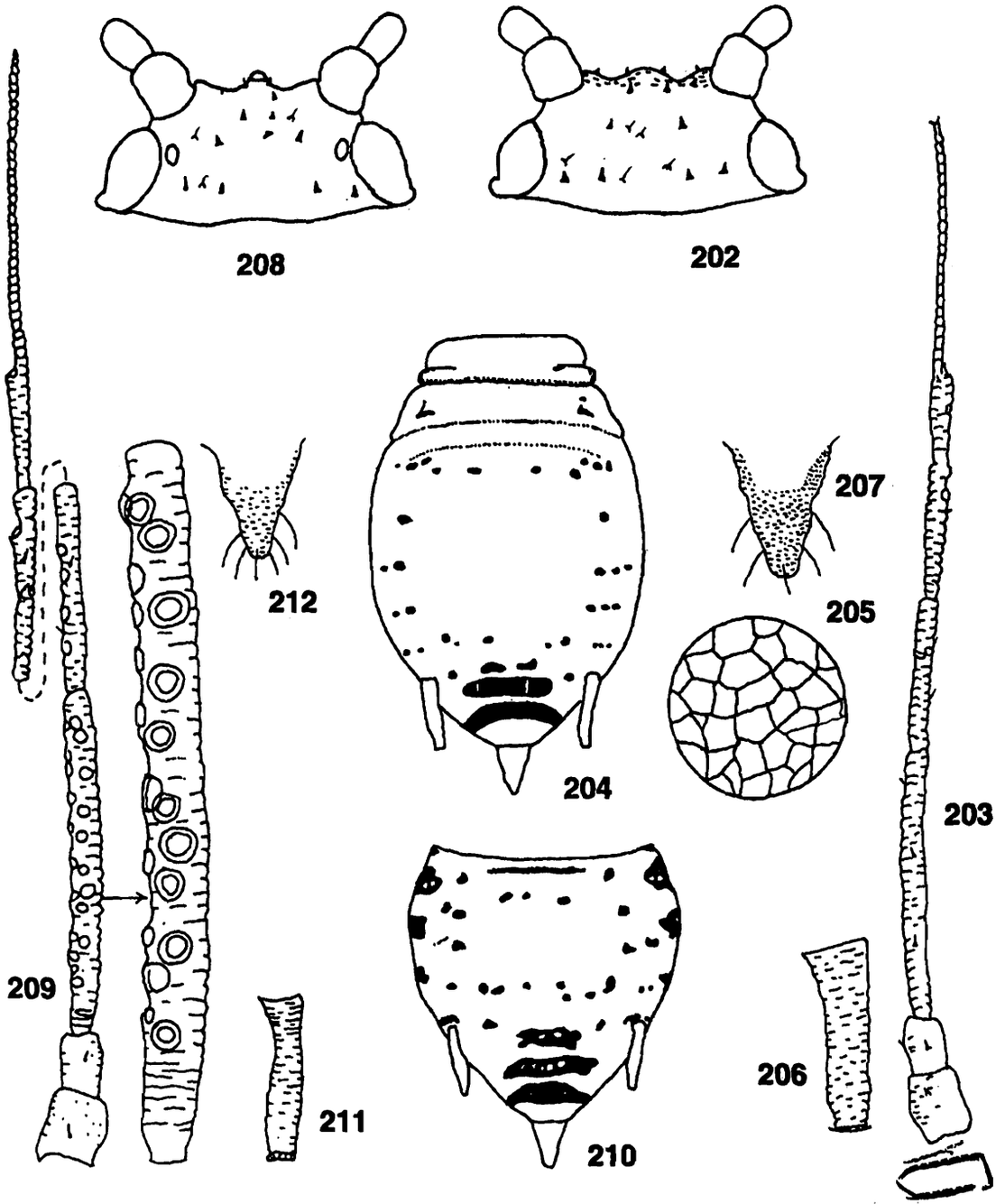
1998. *Lipaphis erysimi* (Kaltenbach) : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series,* **4** : 140. Zool. Surv. India.

2000. *Lipaphis erysimi* (Kaltenbach) : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7**(Part-2) : 359. Zool. Surv. India

2001. *Lipaphis erysimi* (Kaltenbach) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 21.

Diagnosis : Apterous viviparous female : Greenish, somewhat wax-dusted in life. Body 1.4-2.4 mm long with 0.9-1.3 mm as maximum width near the middle of abdomen. Head (Fig. 202) smooth, brownish, with little developed lateral frontal tubercles, antennae (Fig. 203) about 0.5-0.7 times as long as body, with hairs (5μ-9μ long), processus terminals 2-2.75 times as long as the base of the VI antennal segment; rostrum reaches mid coxae, ultimate rostral segment 0.8-0.9 times as long as second joint of hind tarsus. Dorsum (Fig. 204) of abdomen pale but occasionally with scattered sclerites; siphunculi (Fig. 206) cylindrical to weakly clavate near apex, nearly equal to or slightly longer than cauda which is elongate and bears 4-6 hairs; femora ventrally scabrous; tibiae smooth; F.T.C. 3 : 3 : 2 or 3 : 3 : 3.

Alate viviparous female : Body 1.4-2.2 mm long with about 1 mm as maximum width. Head (Fig. 208) brown, almost flat; antennae (Fig. 209) about 0.5 times as long as body, antennal segment III with 17-21, IV with 5-7 and V with 0-2 secondary rhinaria, antennal hairs very short and sparse, processus terminalis 2-3 times as long as the base of the antennal segment VI; rostrum reaches mid coxae, ultimate rostral segment slightly shorter to nearly as long as second joint of hind tarsus. Dorsum of abdomen (Fig. 210) with transverse bands on 6-7th tergites besides sclerotic segmental



Figs. 202-212. *Lipaphis erysimi* (Kalt.) : Apterous viviparous female : 202. Head; 203. Antenna; 204. Posterior abdominal dorsum; 205. Spinular imbrication (enlarged); 206. Siphunclus; 207. Cauda. Alate viviparous female : 208. Head; 209. Antenna; 210. Posterior abdominal dorsum; 211. Siphunculus; 212. Cauda.

patches marginally; siphunculi (Fig. 221) imbricated, weakly clavate distally, about as long as or slightly longer than dark cauda (Fig. 212) bearing 4-6 hairs. Wing veins slightly bordered brown.

Host plants : The pest species is known to infest about 50 species of plants belonging to 32 genera in India [Raychaudhuri, D.N. (*ed.*), 1983; (Chakrabarti & Sarkar, 2001)]. The host plants include a number of brassicaceous plants like cabbage, kale, cauliflower, mustard, broccoli, turnip, brussels sprouts, rape, onion, shallot, garlic, chives etc.

Many genera and species of *Brassica* and some species of brassicaceae *viz. Raphanus* and *Rorippa* serve as primary food plants for this aphid. In addition, plants *viz. Barárea, Capsella, Erysimum, Ieris, Lepidium, Matthiola, Nasturtium, Sinaphis, Sisymbrium, Trlaspi* etc. also occasionally serve as food plants for the pest.

Symptom and Damage : The pest species (both nymphs and adults) attacks all the aerial parts of the mustard plants. These morphs directly damage the plants by sucking the nutrients of the plants and thus cause general devitalisation of plants. They also indirectly affect the health of the plant by their copious secretion of honeydew that occludes the stomatal openings of the leaves, thus their normal photosynthesis and respiration are arrested. Deposition of honeydew on leaf surface also causes growth of sooty mould proving detrimental to the plant life. When attack of this pest occurs in early stages of the plant, the leaves get discoloured, curled and withered. Stunted growth is seen in plant which ultimately gets dried up. Damage is more severe when aphid attacks in flowering and fruiting stages of plant. The flowers get discoloured, distorted and fall down. Due to obvious reason, pod formation does not take place. Attacked pots become curled, shrivelled and no seed formation takes place. If seeds set, the same get shrivelled and there is drastic reduction in seed weight, oil content and vitality of seeds. Under different agroclimatic conditions the aphid species damages the mustard crop from 35-90% particularly in north India where mustard is a principal oil crop. It is reported to cause 6% reduction in oil content. In India, yield losses in rapeseed mustard due to aphids range from 24-90% in different mustard growing states. The avoidable losses in seed yield of the crop occurring due to aphid infestation have been reported even upto 100% (Anonymous 1997). Solanki and Chauhan (1991) reported this aphid pest to cause pollen sterility in rapeseed, mustard.

Biology and Bionomics (Fig. 213) : The pest species predominantly reproduces asexually. The mustard aphid appears in November on the rape and mustard crops. Initially, a small colony of apterous viviparous females colonise and reproduce parthenogenetically. They give birth to nymphs. The growth of the nymphs is rather fast and within 1-2 weeks they become adult. Both apterous and alate forms develop. The developmental period depends on the availability of food plants, for example, on mustard and cauliflower, it takes about 2 weeks and on radish it takes 11 days only. The reproductive period of both forms varies considerably. The alatae (winged) reproduce for 13-17 days while apterae 12-22 days on different brassica plants. An alate viviparous form gives birth of 35-40 nymphs while apterous form larviposits 70-

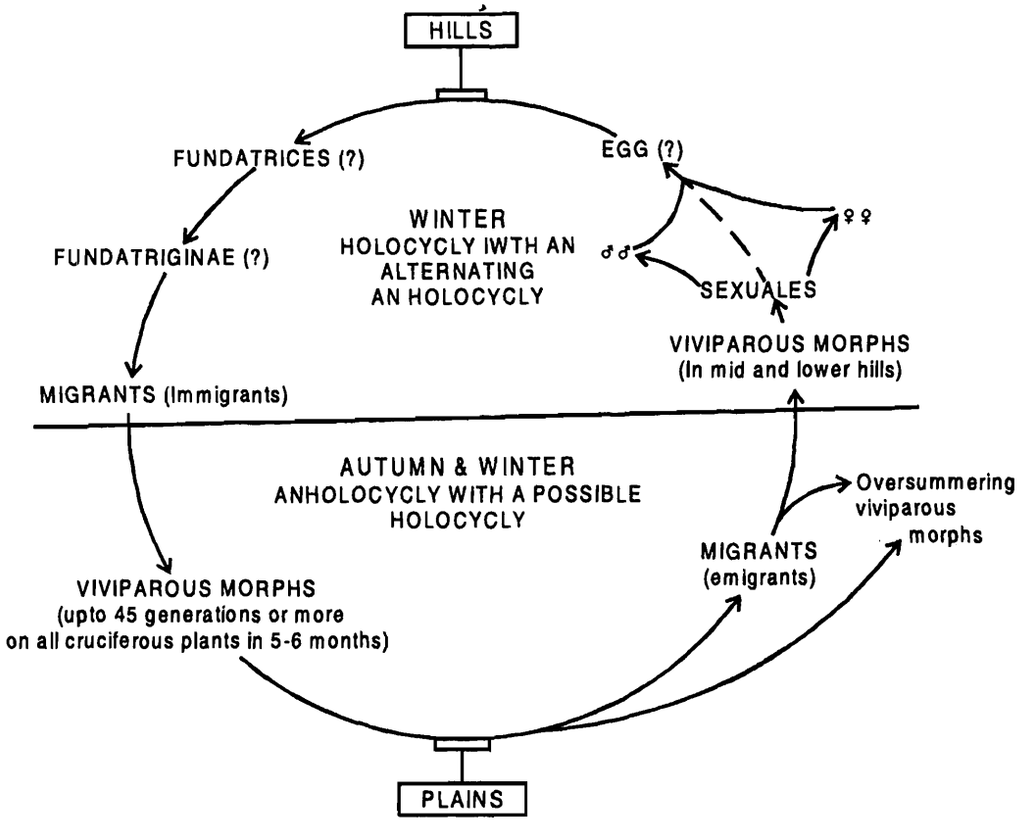


Fig. 213. Possible Life cycle of *Lipaphis erysimi* in India

135 nymphs at the rate of 3.5 nymphs/day in her life time. The females survive for 26-38 days on different food plants. The aphid is active throughout December to February. The alate forms migrate from one field to others and spread the infestation. About 45 generations are completed in a year. Cloudy and cold weather (20^0C or below) is most favourable for multiplication of this notorious pest. Among the abiotic factors, temperature, relative humidity and rainfall have a profound effect on survival and multiplication of the pest.

Earlier, Verma and Mathur (1966) reported alate male of the species and oviparous females by Ghosh, L.K. (1977) from N.W. India while Phalak (1968), Basu *et al.* (1970) reported sexual females (oviparae) from N.E. India. This hints that the pest species possibly enjoys both anholocyclic and holocyclic life in the Indian conditions. The possible life cycle pattern is given (Fig. 213).

Natural enemies-complex :

Predator : *Adonia variegata doubledevi* Mulsant, *Adonia* sp., *Brumoides suturalis* Fabricius, *Cheilomenes sexmaculatus* Fabricius, *Chilocorus nisritus* (Fabricius), *Coccinella septempunctata* Linnaeus, *Coccinella rapanda* Thunberg, *Coccinella transversalis* Fabricius, *Coccinella undecipunctata* Linnaeus, *Harmonia euchoris* (Mulsant), *Hippoctamia variegata* Goeze, *Micraspis allardi* (Mulsant), *Micraspis discolor* (Fabricius), *Micraspis vincta* (Gorham), *Nephus regutris* (Sicard), *Propylea quatuordecimpuncta* (Fabricius), *Propylea japonica* (Thunberg), *Psyllobora bisoctonotata*

(Mulsant), *Rodolia ruficollis* Mulsant, *Scymnus phrocheilous* Mulsant, *Scymnus exrampelinus* Mulsant [Coleoptera : Coccinellidae]. *Anisochrysa boninensis* (Ckomota), *Brinckochrysa scelestes* (Banks), *Chrysoperla carnea* (Steph.), *Micromus timidus* Hagen [Neuroptera]. *Betasyrphus serarius* (Weidmann), *Episyrphus allernans* Macq., *Episyrphus baltealus* (de Geer), *Ischiodon scutellaris* Fabricius, *Lasiopticus pyrastri* Linn., *Lasiopticus selencticus* Burnetti, *Melanostoma orientale* Wiedmann, *Metasyrphus confractor* (Weidmann), *M. latilunulatus* (Collin), *Paragus paragus seratus* Fabr., *Scaeva albomaculata* Macq, *S. latimaculata* (Brunetti), *Sphaerophorea scripta* (Linnacus), *S. indiana* Bigot, *Syrphus alteatus* De Geer, *Syrphus confractor* Wiedmann, *Syrphus isaci* Bhatic, *Syrphus serarius* (Wiedmann), *Syrphus* sp. *Xanthogramma* sp. [Diptera : Syrphidae]. *Leucopis formosana* Henn., *Leucopis gliphinivora* Tanas, *Leucopis griscola* Fabricius, *Leucopis ninae* Tanas, *Leucopis* sp. [Diptera : Chamacmyiidae]. [*Source* : Omkar and Pervez, 2000]

Fungus : *Entomophthora aphidis* Hoffman, *E. coronata* (Costarntin), *Cephalosporium aphidicola* Batch (Parasitie).

Parasites : *Aphidius* sp., *Aphidius gifuensis* Ashmead, *A. matricarieae* Haliday, *Aphidius (Diaeretiella) rapae* Cautis, *Ephedrus persicae* Froggatt, *E. plagiator* Nees, *Ischiodan scutellaris* (Fabr.), *Lepolexis gracilis* Forster, *Lysiphleus erysimi* Stary, *L. testaceipes* Creasson, *Praon volucre* Haliday, *Trioxys revicornis* Haliday, *T. indicus* Subba Rao and Sharma [Hymenoptera]. [*Source* : Stary and A. K. Ghosh, 1983]

Hyperparasites : *Dendrocerous* sp. [Megaspilidae : Hymenoptera], *Opius* sp. [Braconidae : Hymenoptera], *Pachyneuron aphidis* Bch. [Pteromalidae : Hymenoptera]

Distribution : It is a cosmopolitan species and key pest of mustard and other brassicas wherever grown in India.

Remarks : In India, rapeseed mustard contributes nearly 25% of oil seeds production, rape seed mustard being main oil seed crop recorded the total production of about 6.2 million tonnes in 1997-98. The average production of the rapeseed mustard in India is still low (874 kg/ha) as compared to the world average 1262 kg/ha. These crops are mainly produced in North Indian states, M.P., Assam and also its cultivation has been started in South Indian states. India is now second largest country to produce rapeseed mustard constituting 19% of world production. The average yield in India is only 0.5-0.6 t/ha against 2.8 t/ha in western countries like Germany. However, during the last decade, production of rapeseed and mustard crop has improved over 130%. Even then, this increase is not enough due to pressing demand of the oil in our country. Out of several factors affecting their production, the role of insect pests is rated of very high economic importance. Yield can be augmented if the major causes of yield reduction are checked. About three dozen insect pests inflict the yield losses to the oilseed crops of which mustard aphid, *L. erysimi* (Kalt.) is the most serious. It is the most economically important aphid causing upto 96% yield loss in *Brassica* spp. in the country. Pradhan (1964) reported the losses upto 87.77 of the yield of rape and mustard due to atack of the pest.

This aphid species like other species exhibits polymorphism and complicated life cycle. The adult wingless form is small to medium—sized yellowish green, grey green, or olive green with a white wax bloom. In humid condition the body is often more densely coated with wax secreted by the siphunculi. On the other hand, the adult winged form has a dusky green abdomen with distinct dark lateral sclerites and dusky wing veins. Sometimes the aphids are observed in huge numbers on the undersides of leaves which may curl and turn yellow.

Management : The prophylactic measures should be employed first. Cultivation of resistant varieties, application of adequate amount of nitrogen fertiliser, frequency of irrigation, trap cropping etc. are some cultural methods which should be followed to minimise the infestation of the aphids. If necessary, application of following insecticides should be done : chinimix (5%), chlorpyriphos (0.04%), diclilorvos (0.20%), dimethoate (0.06%), endosulfan (0.07%), M.I.P.C. (50%), malathion (0.20%), methyl-o-demeton (0.05%), monocrotophos (0.08%), phosphamidon (0.10%), and quinalphos (0.05%). Other insecticides like bifenthrin, cyfluthrin, cypermethrin, dicrotophos, ethiofencarb, fenvalerate, furadan, imidacloprid, methamidophos, parathion, permethrin, pirimicarb also give satisfactory results.

Also granular insecticides *viz.* 10 kg. of phorate 10G, 33kg of carbofuran 3G per ha followed by a light irrigation is recommended.

Besides, a large number of genotypes/cultivars have been screened for identifying resistance against the pest and many have been reported as promising (Verma, 2000).

Genus 14. ***Macrosiphoniella*** del Guercio

1911. *Macrosiphoniella* del Guercio, **7** : 331.

Type species : *Siphonophora atra* Ferrari, 1872

Head with well-developed diverging lateral frontal tubercles, without any median prominence; Antennae 6-segmented, slightly shorter to much longer than body; hairs on flagellum with acuminate to spatulate apices, about 0.60-3.50 × b.d. III; segment III in apterae with 2-30 small to large round protuberant secondary rhinaria, in alate viviparae secondary rhinaria may be distributed also on segment IV; p.t. 2.30-6.0 × base of last segment; u.r.s. usually stiletto-shaped, shorter to much longer than h.t.2 and with 3 pairs of secondary hairs, basal ones longer than primary hairs. Dorsum of abdomen in apterae often with small dark patches at bases of hairs in alate always with more developed marginal patches, sometimes distinct or indistinct semilunar dark patch present in front of the very base of siphunculi, being 1.2-4.5 × b.d. III. Siphunculi calf-shaped to nearly cylindrical, pale to dark brown, imbricated, reticulated on apical 0.20-0.60 portion, may be shorter to longer than cauda. Cauda is pale to dark brown, thumb-shaped, bearing 8-30 hairs. Legs pale to variable coloured; Wing venation normal. F.T.C. 3 : 3 : 3.

25. *Macrosiphoniella sanborni* (Gillette)
The chrysanthemum aphid
(Fig. 428)

1908. *Macrosiphoniella sanborni* Gillette, *Canad. Ent.*, **40** : 65.

1938. *Macrosiphoniella sanborni* (Gillette) : Hille Ris Lambers, *Temminckia,* **3** : 30.

1962. *Macrosiphoniella sanborni* (Gillette) : Sengupta, Dash and Behura, *J. Utkal Univ.,* Bhubaneswar Vol-2, Sec. 2, No. 1 : 36.

1963. *Macrosiphoniella sanborni* (Gillette) : Behura, *Proc. 1st Summer School Zoology,* Simla : 46.

1968. *Macrosiphoniella sanborni* (Gillette) : Nayak and Behura, *Prakruti-Utkal Univ. J.–Science,* **5**(2) : 1-16.

1973. *Macrosiphoniella sanborni* (Gillette) : Kumar, *Oriental Ins.,* **7**(1) : 11.

1980. *Macrosiphoniella sanborni* (Gillette) : Raychaudhuri, D.N. (*ed.*), Aphids of Northeast India and Bhutan : 174.

1982. *Macrosiphoniella sanborni* (Gillette) : Basu, R.C. and Ghosh, L.K., *Proc. Symp. Ecol. Anim. Popul. zool. Surv. India,* p.t. 3 : 103-106.

1986. *Macrosiphoniella sanborni* (Gillette) : Ghosh, L. K., *Tech. Monogr.* No. **16** : 99. Z.S.I.

1992. *Macrosiphoniella sanborni* (Gillette) : Agarwala and Bhattacharya, *Soc. Nat. Sci.,* **2**(3&4) : 2.

2000. *Macrosiphoniella sanborni* (Gillette) : Ghosh, L. K. and Basu, R. C., *Fauna of Tripura, State Fauna Series,* **7**(Part-2) : 359. Zool. Surv. India.

2001. *Macrosiphoniella sanborni* (Gillette) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 22.

Diagnosis : Apterous viviparous female : Body elongated, 1.8-2.60 mm long. Head dark brown, with moderately well-developed diverging lateral frontal tubercles. Antennae 6-segmented, 0.9-.13 times as long as body, p.t. about 4 times as long as base VI; a.s. III with 10-17 secondary rhinaria; u.r.s. stiletto-shaped, a little longer than h.t.2 with 3 pairs of secondary hairs; dorsal abdominal hairs short, 2-2.3 mm long, usually arising from sclerotic base; siphunculi dark throughout, reticulated on distal half, about 0.1 times as long as body, antesiphuncular sclerite will-developed; cauda thick, blackish, about 1.25-1.5 times as long as siphunculi, bearing 10-18 hairs. Legs dark on distal half of femora, apices of tibiae and tarsi. F.T.C. 3 : 3 : 3.

Alate viviparous female : P.t. never less than 4.5-5.5 times as long as base VI; a.s. III with 20-30, a.s. IV with 3-4 secondary rhinaria; antesiphuncular sclerite distinct; dorsal abdominal hairs on sclerotic bases; other characters as in apterous viviparous female.

Host plants : The species is known to infest at least 12 species of plants belonging to 7 genera besides indet plants of Asteraceae and other families.

Symptom and Damage : The brownish back to bluish-black nymphs and adults suck the plant sap from stem, young and middle-aged leaves, lower buds and lower surface of old leaves. When severe infestation takes place the aphids congregate at the base of flowers and petals. As a result, the leaves and flowers dry up at premature stage itself because of the excessive feeding of the aphids.

Bionomics : The aphid is known to reproduce parthenogenetically in Indian conditions. The apterous viviparous female produces nymphs. The average fecundity is nearly 61 nymphs per females. A newly born nymph passes through four nymphal instars before becoming the adult. The first, second, third and fourth instars are completed in 2, 2, 3 and 3 days respectively. Thus, the nymphs take nearly 10 days whereas adult lives about 25 days. Thus, the average life span of the aphid is nearly 35 days. The aphid species can complete a number of generations during a year as the life cycle lasts for about 35 days only (Sood and Kakar, 1989). At the very beginning the aphids prefer tender twigs and the surrounding leaf buds, then with the gradual maturity of the plants, they start colonising on the young shoots and leaves. With the gradual fall of temperature the density of aphid population increase with more extensive infestation on the shoot system of the plants. The optimum infestation period is generally between 1st week of January and that of the February. With the advent of spring the population declines. Infestation, however, declines very much during the end of March. With the end of monsoon the infestation reappears to a mild extent with the tendency of forming minor colonies particularly during 3rd week of September (Basu and Ghosh, 1982).

Natural enemies-complex :

Predator : *Cheilomenes sexmaculata* (Fabricius), *Oenopia sauzeti* (Mulsant), *Scymnus phrocheilus* Mulsant [Coleoptera : Coccinellidae]. Indet Syrphidae.

Parasite : *Aphidius absinthii* Marshall, *Aphidius commodus* Gahan, *Ephedrus niger* Gautier *et al.*, *Lysaphidus* sp., *Toxares macrosiphophagum* Shuja-Uddin [Hymenoptera-Aphidiidae]. [*Source* : Stary and A. K. Ghosh, 1983]

Vector : Barley yellow dwarf; Brinjal mosaic; Broadbean mosaic; Chrysanthemum aspermy; Chrysanthemum vein mottle; Chrysanthemum virus B; Millet red leaf; Sugarcane mosaic; Wheat mosaic [Muniyappa and Veeresh 1986; Kennedy *et al.* 1962; Misra 2002].

Fungus : *Entomophthora aphidis* Hoffman. [*Source* : A. K. Ghosh, 1974]

Distribution : India : widely distributed; virtually cosmopolitan.

Remarks : Chrysanthemum aphid, *Macrosiphoniella sanborni* (Gillette) is a cosmopolitan pest of *Chrysanthemum* spp. It was first reported in 1923 by Weigel from the United States. Later on, the aphid was recorded by various workers from different corners of the world including India. The species is very common in Northeastern part of India. It infests different species of *Chrysanthemum* and *Artemisia*

also. In the field it is easily recognised by its dark chocolate coloration and colonial habit. They cluster in dense colonies on the terminal shoots than the lower stems and later underface of leaves. The polyphagous species *Aphis gossypii* Glover is also known to occur in association with *M. sanborni* (Gill.) and shows ecological succession on *Chrysanthemums.*

Management : For control of aphid, foliar sprays of dimethoate, malathion, methyl-demeton and phosphamidon prove effective.

Genus 15. ***Macrosiphum*** Passerini

1860. *Macrosiphum* Passerini, *Gli Afidi,* Parma, 27.

Type species : *Aphis rosae* Linnaeus, 1758.

Head smooth, with moderately to strongly developed, diverging smooth lateral frontal tubercles; dorsal cephalic hairs with acute, acuminate, incrassate or blunt apices. Antennae 6-segmented, shorter to longer than body; flagellum imbricated; apterae always with circular non-protuberant secondary rhinaria in a row either restricted usually to the very base of segment III, in alate such rhinaria mostly on segment III but sometimes also on segment IV; p.t. much longer than base of last segment; flagellar hairs like dorsal cephalic hairs, u.r.s. shorter or longer than h.t.2, heart-shaped or elongate with blunt apex and with 4-6 secondary hairs. Abdominal dorsum in apterae either completely pale or sometimes pigmented middorsally and marginally up to segment VI, in alate also pale with brown marginal patches and transverse pleural bands. Siphunculi cylindrical faintly to distinctly imbricated, and reticulated, with reticulations in the form of isodiametrical cells. Cauda elongate pale or dark, with or without a basal constriction. Legs smooth; sometimes hindtibiae with spines besides normal hairs; second tarsal segments with normal imbrications. Wing venation normal. F.T.C. 3 : 3 : 3 or 4 : 4 : 4.

Key to the species of *Macrosiphum*

Siphunculi dark; secondary rhinaria 15-35; femora dark on distal half .. *rosae*

– Siphunculi pale with slightly dark apex; secondary rhinaria 2-5; femora with a small, dark band at distal end ..... *centranthi*

26. ***Macrosiphum centranthi*** Theobald
(Fig. 214-221)

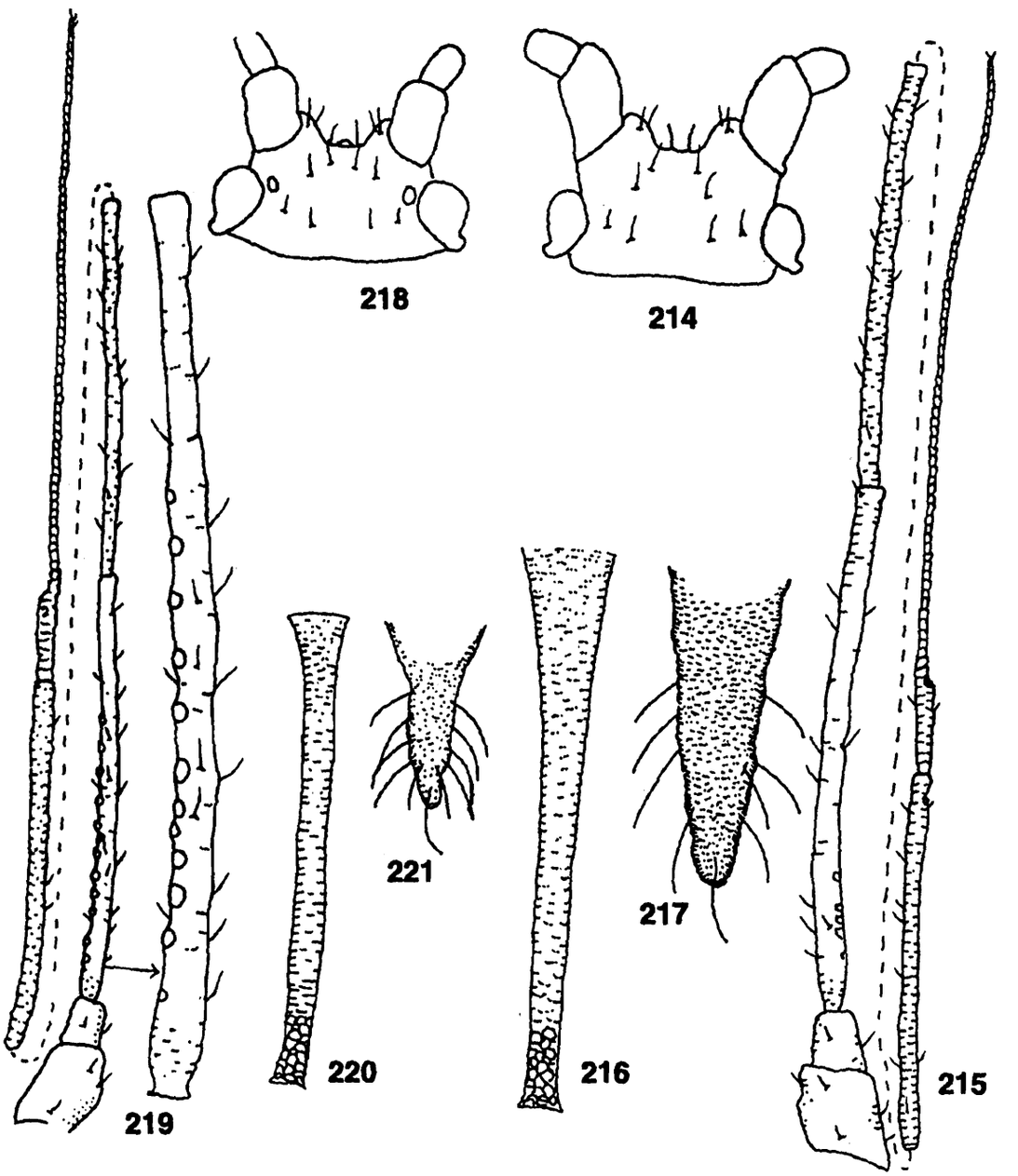
1915. *Macrosiphum centranthi* Theobald, *Entomologist,* **48** : 262.

1956. *Macrosiphum centranthi* (Theobald) : David, *Madras Agric. J.,* **43** : 106.

1975. *Macrosiphum centranthi* Theobald : David, *Oriental Ins.,* **9**(4) : 466.

1997. *Macrosiphum (Macrosiphum) centranthi* Theobald : Remaudiere, G. and Remaudiere, M. Catalogue of the World's Aphididae : 113.

Diagnosis : Body pale, smooth, about 3.0-3.6 mm long. Antennae 6-segmented, flagellar hairs smaller than to a little longer than b.d. III; a.s. III in apterae with 1-7 secondary rhinaria irregularly distributed on the basal. Siphunculi very long, reticulated on distal half, cylindrical, with base nearly colourless, at apex slightly dark. Cauda pale. Femora with characterstic dark band just below the joint with tibiae, h.t.2 quite long, 0.17 mm long; dorsal hairs about 30μ long. Alate with scattered marginal sclerites, a.s. III normally with less than 20 secondary rhinaria; wings with subcostal veins normal; F.T.C. 3 : 3 : 3.



Figs. 214-221. *Macrosiphum centranthi* (Theobald) : Apterous viviparous female : 114. Head; 215. Antenna; 216. Siphunculus; 217. Cauda. Alate viviparous female : 218. Head; 219. Antenna; 220. Siphunculus; 221. Cauda.

Host plants : *Agrostemma coelirosa; Althaea rosae; Calceolaria* sp.; *Chrysanthemum sinense; Chrysanthemum* spp.; *Cineraria* sp.; *Echeveria* sp.; *Lily; Magnifera indica; Pisum sativum; Ranunculus* sp.; *Rosa* spp.; *Solanum tuberosum; Tibouchina semidecandra; Vebena* spp.

Natural enemies-complex :

Predator : *Adonia* sp., *Coccinella* sp. [Coleoptera : Coccinellidae]

Distribution : Originally Holarctic, the species is more prevalent in southern part of India and its distribution extends upto central India.

Remarks : This aphid is a polyphagous species and well known as a potato aphid. It was originally described from North America but now known from wide areas over the world. Bright green apterae were recorded from Roses only in South India (David, 1957). It is found is September and October. Hille Ris Lambers (1939) listed *Rosa* as one of the winter hosts in Europe. There it can lay eggs on Rose.

The species was possibly introduced from Europe into the hills of South India and is continuing to live there on variety of food plants including indigenous ones. It is characterised by the dark band on the femora below the joint with the tibiae.

The knowledge on Biology of the species is obscure. It usually reproduces parthenogenetically in the country.

27. ***Macrosiphum (Macrosiphum) rosae*** (Linnaeus)
Rose aphid
(Figs. 222-235)

1758. *Aphis rosae* Linnaeus, *Syst. Nat.*, 1 (10th ed.) : 452.

1909. *Macrosiphum rosae* (Linn.), Lefroy, *Indian Insect Life* : 743-748.

1957. *Macrosiphum rosae* (Linn.), David, *Indian J. Ent.*, **19** : 295.

1958. *Macrosiphum rosae* (Linn.), Banerjee, S. N. and Basu, A.N., *Indian Agric.*, **2** : 103.

1963. *Macrosiphum rosae* (Linn.) : Behura, *Proc. 1st Summer School Zoology,* (Simla, 1961) : 50.

1969. *Macrosiphum rosae* (Linn.) : David and Rajasingh, *Proc. zool. Soc. Calcutta,* **22** : 155.

1969. *Macrosiphum rosae* (Linn.) : Bindra and Sekhon, *Bull. Ent.*, **10** : 104.

1971. *Macrosiphum rosae* (Linn.) : Ghosh, M.R. *et al., Proc. zool. Soc., Calcutta,* **24** : 165.

1973. *Macrosiphum rosae* (Linn.) : Kumar, *Oriental Ins.*, **7**(1) : 11.

1975. *Macrosiphum rosae* (Linn.) : Chakrabarti and Raychaudhuri, D.N., *Oriental Ins.*, **9**(2) : 201.

1975. *Macrosiphum (Macrosiphum) rosae* (Linnaeus) : David, *Oriental Ins.*, **9**(4) : 475.

1980. *Macrosiphum rosae* (Linn.) : Raychaudhuri, D.N. (*ed.*), Aphids of NE India and Bhutan : 181.

1986. *Macrosiphum rosae* (Linn.) : Ghosh, L. K., *Tech. Monogr., Zool. Surv. India.*, No. **16**, Zool. Surv. India : 103.

1994. *Macrosiphum rosae* (Linn.) : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series*, **3** : 199. Zool. Surv. India.

1997. *Macrosiphum (Macrosiphum) rosae* (Linn.) : L. K. Ghosh *et al., Fauna of Delhi, State Fauna Series*, **6** : 230. Zool. Surv. India.

1998. *Macrosiphum (Macrosiphum) rosae* (Linn.) : Ghosh, L. K. and Basu, R. C., *Fauna of Meghalaya, State Fauna Series*, **4** : 147. Zool. Surv. India.

2001. *Macrosiphum rosae* (Linn.) : Chakrabarti and Sarkar, *J. Aphidology*, **15**(1&2) : 22.

Apterous viviparous female : Body spindle-shaped, smooth, 2.0-3.2 mm long with 1.04-1.35 mm as maximum width near the middle of abdomen. Head (Fig. 222) dark, smooth, lateral frontal tubercles large, rounded on inner side, antennae (Fig. 223) 6-segmented, thin, long, as long as or longer than body, a.s. III with 8-12 secondary rhinaria on basal 0.5 portion, p.t. 5-5.5 times as long as base VI; a.s. IV normally without rhinaria; u.r.s. subequal to h.t.2; abdominal dorsum pale with ante and postsiphuncular sclerites (Fig. 231); lateral abdominal tubercles variably present on tergites 2 to 5; siphunculi (Fig. 224) black, slender, curved outwards, about half as long as body, brownish on basal half and at very apex, rest pale; cauda (Fig. 225) dusky, less than half as long as siphunculi and bears 10-12 hairs. Femora dark on distal half, h.t.2 about 0.14 mm long, F.T.C. 3 : 3 : 3; pink or green in life.

Host plants : *Bignonia* sp.; *Cheilanthes* sp.; *Fagopyrum* sp.; *Inula cappa*; *Pyrus communis*; *Rosa americana*; *Rosa cannia*; *Rosa chinensis*; *Rosa macrophylla*; *Rosa* spp.

Symptom and Damage : The species damages the floral parts of the plant by sucking the cell sap, resulting in the reduction of vigour of the plant and flower quality significantly. Severe attack results in impairment of bud opening and also dropping of buds and flowers.

Biology : The species reproduces usually parthenogenetically in the Indian conditions. The viviparous female gives 18-24 nymphs. There are four instars. Total nymphal period is 11-12 days. Adult longevity ranges from 14 to 16 days. Total longevity is 25-28 days. (Reddy *et al.* 2001). Though conditions are favourable for sexual reproduction available on the Himalaya slopes in India, so far only the apterous and alate viviparous females with their nymphs have been noted.

Natural enemies-complex :

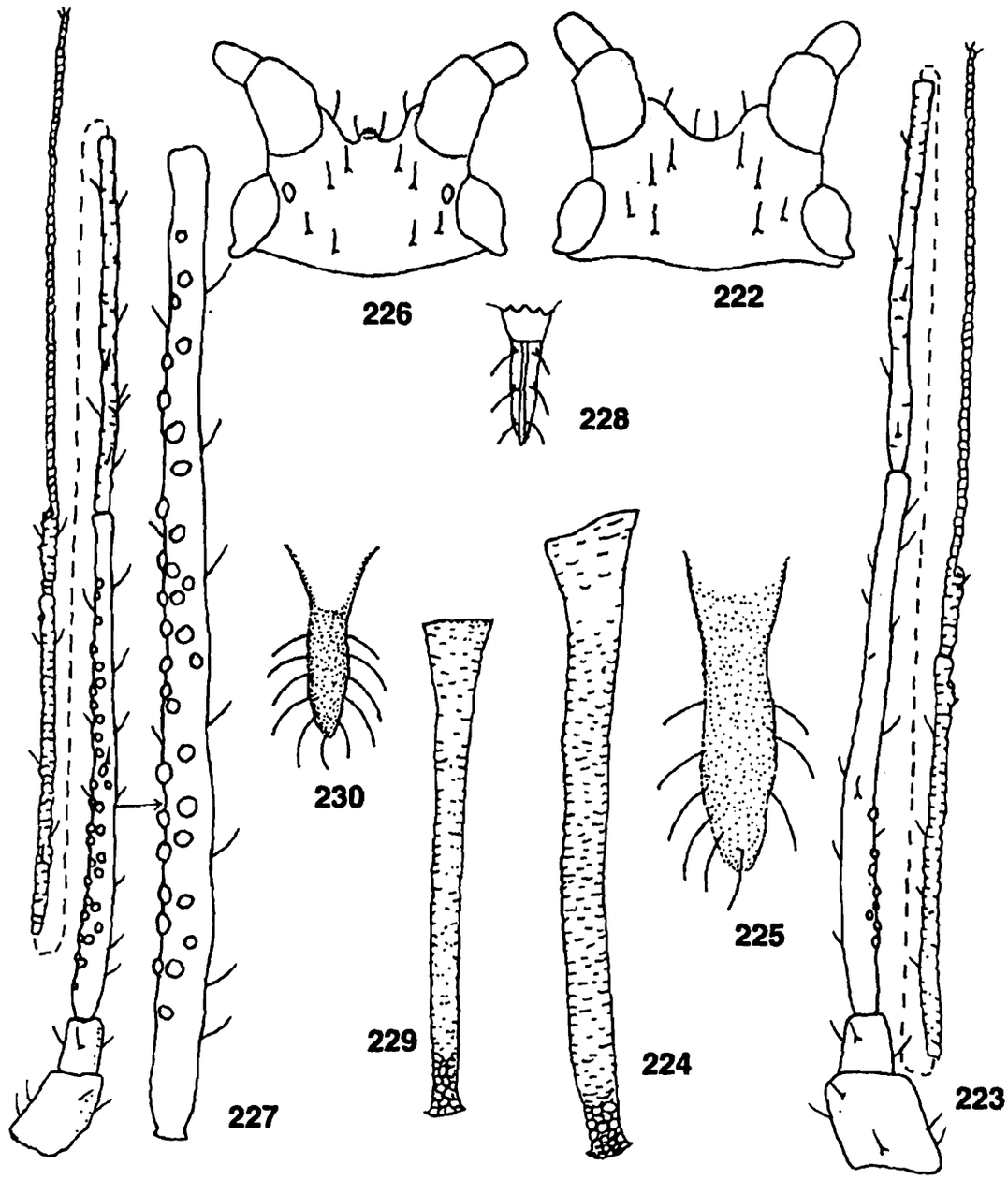
Predator : *Cheilomenes sexmaculata* Fabricius, *Coccinella transversalis* Fabr., *C. septempunctata* Linnaeus, *Coelophora sexareata* Mulsant, *Curinus coeruleus* Mulsant, *Oenopia luteopustulata* Mulsant [Coleoptera : Coccinellidae]. *Allograpta javana* Wiedmann, *Betasyrphus* sp., *Dideopsis aegrota* Fabr., *Episyrphus viriduareus* Wiedmann [Diptera : Syrphidae] [*Source* : Omkar and Pervez, 2000]

Parasites : *Aphidius rosae* Haliday, *Aphidius* sp., *Ephedrus plagiator* (Nees), *Indaphidins curvicaudatus* Stary [Hymenoptera-Aphidiidae].

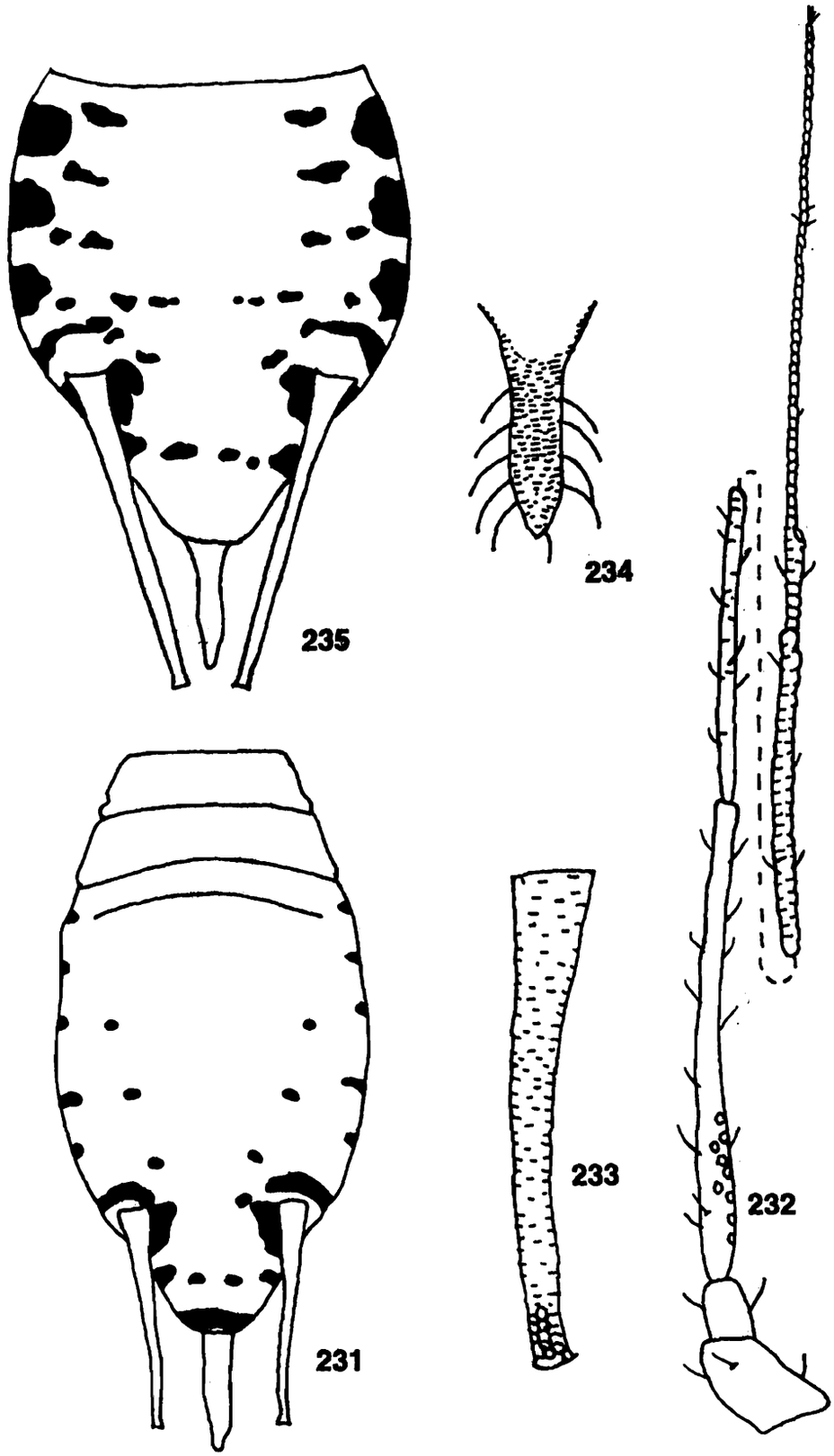
Pathogens : Bean yellow mosaic; Cabbage black ring spot; Cauliflower mosaic; Cucumber mosaic; Pea mosaic [Kennedy *et al.* 1962].

Distribution : India : Throughout.

Elsewhere : Cosmopolitan.



Figs. 222-230. *Macrosiphum rosae* (L) : Apterous viviparous female : 222. Head; 223. Antenna; 224. Siphunculus; 225. Cauda. Alate viviparous female : 226. Head; 227. Antenna; 228. u.r.s.; 229. Siphunculus; 230. Cauda.



Figs. 231-235. *Macrosiphum rosae* (L) : Apterous viviparous female : 231. Posterior portion of body showing ante and post siphuncular sclerite; Alate viviparous female : 232. Antenna; 233. Siphunculus; 234. Cauda; 235. Posterior abdominal dorsum showing sclerotization.

Remarks : The species of temperate region has been found in its typical form in the cooler regions all over India. Though it usually occurs on hill stations but also survives on the plains in the winter season. The species infests all varieties of garden and wild roses and occurs in green and brown colour. Very often it is found to infest the rose plant where *Sitobion rosaeformis* (Das) also occurs.

According to Eastop (1966), this species has been replaced in the far east by several species including *M. (S.) ibarae* Matsumura and *M. (S.) rosaeformis* (Das). In India, the species is much common on the hills of North and N.E. India. In South India, these deep green aphids usually occur all the year round infesting tender parts of the Rose.

Management : As in the case of *Sitobion rosaeformis* (Das).

Genus 16. ***Myzus*** Passerini

1860. *Myzus* Passerini, *Gli Aphidi,* Parma : 27.

Type species : *Aphis cerasi* Fabricius, 1785

Diagnosis : Head warty or spinulose dorsally and ventrally; with weakly developed median prominence but moderately to well-developed lateral frontal tubereles with the inner margin converging to diverging; dorsal cephalic hairs very short to somewhat long with acuminate to *Myzine*-type of apices, much shorter to longer than b.d. III. Antennae 6-segmented, segment I and II scabrous; flagellum gradually more distinctly imbricated apicad; flagellar hairs usually short and sparse, and with *Myzine*-type of apices, apterae without secondary rhinaria, but alatae always with small to large somewhat protuberant secondary rhinaria; p.t. slightly to much longer than last antennal segment. U.r.s. much shorter to much longer than h.t.2 with blunt and obtuse or normal apex, with 2-4 secondary hairs. Dorsum of abdomen rugose and sparsely to strongly spinulose; in apterae pale to sclerotic entirely and without scattered patches, but in alatae with a dark, large central patch (Fig. 244), besides sclerotic marginal patches.; hairs on dorsum like those on antennae; Siphunculi cylindrical to tapering, slightly to distinctly clavate or at least swollen on distal 0.50 portion, nearly smooth to strongly imbricated, with sometimes one or two rows of striae near apex, with or without a distinct flange, about 0.05 to 0.30 × body and slightly shorter to distinctly longer than cauda. Cauda bluntish, bearing 4-9 hairs. Wing venation normal. Femora sometimes with dense spinules besides normal imbrications; tibiae smooth but hind tibiae in nymphs sometimes strongly spinulose; F.T.C. 3 : 3 : 2 or 3 : 3 : 3.

Apterous viviparous female :

1. Siphunculi strongly clavate; nymphs without spinules on hind tibiae *persicae*

– Siphunculi usually cylindrical, but sometimes becomes tapering on very weakly swollen on inner margin 2

2. Distance between 6th and 7th abdominal spiracles as long as or a little longer than between 5th and 6th; abdominal dorsum with segmentally arranged dark marks ..... *ornatus*

– Distance between 6th and 7th abdominal spiracles shorter than that between 5th and 6th; abdominal dorsum not as above 3

3. U.r.s. a little longer (1.1-1.3 times) than h.t.2; siphunculi 1.8-2.5 times as long as cauda; F.T.C. 3 : 3 : 3 ..... *cerasi*

– U.r.s. a little shorter (0.8-0.9 times) than h.t.2; siphunculi 2.6-3.5 times as long as cauda; F.T.C. 3 : 3 : 2 ..... *cornutus*

28. ***Myzus cerasi*** (Fabricius)
(Figs. 236–244)

1775. *Myzus cerasi* Fabricius, *Syst. Entomologiae* : 734

1971. *Myzus cerasi* (Fabricius) (Partim); Miyazaki, *Insecta Matsum.*, **34**(1) : 119

1970. *Myzus cerasi* (Fabr.); Chakrabarti, Ghosh, A.K. and Raychaudhuri, *Oriental Ins.*, **4**(4) : 449.

1970. *Myzus cerasi* (Fabr.); Ghosh, A.K., Ghosh, M.R. and Raychaudhuri, D.N. *Oriental Ins.*, **4**(2) : 202.

1971. *Myzus cerasi* (Fabr.); Ghosh, M.R., Ghosh, A.K. and Raychaudhuri, D.N. *Proc. zool. Soc., Calcutta,* **24** : 50.

1972. *Myzus cerasi* (Fabr.); Chakrabarti, Ghosh, A.K. and Raychaudhuri, *Oriental Ins.*, **6**(3) : 395.

1974. *Myzus cerasi* (Fabr.); Basu, R.C., Ghosh, A.K. and Raychaudhuri, D.N. *Sci. & cult.*, **40** : 42

1974. *Myzus tsengi* Tao; Basu, R.C., Ghosh, A.K. and Raychaudhuri, R.N. *Sci & Cult.*, **10**(1) : 99.

1980. *Myzus cerasi* (Fabricius); Raychaudhuri, D. N. (ed.) In : Aphids of North East India and Bhutan : 212.

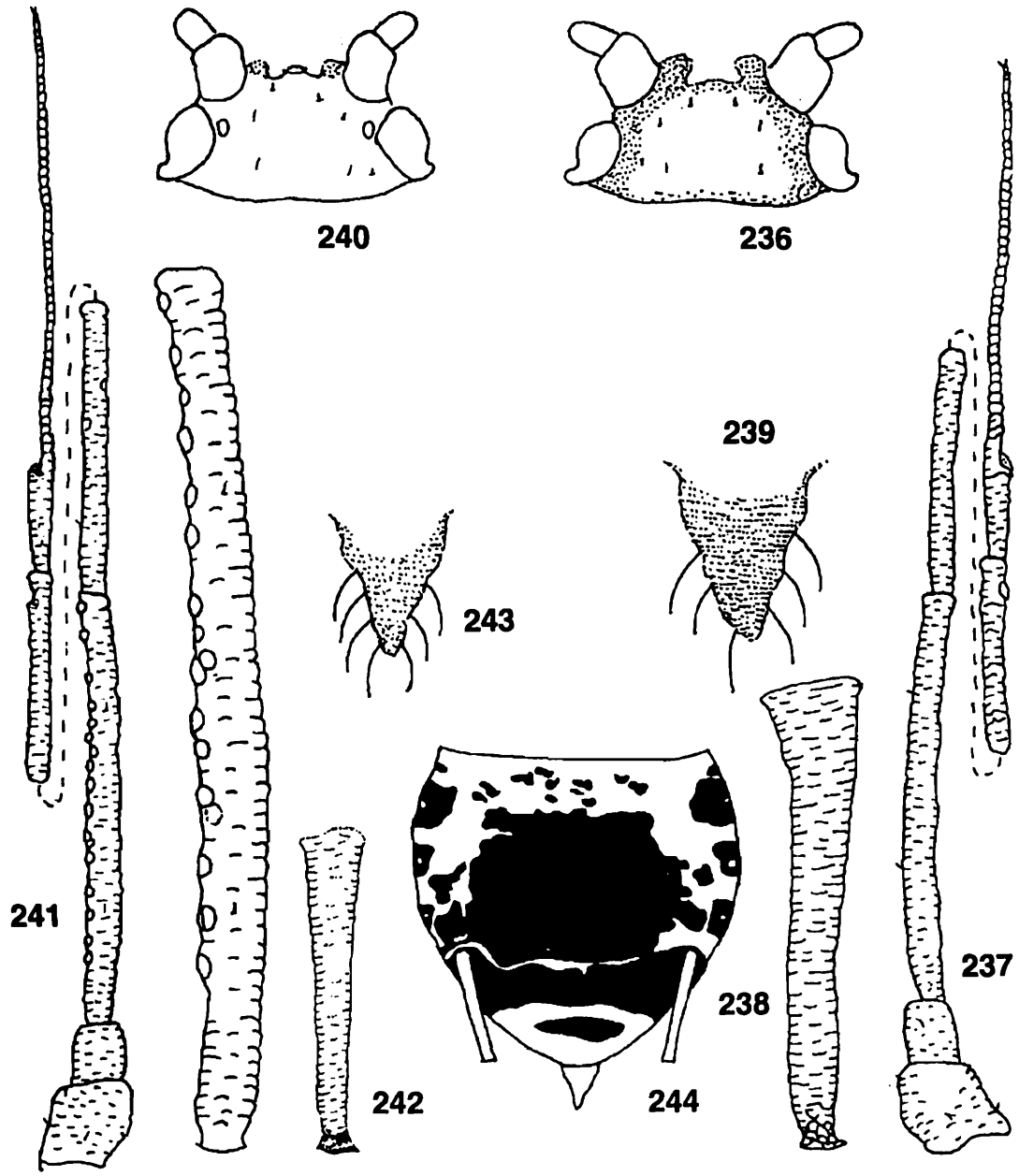
1994. *Myzus cerasi* (Fabr.); Ghosh, L.K. and Basu, R.C. *Fauna of West Bengal, State Fauna Series*, **3** : 213. Zool. Surv. India.

2003. *Myzus cerasi* (Fabr.); Ghosh, L.K. and Basu, R.C. *Fauna of Sikkim, State Fauna Series*, **9** : 300. Zool. Surv. India.

Diagnosis : *Apterous viviparous female* : Head (Fig. 236) with prominent antennal tubercles. Antennae (Fig. 237) 6-segmented, imbricated, antennal hairs small, without secondary rhinaria, about 0.7 times as long as body; p.t. about 2-2.5 times as long as base VI; u.r.s. about twice as long as h.t.2. Siphunculus (Fig. 238) cylindrical, gently tapering to apex, flanged, slightly bent outwards apically, imbricated and with a few interconnecting striae and reticulations apically, about 2.5 times as long as cauda. Cauda (Fig. 239) spinose, conical, with 4-7 hairs, arranged usually 2 or 3 each side.

Alate viviparous female : Head (Fig. 240) with antennal tubercles distinct but much smaller than in apterae, converging only very slightly. Antennal segment III (Fig. 241) with 8-21 oval secondary rhinaria distributed along the entire length. Genital plate imbricated and with 10-14 hairs. Other characters as in apterous viviparous female.

Host plants : *Artemesia vulgaris* (Asteraceae); *Artemesia* Spp. (Asteraceae); *Cardamina* sp. (Brassicaceae); *Galium asperifolium* (Rubiaceae); *Galium mollugo* (Rubiaceae); *Polygonum* sp. (Polygonaceae); *Prunus cerasoides* (Rosaceae); *Prunus*



Figs. 236-244. *Myzus cerasi* : Apterous viviparous female : 236. Head; 237. Antenna; 238. Siphunculus; 239. Cauda. Alate viviparous female : 240. Head; 241. Antenna showing pseudorhinaria; 242. Siphunculus; 243. Cauda; 244. Posterior abdominal dorsum showing abdominal sclerotization.

cornuta (Rosaceae); *Rubia cordifolia* (Rosaceae); *Sambucus javanica* (Sambucaceae); plants of indet families; *Smilax* sp. (Liliaceae).

Symptoms and Damage : This aphid infests the under surface of leaves of *Prunus*. It severely damages spring foliage of Cherries (Cottier, 1953).

Life cycle : It is a holocyclic and heteroecious species alternating between Cherries (primary host) and various secondary hosts including *Galium, Cardamine, Artemisia* (Medda *et al.*)

The life cycle is not known much in India. However, in England the species lays overwintering eggs on Cherry. These eggs hatch early in the spring and infest the young foliage. Alatae produced in June and July, migrate to cleavers and other secondary hosts (Wimshurst 1925).

Distribution : India : H.P., Meghalaya, Sikkim, U.P., W.B.; virtually cosmopolition.

Management : *As in Myzus persicae* (Sulzer).

Remarks : This aphid is recognised by shiny black coloration. sweet cherries are the favoured host. It is an European species that has become the most common member of the family attacking cherry in most parts of the European countries. The winter eggs, which are tucked in among the buds, hatch about the time the buds are burting. The nymphs suck plant sap and develop rapidly on the new growth, causing curling and damages of the leaves. There are several generations of apterous viviparous, ovoviviparous females. In mid summer, alate viviparous females develop and migrate to other plants of Brassicaceae and give birth to succeeding generations. Winged females again develop in late fall that return to cherry and produce the apterous oviparous females laying overwintering eggs.

Myzus cornutus Medda and Chakrabarti

1986. *Myzus cornutus* Medda and Chakrabarti, *Entomon,* **11**(3) : 203-210.

1997. *Myzus cornutus* Medda and Chakrabarti, Remaudiere and Remaudiere, Catalogue of the World's Aphididae, Inra : 125.

2001. *Myzus cornutus* : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 23.

Diagnosis : *Apterous viviparous female* : Head spinulose both dorsally and ventrally, with diverging lateral frontal tubercles well developed; hairs on lateral frontal tubercles with acuminate to myzine-type. Antennae 6-segmented, segments I and II scabrous, flagellum progressively more distinctly imbricated from base towards apex, p.t. 1.8-2.9 times as long as base VI. Rostrum reaches mid coxae, u.r.s. a little shorter than h.t.2 and with 2 secondary hairs. Abdomen pale, somewhat rugose, with lateral tubercles; 8th abdominal tergite with 4 hairs. Siphunculi subcylindrical, denticulately imbricated, flanged with a few preapical transverse striae, 2.6-3.5 times as long as dusky and triangular cauda bearing 6 hairs. Nymphs with hind tibiae spinulated.

Alate viviparous female : Head almost smooth, slightly scabrous with ill developed lateral frontal tubercles; dorsal hairs with fine apices. A.s. III with 9-15 secondary rhinaria, p.t. 2.6-3.1 times as long as base VI. Abdominal tergites smooth and sclerotic, tergites 1-3 and 7 and 8 with spinopleural sclerotic bands. Siphunculi cylindrical, imbricated, with poorly developed flange. Cauda with 5-6 hairs. Wing venation normal. Other characters as in apterous viviparous female.

Host plants : *Prunus cornuta* (Rosaceae).

Symptoms and Damage : The species infests the undersurface of leaves. As a result, it causes deformation of leaves forming ventrally rolled galls on either side of lamina. The infested leaves show rugose appearence on the dorsal side and turn yellowish in case of heavy attack of the aphid. (Medda and Chakrabarti 1986).

Life cycle : This aphid is found to disperse from *Prunus cornuta* to other unknown host plants during June and hence may be host alternating (Medda and Chakrabarti, *op. cit.*).

Natural enemy complex : Not known.

Distribution : The species is originally described from Garhwal Himalaya and known from northern part of the country.

Remarks : The species is very close to Japanese one, *M. mumecola* (Matsumura) but can be distinguished in having shorter u.r.s., presence of lateral tubercles on the abdomen and spiracles on 6th and 7th abdominal tergites being closer than on 5th and 6th ones and also in the spinulosity in the hind tibiae of nymphs.

Management : As in the case of *M. persicae*.

30. ***Myzus ornatus*** Laing
(Figs. 245–254)

1932. *Myzus ornatus* Laing, *Ent. Monthly Mag.*, **68** : 52.

1953. *Myzus ornatus* Laing : Cottier, *Aphids of New Zealand,* : 277.

1956. *Myzus ornatus* Laing : David, *J. Bombay nat. Hist. Soc.*, **53** : 482.

1962. *Myzus ornatus* Laing : Ghosh, A.K. and Raychaudhuri, D.N., *J. Asiat. Soc.*, **4**(3&4) : 106.

1963. *Myzus ornatus* Laing : Ghosh, A.K. and Raychaudhuri, D.N. *Sci. & Cult.*, **29** : 104.

1968. *Myzus ornatus* Laing : Ghosh, A.K. and Raychaudhuri, D.N. *Proc. Zool. Soc. Calcutta,* **65**(2) : 511.

1969. *Myzus ornatus* Laing : Basu, A.N. *Oriental Ins.*, **3**(4) : 363.

1969. *Myzus ornatus* Laing : Chowdhuri, Basu, R.C., Chakrabarti and Raychaudhuri, D.N. *Oriental Ins.*, **3**(1) : 88.

1969. *Myzus ornatus* Laing : Bindra and Sekhon, *Bull. Ent.*, **10**(1) : 103.

1971. *Myzus ornatus* Laing : Ghosh, A.K., Banerjee and Raychaudhuri, D.N. *Gaveshana,* **3** : 10.

1971. *Myzus ornatus* Laing : Chakrabarti, Ghosh, A.K. and Raychaudhuri, D.N. *Sci. Cult.,* **37** : 247.

1972. *Myzus ornatus* Laing : Chakrabarti, Ghosh, A.K. and Raychaudhuri, D.N. *Curr. Sci.,* **41**(2) : 70.

1975. *Myzus ornatus* Laing : Chakrabarti and Raychaudhuri, *Oriental Ins.,* **9**(2) : 149.

1968. *Myzus ornatus* Laing : Chowdhuri, Basu, R.C., Chakrabarti and Raychaudhuri, D.N. *Sci. Cult.,* **34** : 134.

1972. *Myzus* sp. : Basu, R.C., Ghosh, A.K. and Raychaudhuri, *Sci. Cult.,* **38** : 495.

1976. *Myzus ornatus* Laing : Basu, R.C. and Raychaudhuri, D.N., *Oriental Ins.,* **10**(1) : 107.

1980. *Myzus ornatus* Laing : Raychaudhuri, D.N. (*ed.*), Aphids of NE India and Bhutan : 217.

1983. *Myzus ornatus* Laing : Raychaudhuri, D.N. (*ed.*), Food Plant Catalogue of India Aphididae : 44.

1992. *Myzus ornatus* Laing : Agarwala and Bhattacharya, *Soc. Nat. Sci.* **2**(3 & 4) : 2.

1994. *Myzus ornatus* Laing : Ghosh, L.K. and Basu, R.C., *Fauna of West Bengal, State Fauna Series,* **3** : 215. Zool. Surv. India.

1997. *Myzus ornatus* Laing : Remaudiere, G. and Remaudiere, M. Catalogue of the World's Aphididae : 126.

2000. *Myzus ornatus* Laing : Ghosh, L.K. and Basu, R.C., *Fauna of Tripura, State Fauna Series,* **7** : 360. Zool. Surv. India.

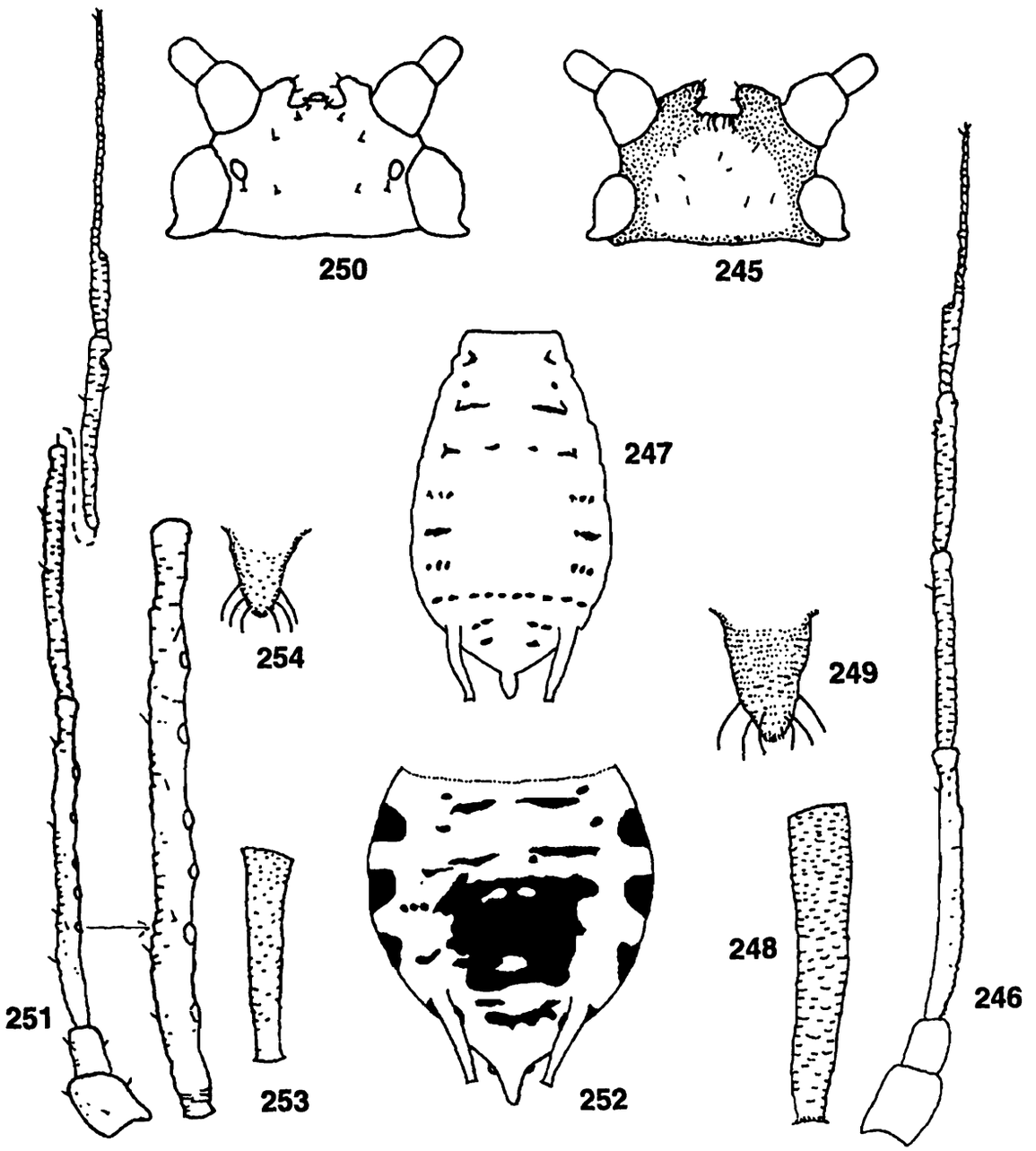
2001. *Myzus ornatus* Laing : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1 & 2) : 23.

2003. *Myzus ornatus* Laing : Ghosh, L.K. and Basu, R.C. *Fauna of Sikkim, State Fauna Series,* **9**(Pt. 2) : 300. Zool. Surv. India.

Diagnosis : *Apterous viviparous female* : Body elongated oval, 1.10-1.30 mm long with 0.70 mm as width. Head (Fig. 245) with antennal tubercles very prominent, much roughened. Rostrum reaches upto second coxae; u.r.s. about half as long as h.t.2; Antennae (Fig. 246) about 0.6 times as long as body. Body with a series of groups of small dark markings down each side of dorsum. Siphunculi (Fig. 248) cylindrical, tapering to apex, usually bending towards each other for the greater part of their length and then somewhat outwards towards apices, imbricated, with a few apical striae, with apical flange. Cauda (Fig. 249) spinose and somewhat conical, about 0.4 times as long as siphunculi and with 5-6 hairs.

Alate viviparous female : Head (Fig. 250) with distinct antennal tubercles, not as large as in apterae. Dorsum smooth with some longitudinal wrinklings; secondary rhinaria distributed : a.s. III with 5-10 small to large subcircular secondary rhinaria distributed along the whole length (Fig. 250). Other characters as in apterae.

Host plants : This aphid is extremely polyphagous, infesting nearly 180 species of plants. Infestion takes place ususlly on the undersurface of the leaves. It causes leafgalls on *Prunus* sp.



Figs. 245-254. *Myzus ornatus* (Laing) : Apterous viviparous female : 245. Head; 246. Antenna; 247. Abdomen showing dorsal pigmentation; 248. Siphunculus; 249. Cauda. Alate viviparous female : 250. Head; 252. Posterior abdominal dorsum showing sclerotization; 253. Siphunculus; 254. Cauda.

Symptoms and Damage : Both nymphs and adults suck sap from the undersurface of host plants. As a result, if causes deformation of leaves in the form of galls.

Life cycle : Both alate males (Chakrabarti and Raychaudhuri, 1975) and oviparaous females (Maity and Chakrabarti, 1981) are known from India. This suggests that the species enjoys holocyclic life cycle besides usual anholocyclic life in the Indian conditions.

Natural enemy complex :

Parasites : *Aphidius matricariae*; *Aphidius* sp.; *Lysophidus quadri*; *Praon* sp.; *Taxares macrosiphophagum*

Predators : *Coccinella septempunctata* Linn.; *Hippodamia variegata* Goeze

Fungus : *Entomophthora aphidis* Hoffman

Transmission of virus : Bett yellows; Canliflower mosaic; Cucumber mosaic; Dahlia mosaic; Onion yellow dwarf; Pea enation mosaic; Potato leafroll; Potato virus Y; Radish mosaic; Soyabean mosaic; Tomato dwarfing.

Distribution : India : all over.

Elsewhere : Cosmopolitan.

Remarks : This aphid is characterised by typical ornamentation in the dorsum of abdomen of apterae. However, specimens from different hosts at different seasons exhibit much variation in the pattern of ornamentation. This perhaps depends on physiological condition of host plant.

Management : As in the case of *M. persicae* (Sulzer).

Parasites : *Aphidius matricariae*; *Aphidius* sp.; *Lysophidus quadri*; *Praon* sp.; *Taxares macrosiphophagum*.

31. ***Myzus (Nectarosiphon) persicae*** (Sulzer)
Potato Aphid
(Fig. 255–267)

1776. *Aphis persicae* Sulzer, *Abgekurz, Gesch. Insekten,* **105.**

1928. *Myzus persicae* (Sulzer) : Krishnamurti, *J. Bombay nat. Hist. Soc.,* **33**(1) : 214.

1930. *Myzus persicae* (Sulzer) : Krishnamurti, *J. Bombay nat. Hist. Soc.,* **34**(2) : 418.

1937. *Myzus persicae* (Sulzer) : Deshpande, *J. Bombay nat. Hist. Soc.,* **39**(4) : 741.

1946. *Myzus persicae* (Sulzer) : Trehan and Pingle, *J. Bombay nat. Hist. Soc.,* **46**(1) : 139.

1953. *Myzus persicae* (Sulzer) : Batra, *Indian J. Ent.,* **15**(1) : 45.

1955. *Myzus persicae* (Sulzer) : Banerjee and Badu, A.N. *Curr. Sci.,* **24**(2) : 61.

1957. *Myzus persicae* (Sulzer) : David, *Indian J. Ent.,* **19**(4) : 292.

1958. *Myzus persicae* (Sulzer) : Basu, A.N. and Banerjee, *Indian Agric.,* **2**(2) : 104.

1958. *Myzus persicae* (Sulzer) : Raychaudhuri and Ghosh, A.K. *Curr. Sci.,* **27** : 402.

1959. *Myzus persicae* (Sulzer) : Ghosh, A.K. and Raychaudhuri, D.N. *J. Bombay nat. Hist. Soc.,* **56**(3) : 661.

1962. *Myzus persicae* (Sulzer) : Ghosh, A.K. and Raychaudhuri, D.N. *Indian Agric.,* **4**(1&2) : 228.

1962. *Myzus persicae* (Sulzer) : Ghosh, A.K. and Raychaudhuri, D.N. *J. Bombay nat. Hist. Soc.,* **59**(1) : 246.

1962. *Myzus persicae* (Sulzer) : Ghosh, A.K. and Raychaudhuri, D.N. *Sci. & Cult.,* **28** : 539.

1964. *Myzus persicae* (Sulzer) : Sharma and Bhalla, *Indian J. Ent.* **26** : 318.

1965. *Myzus persicae* (Sulzer) : Ganguli and Ghosh, A.K. *Sci. & Cult.,* **31** : 41.

1968. *Myzus (Nectarosiphum) persicae* (Sulzer) : David, Rajasingh and Narayanan, *J. Bombay nat. Hist. Soc.,* **65**(2) : 511.

1968. *Myzus (Nectarosiphum) persicae* (Sulzer) : Ghosh, A.K. and Raychaudhuri, D.N. *Proc. Zool. Soc. Calcutta,* **21** : 187.

1969. *Myzus (Nectarosiphum) persicae* (Sulzer) : Ghosh, L.K. *Sci. & Cult.,* **35** : 493.

1969. *Myzus persicae* (Sulzer) : Chowdhuri, Basu, R.C. and Raychaudhuri, D.N. *Sci. & Cult.,* **35** : 335.

1970. *Myzus persicae* (Sulzer) : Rizvi and Khurana, *Sci. & Cult.,* : **36** : 49.

1970. *Myzus (Nectarosiphum) persicae* (Sulzer) : Ghosh, A.K., Basu, R.C., and Raychaudhuri, D.N. *Oriental Ins.,* **4**(1) : 74.

1970. *Myzus (Nectarosiphum) persicae* (Sulzer) : Ghosh, L.K. *Sci. & Cult.,* : **36** : 49, 563.

1971. *Myzus persicae* (Sulzer) : Verma, *Sci. & Cult.,* **37** : 248.

1971. *Myzus persicae* (Sulzer) : Miyazaki, *Ins. Matsumurana,* **34**(1) : 172.

1971. *Myzus persicae* (Sulzer) : Ghosh, A.K., Basu, R.C. and Raychaudhuri, D.N. *Kontyu,* **39**(2) : 122.

1975. *Myzus (Nectarosiphum) persicae* (Sulzer) : Chakrabarti and Raychaudhuri, *Oriental Ins.,* **9**(2) : 150.

1976. *Myzus persicae* (Sulzer) : Basu, R.C. and Raychaudhuri, D.N., *Oriental Ins.,* **10**(1) : 107.

1980. *Myzus persicae* (Sulzer) : Raychaudhuri, D.N. (*ed.*), Aphids of NE India and Bhutan : 217.

1983. *Myzus persicae* (Sulzer) : Raychaudhuri, D.N. (*ed.*), Food Plant Catalogue of Indian Aphididae : 46.

1992. *Myzus persicae* (Sulzer) : Agarwala and Bhattacharya, *Soc. Nat. Sci.* **2** : (3 & 4) : 2.

1994. *Myzus persicae* (Sulzer) : Ghosh, L.K. and Basu, R.C., *Fauna of West Bengal, State Fauna Series,* **3** : 215. Zool. Surv. India.

1997. *Myzus (Nectarosiphum) persicae* (Sulzer) : Remaudiere and Remaudiere, Catalogue of the World's Aphididae : 126-127.

1997. *Myzus persicae* (Sulzer) : Ghosh, L.K. *et al., Fauna of Delhi, State Fauna Series,* **6** : 231. Zool. Surv. India.

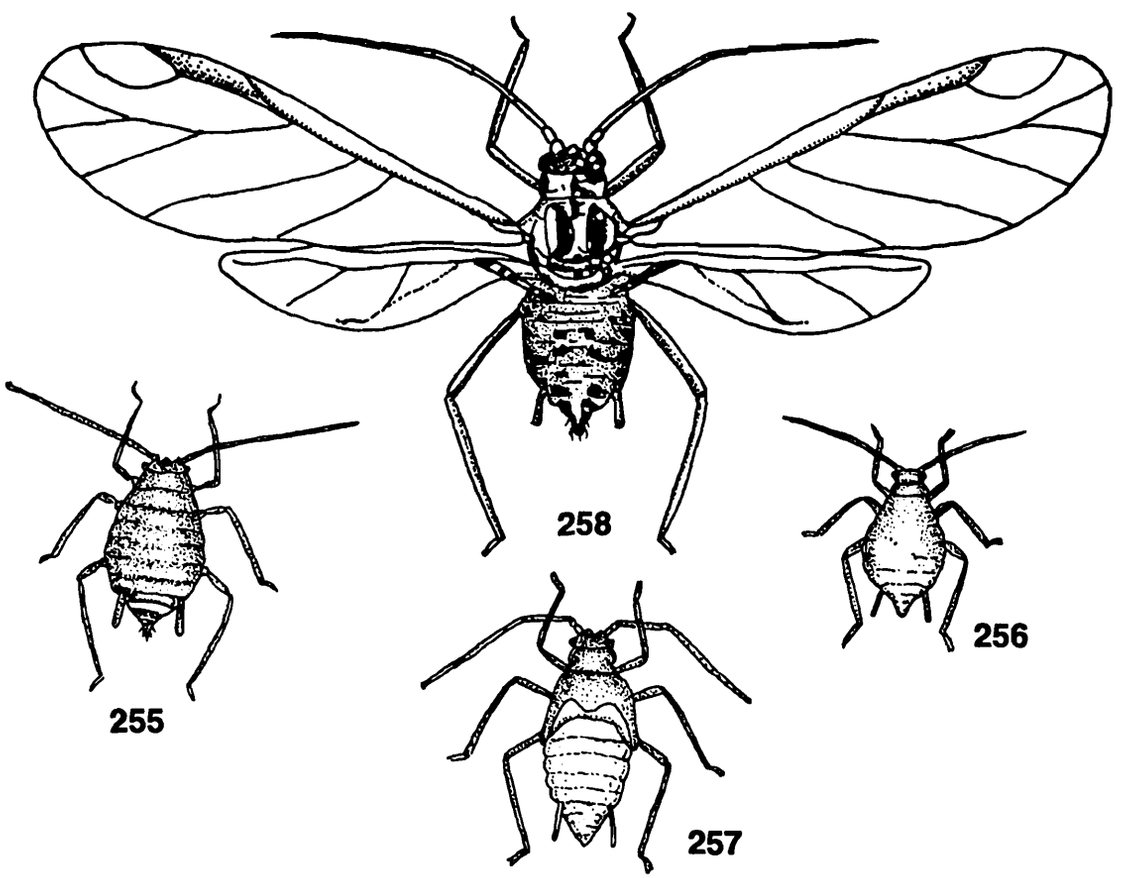
2000. *Myzus persicae* (Sulzer) : Ghosh, L.K. and Basu, R.C., *Fauna of Tripura, State Fauna Series,* **7**(Part-2) : 360. Zool. Surv. India.

2001. *Myzus (Nectarosiphum) persicae* (Sulzer) : Chakrabarti and Sarkar, *J. Aphidology,* **15**(1&2) : 23.

2003. *Myzus persicae* (Sulzer) : Ghosh, L.K. and Basu, R.C., *Fauna of Sikkim, State Fauna Series,* **9**(Pt. 2) : 301. Zool. Surv. India.

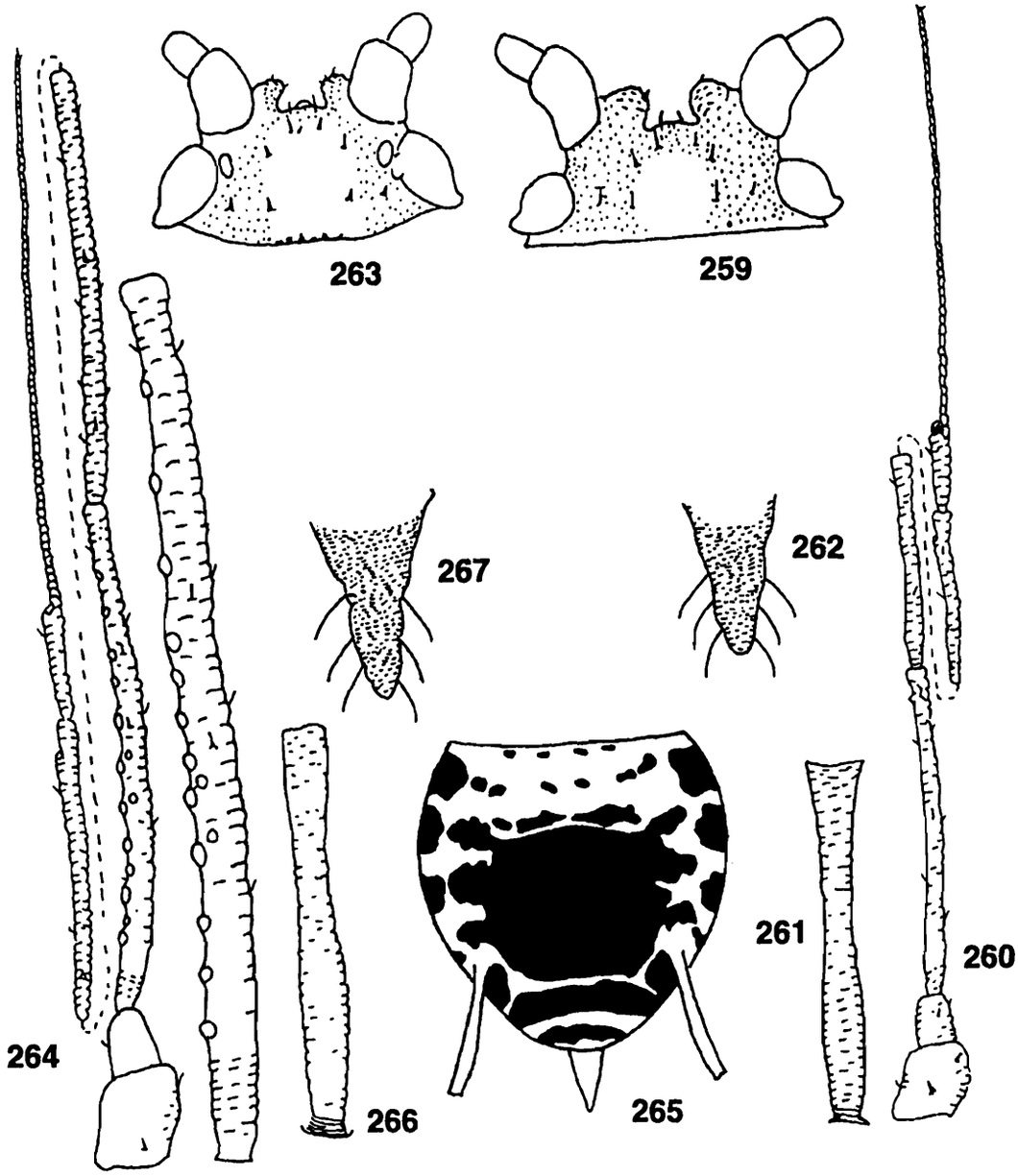
Host plants : The species is extremely polyphagons, infesting nearly 250 species belonging to 77 genera in India. [Raychaudhuri, D.N. (ed.), 1983; Chakrabarti and Sarkar, 2001].

Diagnosis : *Apterous viviparous female* : Body 1.2-2.6 mm long. Head (Figs. 255-259) spinulose, with much roughened antennal tubercles, with numerous minute tooth-like projections, lateral frontal tubercles diverging to converging, u.r.s. at most 1.2 times as long as h.t.2 dorsal hairs small to medium, often somewhat dilated at apices; antennae 6-segmented, without secondary rhinaria on a.s. III, antennal segments imbricated, siphunculi (Fig. 261) cylindrical, swollen at apical third, flanged apically, 0.3-0.4 mm in alatae and 0.4-0.5 mm in apterae; 2-2.5 times as long as cauda, abdominal dorsum roughened. Cauda (Fig. 262) spinose, often somewhat constricted at or near middle, 0.10-0.12 times as long as body bearing 5-8 hairs; genital plate imbricated and with 9-20 hairs. Hind tibiae of nymphs smooth (Figs. 256, 257). F.T.C. 3,3,3. Light green to dirty in life.



Figs. 255-258. *Myzus persicae* (Sulzer) : 255. Apterous viviparous female. 256. Apterous nymph; 257. Alate nymph; 258. Alate viviparous female.

Alate viviparous female : Body (Fig. 258) 1.3-2.5 mm long; head (Fig. 263) with prominent antennal tubercles which are smaller than apterae, much roughened. Dorsum of head with patches of very small tooth-like projections; rostrum reaches upto 2nd coxae; antennae imbricated, 6-jointed, secondary rhinaria distributed on a.s. III 6-17 extending nearly over entire length, IV usually without rhinaria. Abdomen without tubercles or more usually with 1 small on one or both the lateral patches or bands on abdominal segments II, III or IV (Fig. 265). Siphunculi dusky, cylindrical, swollen on apical half to third, with a flange (Fig. 266); cauda (Fig. 267) dusky, spinose often somewhat constricted at middle, with 5-7 (usually 6) hairs; genital plate



Figs. 259-267. *Myrus persicae* (Sulzer) : Apterous viviparous female : 259. Head; 260. Antenna; 261. Siphunculus; 262. Cauda. Alate viviparous female : 263. Head; 264. Antenna; 265. Dorsum abdomen showing scleratization; 266. Siphunculus; 267. Cauda.

with 10-18 hairs (usually 14). F.T.C. 3,3,3. Pale yellow to green sometimes with green stripes in life with head and thorax black, abdomen green with black patch in life.

Host plants : Extremely polyphagous.

Symptoms and Damage : The aphids mainly settle down on the upper and lower surfaces of leaves, apical shoots, flowers, flower buds and young fruits. The plants turn pale and it looks sick in appearance. The leaves show curling symptoms and drop, when the intensity is high. The plants become stunted and "sooty mould" develops on the honeydew excretion of aphids deposited on leaves.

Biology : The pest species usually appears on potato crop in the field from mid November onwards in most parts of Indo-gangetic plains and does not migrate to the primary host plant for egg laying as in other temperate countries. Its population grows on increasing up to the end of February as early March (Chanhal *et al.* 1975). However, by the end of March many alatae are formed and migrate to mid and then to higher hill where the climate is mild and suitable and a number of secondary host plants are available. The aphids keep on multiplying till November-December on high hills and thereafter, its return migration starts from hills to plains and *vice versa*.

It is, thus, clear that *M. persicae* is present on the secondary host plants throughout the year either in the plains or hills. It can also overwinter in the hills, in green houses, sprouts of stored tuber and even in the fields (Lal and Verma 1987).

At the end of January and February, a few gynoparae (alatae) which produce oviparae, also start arriving on peach trees, the nymphs laid by these alatae mature into oviparous females by the middle of February. The males also start arriving during this period and mating takes place which lasts for about 2-5 minutes. The eggs are laid in the crevices of auxillary buds in clusters. Some eggs are also laid on the twigs. The eggs are first greenish in colour which later turn into shining black. During this period, the temperature and day length go on rising daily and most of the eggs die and are also preyed on by the predators. It seems that these conditions are not suitable for egg hatching. It is therefore clear that this aphid has both sexual and asexual life-cycle but reproduces mostly parthenogenetically, Thus, an abortive type of life-cycle exists under these conditions. Such type of life-cycles are also known in other countries (Blackman 1974).

The biology and life-cycle of *M. persicae* is very complex. As regards its development, it has four nymphal instars. The general morphology of nymphal instars agrees well with that of the apterae. The former differs from the latter by possessing wing pads in the fourth instar. The first instar takes 1-2 days, second and third 2-3 days and fourth 4-5 days for the development. The adult starts reproducing in about a day after the final ecdysis. The nymphal period varies from 1.3 to 14.6 days on different potato cultivars. The pre-reproductive, reproductive and post-reproductive periods are found to be between 0.7 and 1.2, 8.3 and 14.0, and 1.8 and 1.8 days respectively. The average fecundity on different varieties ranges between 12.4 to 55.01 nymphs per female in case of apterae. Per day nymphal production varies from 1.3 to 4.5. (Verma, 2000).

Both winged and wingless forms occur. Nymphs pass through four instars; the duration being 27, 30, 37 and 45 hours respectively and the total development period varies from 1387 to 1498 hours.

The longevity is usually about 157 days. Adults start larvipositing within 1 to 2 days after final moulting and gradually increase and reach the peak on sixth or seventh day and thereafter decrease. The fecendity is 38 nymphs on chillies and is less than compared to that on cauliflower (43) and cabbage (43).

Alternative hosts : It is a cosmopolitan one having several wild and cultivated plants as its hosts about thirty families. Plants under the families of Cruciferae and Solanaceae are the most important hosts. The important host plants are brinjal, chillies, cabbage, cauliflower, radish, potato, sugarbeet, tobacco, papaya, peacti, pear, tomato, cucurbits, amaranthus, spinach, lettuce, etc. Though the aphids are recorded on cucurbits, these are not the preferred food plants. The aphid cannot live long on cucurbits. It keeps on moving from plant to plant, sampling the same for food and incidentially spreading mosaic virus diseases on cucurbits.

Ecology : This insect occurs on many plants along with other species of insects like scales, whiteflies, mealy bugs, thrips and mites with similar feeding habits and live and feed on the same plants. The population attains its peak in January and then declines on chillies. The lower leaves are heavily infested with compared to middle and the top leaves of the plants. *Myzus persicae* dominates *Aphis gossypii* when the plants are infested by both the species. The relation between *M. persicae* and *Tetranychus cinnabarinus* (spider mite) is interesting. The aphids predominate during winter periods (November-December) while the spider mites predominate during summer periods (February-March). Aphids prefer the lower surface while the mites prefer the upper surface of the leaves, but both prefer the bottom and middle leaves than the terminal leaves.

Colour forms : They exhibit different colour forms on various plants under varied climatic conditions. In Tamil Nadu, three colour forms are observed, i.e. yellow, green and red; yellow forms dominating the total population irrespective of the host plants followed by green and red forms. Generally, yellow form predominates on tobacco, chilli and brinjal, green forms on cauliflower and cabbage. The colour pattern was mainly due to differences in pigmentation of the haemolymph and in the hypodermis.

Weather Factors : The temperature, rainfall and high winds regulate the population of aphids. High winds and heavy rains cause reduction in aphids population. Cool conditions either through local variations in weather or increasing elevation and latitude decreases the size of infestation or delay its increase to peak density. There is a considerable interaction between the temperature and biotype of aphid influencing on its development. The thermal requirements determined over a range of constant temparature from 12.4° to 29.4°C revealed that off-springs produced and survived decreased as temperature increased. The aphids require on optimum temperature

between 12.4-15.6°C. Offsprings produced and survived decrease as the temperature increases. At 29.4°C, only about 27% of aphids survive.

The aphids are influenced by one or more weather factors either to take off into the air for active flight, to be carried.

Natural enemmy complex :

i) Parasitoids : Seven species of aphelinids (Hymenoptera) have been well recognised on this aphid. *Aphelinus jucundus* Howard, *A marlatti A. semiflavus, Aphelinus* sp. near *loxopteraphidis, A. asychis* Walker, *A. mali* Hald and *A. flavipes (A. kurdjumovi* Mercet) A species close to *A. flavipes* from *M. persicae* and other aphids was introduced to U. K. from India and it successfully established on *Aphis gossypii.* In Tamil Nadu more than 93 per cent of green house population of *M. persicae* is parasitised by *A. platensis* Ereathes. Peak incidence of *A. pletensis* and *Aphelinus* sp. occur from last week of December to the end of January. This corresponds to the last stage of chilli crop and coincides with peak incidence of *M. persicae. Aphelinus kurdjumavi* occurs regularly, the maximum being 88 per cent, while *Aphidius absinthii* occurs sporadically in the plains and regularly on the hills causing a maximum parasitism of 98%. In field the activity of both parasitoids was found lagging behind that of the aphid. There is an ample scope of utilising these natural enemies if suitable mass culturing techniques could be evolved for making accretive release. The parasitism found to be rather uniform in the aphids on the tip, middle and bottom leaves of chilli. The peak incidence of *M. persicae* as well as parasitoid. *A. kurdjumovi* was observed during November-December compared to Fenruary-March in *M. persicae* on other crops like egg plant. The impact of this parasitoid was not seen on cauliflower under field conditions. Most plants influence the parasitism on aphids. It seemed chilli plants predisposed the aphid to the parasitoids better than brinjal and cabbage. On artificial release, the parasitism increases gradually from the day of release of parasitoids and reaches the maximum 30 days after release.

Parasitism by *Aphidius absinthii* was almost double during January than in late February. This also preferred the aphid on chilli rather than on brinjal and cabbage.

ii) Predators : Though a number of preators were recorded on this insect most of them have been observed on other crops. The predators found on this aphid are coccinellids *(Coccinella trans-versoquttate richardsoni* Brown, *Coleomezilla maculate* Deg, and *Hippodamia convergens* (Guer), predaceous Hemerobiid Brown lace wing [*Micromus tasmaniae* (Walk.)] on egg.

iii) Fungal pathogens : A number of fungi infect *M. persicae* in different parts of the world. They include *Neozygites fresenii* (Nowakowski) Gustafsson, *Acrostajagmus aphidium* Oud., *Beauerià basiana* Bais, *Zoophthora aphidis, Conidiobolus osmodes, Basidiboulus verticillium lecanii* Zimm, *v. fusisporum, Acrimonjum strictum* W. Gams.

iv) Vector pathogen : Amorphophallus mosaic; Bajra mosaic; Balsam mosaic; Banana mosaic; Bean common mosaic; Benincasa mosaic; Bittergourd mosaic; Blackgram

mosaic; Brinjal mosaic; Brinjal mosaic (pototo virus-Y); Brinjal mosaic (tobacco etch virus); Broadben mosaic; Buttercup mosaic; Calendula mosaic; Calliopsis mottle; Canna mottle; Cape gooseberry mosaic; Chickpea leaf reduction; Chilli mosaic; Chilli van banding; Chinese sarson mosaic; Chrysanthemum aspermy; Citrus tristeza; Commelina mosaic; Cowpea mosaic; Cucumber mosaic; Cynodon mosaic; Datura distortion mosaic; Datura leaf distortion mosaic; Digitalis lanata mosaic; Eleusine mosaic; Garlic mosaic; Hyoscyamus mosaic; Launaea mosaic; Lettuce mosaic; Marigold mosaic; Mulberry mosaic; Muskmelon mosaic; Nasturtium ring spot; Onion yellow dwarf; Panicum crus-galli mosaic; Papaya distortion ring spot; Papaya mosaic; Papaya ring spot; Pea mosaic; Peanut green mosaic; Pepper veinal mottle; Petunia mosaic; Petunia mottle; Pigweed mosaic; Poppy mosaic; Potato leaf rool; Potato virus-A; Potato virus-M; Potato virus-Y; Primula mottle; Pumpkin mosaic; Radish mosaic; Ragi mosaic; Rai mosaic; Ridgegourd mosaic; Safflower mosaic; Safflower mosaic (cucumber mosaic virus); Snakegourd mosaic; Solanum aviculare mosaic; Solanum jasminoides mosaic; Solanum khasianum mosaic; Soybean mosaic; Spinach mosaic; Tree tomato mosaic; Urdbean leaf crinkle; Vegetable marrow mosaic; Vigna catjang mosaic; Watermelon mosaic; Zinnia mosaic.

Distribution : India : Widely distributed.

Elsewhere : Cosmopolitan.

Remarks : This green peach aphid is a notorious polyphagous pest inflicting heavy losses to variety of crops and is also an important vector of many plant virus diseases. It is universally distributed occurring under varied ecological conditions.

It is a known vector of about 90 plant viruses, the most important being potato virus Y (PVY) and potato leafroll virus (PLRV). Both the viruses are aphid borne and are carried from plant to plant. They reduce quality and yield of potato. Precise information about the economic losses caused by potato viruses in India is lacking. However, based on a rough estimates over 50% yield reduction have been reported. By the turn of the century area under potato will be around 1.4 million hectare, and yield may increase to about 20t/ha and production about 25 million tonnes. (Verma, 2000). A. K. Ghosh and D. N. Raychaudhuri (1962) recorded sexual male from Delhi while Verma and L. K. Ghosh (1990) dealt with oviparous female and discussed on the sexuales of this species. It is presumed that the green peach aphid enjoys both asexual and sexual life cycle in northern India.

Genus 17. ***Pentalonia*** Coquerel

1859. *Pentalonia* Coquerel, *Ann. Soc. ent. Fr.*, **3** : 259.

Type species : *Pentalonia nigronervosa* Coquerel, 1859.

Head pigmented, heavily spinulose on both surfaces; lateral frontal tubercle low but distinct and spinulosely scabrous, with diverging inner margins; median frontal prominence low; dorsal cephalic hairs short with fan-shaped apices and placed on

raised sockets. Antennae 6-segmented, shorter to longer than body; segment I almost as long as wide with spinulose imbrications on outer aspect and with inner aspect particularly distally heavily scabrous, segment II heavily scarbous, flagellum densely imbricated; apterae without secondary rhinaria, alatae with circular non-protuberant secondary rhinaria on segments III, IV and V; flagellar hairs short with blunt apices; p.t. much longer than base of segment VI. Rostrum extends a little beyond hindcoxae; u.r.s. normal, longer than h.t.2, with 2-6 secondary hairs, Abdominal dorsum with polygonal reticulations particularly on antesiphuncular segments and with transverse spinular striae on postsiphuncular segments, segment 8 with spinopleural pigmented band; dorsal hairs short with expanded apices and placed on raised sockets. Siphuncnli distally slightly attenuated, without distinct apical flange and with dense spinulose imbrications all over. Cauda short, dusky, with a bulbous base and blunt apex, about 0.35-0.42 × siphunculi and bears 4-6 hairs. Coxae, trochanters and femora densely spinulose but tibiae smooth or sometimes distally faintly imbricated; hairs mostly thick, short, with bluntish apices, a few with widely expanded apices on femora in apterae; Wing-venation typical, Rs fusing with anterior branch of M in forewing. Hindwing with one oblique vein; veins strongly bordered brown. Nymphs with hind tibiae spinulose. F.T.C. 3 : 3 : 2.

32. ***Pentalonia nigronervosa*** Coquerel
Banana Aphid

1859. *Pentalonia nigronervosa* Coquerel, *Ann. Soc. Ent. Fr.* (3)**7** : 260.

1949. *Pentalonia nigronervosa* Coquerel : Hille Ris Lambers, *Temminckia,* **8** : 221.

1967. *Pentalonia nigronervosa* Coquerel : Menon, *Indian J. Ent.,* **29** : 393.

1971. *Pentalonia nigronervosa* Coquerel : Ghosh, A.K., Banerjee and Raychaudhuri, D.N., *Proc. zool. Soc., Calcutta,* **24** : 165.

1976. *Pentalonia nigronervosa* Coquerel : Nayar, Ananthakrishnan and David, General and Applied Entomology : 202.

1980. *Pentalonia nigronervosa* Coquerel : Raychaudhuri, D.N., Ghosh, M.R. and Basu, R.C., Aphids of Northeast India and Bhutan : 235.

1992. *Pentalonia nigronervosa* Coquerel : Agarwala and Bhattacharya, *Soc. Nat. Sci.,* **2**(3 & 4) : 2.

1994. *Pentalonia nigronervosa* Coquerel : Ghosh, L. K. and Basu, R. C., *Fauna of West Bengal, State Fauna Series,* **3** (Pt. **5**) : 221. Zool. Surv. India.

1997. *Pentalonia nigronervosa* Coquerel : Ghosh, L.K., Biswas, Ghosh, M. and Chakrabrati, *Fauna of Delhi, State Fauna Series,* **6** : 231. Zool. Surv. India.

2000. *Pentalonia nigronervosa* Coquerel : Ghosh, L.K., and Basu, R.C., *Fauna of Tripura*, p.t. 2, *State Fauna Series,* **7** : 361. Zool. Surv. India.

Diagnosis : *Apterous viviparous female* : Body pyriform, 1.20-1.7 mm long with 0.7-1.05 mm as maximum width. Head strongly spinulose on both surfaces; lateral frontal

tubercles well developed, which are parallel to diverging; dorsal cephalic hairs with fan-shaped apices. Antennae 6-segmented, shorter to longer than body; flagellum progressively more distinctly imbricated, a.s. III without secondary rhinaria; p.t. much longer, 5-8 times as long as base VI. Rostrum reaches hind coxae; u.r.s. 1.5-2.2 times as long as h.t.2, with 2-4 secondary hairs. Mid thoracic furca with separate arms. Abdomen dark brown, shining and slightly bulged. Adominal dorsum sclerotic and reticulated, dorsal abdominal hairs short and fan-shaped apices. Siphunculi dark brown, densely spinose, heavily imbricated, slightly clavate, with distinct apical flange, about 3-4 times as long as pale bulbous cauda bearing 4-6 hairs. Coxa, trochanter and femora densely spinose, tibiae rather smooth. Nymphs of hind tibia spinulose. F.T.C. 3 : 3 : 2.

Alate viviparous female : Body dark brown, elongated and pyriform. Antennal segments III, IV and V with secondary rhinaria; abdomen with marginal pigmented sclerites besides scattered pigmented sclonesrites; Wing venation typical, RS fusing with anterior branch of M in forewing. Hindwing with one oblique vein, veins thick strongly bordered brown. Other characters as in apterae.

Host plants : *Alocasia macrorrhiza* (Araceae); *Amomum subulatum* (Zingiberaceae); *Amomum* sp. (Zingiberaceae); *Amomum annaecarpum* (Zingiberaceae); *Caladium* spp. (Araceae); *Caladium bicolor* (Araceae); *Colocasia antiquorum* (Araceae); *Colocasia* spp. (Araceae); Costus speciosus; *Curcuma domestica* (Zingiberaceae); *Curcuma longa* (Zingiberaceae); *Eletteria cardamomum* (Zingiberaceae); *Hedychium* sp. (Zingiberaceae); *Heliconia* sp.; *Musa cavendishii* (Musaceae); *Musa paradisica* (Musaceae); *Musa rosaceae* (Musaceae); *Musa sapientinum* (Musaceae); *Musa superba* (Musaceae); *Musa* spp. (Musaceae); *Psidium guajava* (Myrtaceae); *Selaginella* sp. (Selaginellaceae); Leguminosae indet.

Symptoms and Damage : Aphids colonise between the folds of scales or leaves of tender shoots at the base of the plants. If abundant, they may be found in colonies on an exposed surface of tender leaves, mostly on under surface, on the sides of midrib, at the top and also within leaves being unopened. Being reddish brown in colour, it matches well with the colour of host perfectly and thus, escapes ready notice. The presence of ants gives indication of infestation. The Foorki diseased plants produce a bushy growth of stunted shoots which do not produce flowers making them completely sterile. Bunchy Top disease of banana caused by the aphid includes dark green streaking on the leaves, midrib and petioles, progressive leaf-dwarfing, marginal chlorosis and leaf curling. Fruit bunches become small and distorted and the fruit becomes unsaleable due to heavy infestation of the pest species.

The apterous viviparous females being sluggish, they crawl slowly from plant. But they may be washed out by rain and migration from one plantation to another is affected through rhizomes used as planting materials. The alate forms (winged) are usually carried out by wind currents. The pest population reaches its peak during the cool and humid (May-August) months and initiate the maximum infection of the

Foorki disease during this period. As this coincides with reproductive phase of plants, the damage caused is considerable.

In cardamom, the banana aphids feed on the leaf sheath and pseudostem. It causes little direct damage but acts as a vector mosaic viruses of cardamom. The occurrence of pest species is spread in cardamom plantation mostly by crawling from the plant.

Biology : Both apterous (wingless) and alate (winged) forms are found. They reproduce asexually and viviparously. In mass culture, due to overcrowding, apterous adults produce winged forms. Alatae give birth to only apterous nymphs. The longevity of adult varies from 8 to 26 days with an average period of 13.9 days. The number of offsprings laid by a single female varies from 8 to 28 with an average of 14. The maximum number of offsprings produced by a single female during a period of 24 hour is 4. Its development is accompanied by three moults in 12.6 days, from November till January 4 moults take place in 15 days, both on Cardamom and *Colocasia*. These are attended by small ants which help in maintaing sanitation in the aphid colony by removing the copious excreta (honey dew) continuously. However, these ants were not found to carry the aphids. There could be 21-24 generations in a year. Ants always accompany the aphid colonies, and they are responsible for establishment of new colonies.

The aphid usually reproduces asexually (Anholocyclic) throughout the year in Indian conditions although apterous oviparous female is known from the Indian plain (Bhanotar and L.K. Ghosh, 1969). But male is still unknown. Therefore, it is doubtful whether the banana aphid completes its sexual life cycle. However, the species leads anholocyclic life cycle throughout the banana growing areas of the world.

Natural enemies-complex :

Predator : *Pseudospidimerus circumflexa* (Motschulsky), *Coccinella septempunctata* Linnaeus, *Micraspis discolor* (Fabricius), *Thea cincta* (Fabricius), *Anisolemnia dilatata* Fabricius, *Scymnus nubilus* (Mulsant).

Vector : Bunchy top virus (Varase 1954), Mosaic disease of cardamom (Verma, 1956, 1958), 'Katte' disease of cardamon (Verma 1962), Banana mosaic (Kennedy *et al.* 1962).

Distribution : India : almost throughout.

Elsewhere : Canary Isles; Sierra Leone; West Africa; Egypt; East Africa; Mauritius; Madagascar; Sri Lanka; China; Bangladesh; Philippines; Indonesia; Australia; New Guinea; Pacific Is.; Hawaii; West Indies; America.

Remarks : *Pentalonia nigronervosa* Coquerel, known as Banana aphid, is a major pest of banana. In India, it is predominant in Kerala, Tamil Nadu, Karnataka, Maharashtra, West Bengal and states of northern and eastern India. Warm and moist weather is most favourable for the rapid multiplication and colonies may be seen

congregated on the ventral surface of leaves. The species causes damage more as a vector rather than a pest. It is a well known vector of the banana bunchy top virus, cardamom mosaic ("Katte" disease), *Amomum* mosaic and "Foorkey" disease of large cardamom. Of these, "Katte" disease of cardamom has been responsible for the low and rapid decline in yield in South India. The aphid acts as potential vector for the spread of this disease. It occurs on banana usually in small to very large colonies consisting of alate and apterous viviparous females and nymphs. Apterous forms are predominant in a population. Often one can notice aphid free plants near plants harbouring large colonies of the pest species.

Management : Chemical treatments are usually only effective of accompanied by careful eradication of infested plants. Parathion, phosphamidon, dicrotophos and endrin should be sprayed at the plant crown and pseudostem base, below soil level between the outer leaf sheath and stem, and over the surrounding soil. For controlling the pest on cardamom spraying a systematic like dimethoate, methyl demeton, thiometion, phosphamiclon, etc. may be effective.

Genus 18. ***Rhopalosiphoninus*** Baker

1920. *Rhopalosiphoninus* Baker, *U. S. Dept. Agric. Bull.*, **826** : 58.

Type species : *Amphorophora latysiphon* Davidson, 1912

Body broadly oval. Head with spinulose lateral frontal tubercles, Antennae 6-segmented, basal two segments scabrous with spinnules; apterae with or without secondary rhinaria; alatae with secondary rhinaria on a.s.iii, sometimes also on a.s.iv, very rarely on a.s.v. U.r.s. subequal to h.t.2, with 2-4 secondary hairs. Midthoracic furca with narrow base. Abdominal dorsum in apterae pale, smooth or wrinkled or sometimes with polygonal spinular reticulation, in alatae usually with spino-pleural patches, dorsal abdominal hairs short with blunt to slightly incrassate apices. Siphunculi bagpipe-like with hexagonal reticulation just above thick apical flange, 0.2-0.3 times as long as body. Cauda short, triangular, with 4-6 hairs. F.T.C. 3,3,3 or 3,3,2. wing venation normal.

Distribution : India.

Elsewhere : Europe, Japan; Nepal; U.S.A.

33. ***Rhopalosiphoninus latysiphon*** (Davidson)

1912. *Amphorophora latysiphon* Davidson, *J. Econ. Ent.*, **5** : 405.

1975. *Rhopalosiphoninus latysiphon* (Davidson) : Ghosh, A. K., *J. Bombay nat. Hist. Soc.*, **71(2)** : 219.

Diagnosis : Body oval. Head brown with median frontal prominence and spinulose lateral frontal tubercles which project inwards or inner sides of tubercles more or less parallel to each other; tubercles armed with spinules. Antennae 6-segmented,

imbricated, a.s.III being conspicuously armed with subcircular secondary rhinaria; first segment markedly imbricated. Body without marginal tubercles. U.r.s. normal, subequal to h.t.2, bearing 2 secondary hairs; dorsum of abdomen pale, either smooth or wrinkled or with hexagonal spinular reticulation; dorsal hairs short in incrassate apices. Siphunculi brown, pitcher-shaped, basal cylindrical portion rather wrinkled or apical cylindrical portion with a few rows of transversely elongated cells before well developed apical flange. Cauda spinose, comparatively short and conical, with bulbous base and nearly rounded apex. F. T. C. 3, 3, 2.

Host plants : *Poa* spp., *Pyrus malus*; *Solanum tuberosum, Triticum* Spp. and other plants of indet. families.

Natural enemy complex : Virus transmission : Cucumber mosaic, Potato Leafroll.

Distribution : India : Himachal Pradesh; Meghalaya; South India.

Elsewhere : England, Germany, Netherlands, North America, Switzerland.

Genus 19. ***Sitobion*** Mordviko

1914. *Sitobion* Mordviko, *Fauna Russie Ins. Hem.*, 1(1) : 337.

Type species : *Aphis granaria* Kirby, 1798 = *Aphis avenae* Fabricius, 1775

Diagnosis : Head and body smooth. Lateral frontal tubercles small, arising away from the median prominence. Secondary rhinaria usually few, located near base of antennal segment III; Dorsal hairs equal to shorter than b.d.III. Head, antennae or leg joints variously pigmented, abdominal tergum normally distinctly sclerotic, often with the pleural, intersegmental sclerites somewhat pigmented. Siphunculi usually sharply tapering broad at base and narrow on the distal half. Cauda pale or dark.

Key to the species of *Sitobion*

Antennae much longer than body, dark brown throught except at very base of a.s.III; p.t. less than a.s.III; siphunculi dark brown throughout; caudal hairs 5-8 (average 7); on various grasses ..... *miscanthi*

– Antennae equal to or less than body, dark at junctions; p.t. about as long as a.s.III; . siphunculi pale at base and dark on distal portion; caudal hairs 8-11 (average 9); on *Rosa* spp. ..... *rosaeformis*

34. ***Sitobion miscanthi*** (Takahashi)

1921. *Macrosiphum miscanthi* Takahashi, *Aphididae of Formosa,* pt. 1 : 8-9.

1975. *Macrosiphum (Silobion) miscanthi* (Takaharhi); David, *Oriental Ins.,* **9**(4) : 470.

Diagnosis : (Aptera) : Body dark, 2.5-3.0 mm long with 1-1.4 mm as maximum width. Head with well developed lateral frontal tubercles; antennae longer than body,

a.s.III with 1-3 secondary rhinaria; p.t. 6-7.5x base VI; rostrum reaches beyond mid coxae; u.r.s. blunt, 0.7-0.8 times as long as h.t.2; abdominal dorsum with an almost continuous dark patch extending from segments 2-6; siphunculi black, 1.3-1.4 times as long as cauda which is dark elongate and bears 7-10 hairs. F.T.C. 3,3,3.

Alate viviparous female : Head with antennal tubercles prominent and smooth. Dorsum also smooth; hairs medium; u.r.s. extends to mid coxae; a.s.III. smooth except for some imbrications on basal and apical portions, remainder with distinct imbrications; a.s.III with 8-16 small to large oval secondary rhinaria in a line on basal half; prothorax with 1 small marginal tubercle on each side. Siphunculi cylindrical, tapering from base to just before apex, reticulated on apical quarter; cauda spinose, constricted at basal 1/3 portion, with 7-10 hairs; genital plate imbricated with about 12-15 hairs. Other characters as in apterous viviparous female.

Host plants : *Agropyron* sp., *Agrostis* sp., *Ardropogon vulgare; Andropogon* spp., *Anthoxantham odoratum, Aristidia* sp. *Avena sativa, Bothriochola iinsculpta, Bothrichola perthusa, Brachypodium sylvasticum, Brassica oleraua, Bridelia* sp. *Bromus uniloides, Capillipedium parviflorum, Chloris inflata, Chrysopogon zeylanica, Cineria* sp., *Crepis japonica, Cymbopogon martini, Cyrbopogon martini, Cymbopogon nardus, Cynodon dactylon, Cyperus potundus, Cyperus* sp., *Echinocholoa* sp., *Eleusine coracana, Eleusine indica, Eleusine* spp. *Elsholtzia blanda, Enteropagon* sp., *Eragrostis gangetica, Eragrostis superba, Eragostis* sp., *Erigeron* sp., *Galium mollugo, Granotia* sp., *Helianthus annuus, Hordeum vulgare, Ischaemum rugosum, Ischaemum* sp, *Koeleria cristata, Lactuca sativa, Oplismenus* sp., *Oryza sativa, Panicum* spp., *Paspalum conjugatum, Paspulum dilatum, Paspalum* spp. *Pennisetum flaccidium, Pennisetum typhoideum, Poa annua, Poa pratenis, Poa* spp., *Polygonum capitatum, Polygonum chinese, Polypogon littoralis, Ranunculus arvensis, Ranuncules* sp., *Rosa indica, Rosa* spp., *Saccharum officinarum, Secale cerrale, Setaria glauca Setaria palmitolia, Smilax* sp., *Spinacia oleracea, Thrasanolaena agrostis, Triticum aestivum, Tritisum sativum, Triticum vulgare, Triticum* spp., *Zea meys.*

Natural enemy-complex :

Parasites : *Aphelinus gossypii, Aphidius wrbekistaricus, Praon* sp.

Predator : *Coccinclla septempunctata* Linnaeus, *C. undecipunctata* Linnaeus, *Hippodamia variegata* Goeze [Coccinellidae : Coleoptera]

Symptoms and damage : Both nymphs and adults suck the sap from plants, particularly from their ears. The aphids appear on young leaves or ears in large numbers during the cold and cloudy weather. The infested plants remain stunted. In case of severe infestation, the main shoot dries up resulting in the production of late tillers bearing ear heads without grains. The grain yield losses vary from 3-68% in some promising and commercial varieties. Besides causing direct damage, these aphids also transmit mosaic streak disease.

Life cycle : The females give birth to young ones asexually. (Parthenogenetical reproduction). Aphids multiply at fast rate during cold weather and attain peak of their population in February-March, when the ears ripe. When wheat crop ripens and the summer approaches winged (alate) forms are produced and they migrate to other secondary hosts like herbs and shrubs. In the months of October-November the aphids again appear on wheat. The losses due to this attack of aphids have been reported upto 36%. The pest species completes many generations in a year.

Distribution : India : widely distributed.

Elsewhere : Australia; China; England and Taiwan.

Remarks : This is commonly known as wheat aphid which attacks not only wheat but also barley, Oats etc., and is widely distributed in India. Like other aphids, the nymphs and adults suck the sap from the plants, particularly from their ears. These green aphids appear on young leaves or ears in large numbers during the cold and cloudy weather. The nymphs and the females (adult) look alike, except that the latter are larger. The winged forms appear only in early summer.

Management : Spraying of monocrotophos (0.036%), Oxydemetonmethyl or phosphamidon (0.025%) are most effective.

35. ***Sitobion rosaeformis*** (Das)

1918. *Macrosiphum rosaeformis* Das. *Mem. Indian Mus.*, **6**(4) : 158.

1957. *Macrosiphum (Sitobion) rosaeformis* (Das) : David, *Indian J. Ent.*, **19**(4) : 298.

Diagnosis (Aptera) : Body elongated, 3-4 mm long, 1.4-1.8 mm as maximum width. Head pale, lateral frontal tubercles diverging; antennae slightly shorter than body, a.s. III with 3-6 secondary rhinaria situated near base, p.t.5-6 x base VI, u.r.s. as long as h.t.2 and about 1.2 x its basal width. Hairs small on antennae on body. Abdominal dorsum pale but with scattered brown patches; siphunculi cylindrical, dark, with broad base and narrow apex, 0.25-0.3 x body and a little less than to little over 2 x pale cauda which is conical and bears 9-12 hairs.

Alata : Body 2.01-3.7 mm long with 1.1-1.2 mm wide, antennae slightly longer than body, a.s.III. with 13-18 secondary rhinuria; p.t.5.6-6.0 times as long as base VI; u.r.s. a little shorter to as long as h.t.2.; longest hair on a.s.III 0.50-0.57 times as long as b.d.III ; longest hair on anterior abdominal dorsum 0.57-0.64 times as long as b.d.III. Siphunculi dark brown to black but often paler on basal 0.16-0.2 portions. Other characters as in apterae.

Host Plants : *Allium sativum, Anthistaria ciliata, Apluda mutice, Cestrum* sp, *Coix lachryma-jab, Desmodium* Sp., *Digitaria sanguisalis, Digitaria scandens, Elsholtzia blanda, Hibiscus rosa-sinensis, Hordeum vulgare Pisum sativum, Rosa cania, Rosa centifolia, Rosa damascus, Rosa indica, Rosa macrophylla, Rosa moschata, Rosa* spp., *Rubus lasiocarpus, Rubus* sp., *Secale cereale, Secale* sp., *Smilax* sp., *Sonchus* sp., *Spiraea corymbosa, Urtica parviflora.*

Symptoms and Damage : Both nymphs and adults suck cell sap from the tender leaves, buds and twigs. The aphids pink or green in life, are particularly injurious to tender buds. As a result, the flowers become disfigured and wither away. Each aphid makes punctures, producing wounds leaving their mark as the flowers open. The honey dew excreted by the aphids invites black fungus, thus giving an ugly appearence to the plant.

Life cycle : The females reproduces parthenogenetically. Nymphal development is completed in 10-15 days of the apterous morphs on 15-20 days of the alate forms, the growth is quickest in February-March. The population increases progessively and is highest in March. At the advent of summer when the temperature rises, the population of aphids starts declining. The winged forms are present throughout the period from November to April. Their number increases from December onwards and reaches peak in March, During this time 90% of the adults become alate. During late spring, the aphids multiply vigorously but decreases in number gradually because they can not withstand high temperature in summer.

Management : Spray 500 ml. of malathion 50 EC or methyl dimelon 25EC or 200 ml. of phosphamidon 85 wsc in 500 litres of water per ha.

Natural-enemy-complex :

Predator : *Coccinella* sp., *Coccinella septempunctata* (L.), *Hippodamia variegata* (Goeze), *Adonia* sp. [Coleoptera : Coccinellidae], *Menochilus sexmaculata* (Fab.) Col. Coccinellidae], *Sphaerophoria scripta* (Syrphidae), *Syrphus* sp. [Diptera : Syrphidae], *Metasyrphus corollae* [Do]

Parasitoid : *Praoni* sp. [Hymenoptera : Braconidae], *Aphidius* sp., *Ephedrus plagiator, Lysiphlebus* sp.

Pathogen : Cardamom mosaic or katte disease, Pumpkin mosaic

Remarks : The rose aphid infests the tender flower buds, young growing shoot and leaves of all varieties of garden and cultivated roses. Severe infestation causes determination in the quality of flowers. Therefore, it is an important floricultural pest of economic importance, as roses are the source of major profit genearting sector in the floriculture industry. Moreover, a number of oils are extracted from roses for the perfume industry.

In India, the biology, economy and control were studied in the past (Atwal & Dingra 1971; Rana and Bisht 1989; Kakar & Sood 1989). Recently, Hajong and Varman 2001 studied at Shillong (Meghalaya) the life cycle pattern of this pest species under the influence of environmental factors.

Distribution : India : Arunachal Pradesh, Delhi, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya, South India, Uttar Pradesh, West Bengal.

Elsewhere : Pakistan.

Genus 20. ***Uroleucon*** Mordvilko

1914. *Uroleuwn* Mordvilko, *Fauna de la Russie,* **1** : 64

Type species : *Aphis sonchi* Linnaeus, 1767

Diagnosis : Body elongate to spindle-shaped. Lateral frontal tubereles well developed with diverging inner sides. Antennae 6-segmented, a.s.III in apterae with many protuberant secondary rhinaria, in alatae a.s.III with more than 40 similar secondary rhinargia, flajellar hairs about as long as b.d.III, p.t. 4-6 times as long as base VI; u.r.s. with 4-8 secondary hairs. Dorsal abdominal hairs longer than b.d.III and arising from dark scleroites; alatae with well developed marginal sclerites. Siphunculi usually balck with apical reticulation, about twice as long as elongate cauda F.T.C. 5,5,5, or 3,3,3.

Key to the species of *Uroleucon*

1. Antennal segment III in apterae with 50-60 secondary rhinaria; antennae longer than body ..... *carthami*

– Antennal segment III in aptera with more than 60 (79-91) secondarry rhinaria; antennae shorter than body ..... *compositae*

36. ***Uroleucon (Uromelan) carthami*** (H.R.L)

1848. *Dectynotus (Uromelan) carthami* Hille Ris Lambers, *Trans. R. ent. Soc. Lord.,* **99** : 276.

1957. *Dactynofns (Uromelan) carthami* HRL; Bodenheimer and Swirski, the Aphidoidea of the Middle East : 269.

Diagnosis : Body broadly spindle-shaped, soft, measuring 1.5-2.0 in length. Antennae with about 60 secondary rhinaria, in alatae nearly 100 secondary rhinaria; Siphunculi reticulated on apical 0.20 portions, more than 0.25 times as long as body (sometimes nearly 0.33 times); ultimate rostal segment longer than 2nd joint of hind tarsus; Deep black in life.

Host platns : Various host plants of safflower aphid such as niger in *kharif* and *Arctotis,* Aster, *Callopsis,* chysanthemm, Dahlia, Gallardia, *Helichrysum, Launea, Seet sultan, Vernonia* in *Rabi,* Mulbery, okra, composite weeds, *Vicoa indica* and *Vernonia* spp.

Symptom and Damage : Both nymphs and adults suck the sap from tender shoots, young leaves, peduncles of developing capitula and stems. The honey due excreted by the aphids produce 'sooty mould' which arrests photosynthesis. As a result, plants become stunted and weak. Secretion deposited on flowers also affects pollination. In case of severe infestation the plants give blackish shiny appearence and may die.

Life cycle : The parthenogenetic female gives birth to 5-56 with an average of 21-33 nymphs at an average deposition rate of about 4-5 nymphs per day for 6-9 days. The nymphs moult four times in 9-16 days with an average of 10-11 days. An adult lives for about 7-13 days. The life cycle is completed in about 8-13 days. Rathore (1983) reported biology of this pest species from Madhya Pradesh.

Incidence and population build up of the aphids is greatly influenced by the stage of the crop growth and prevailing weather conditions. The first incidence of the aphids on safflower occurs 40-50 days after sowing when plant shows elongation, branching and iritiation of bud. The active period of the pest species is from October to February.

Natural enemy-complex : Predator : *Cheilomenes sexmaculata* (Fab.); *Coccinella septempunctata* Linnaeus.

Remarks : This is a predominant and major pest and cause considerable damage to safflower. Narangalkar and Shivpuje (1990) reported that yield losses in safflower crop average about 37% due to aphids infestation in India. The aphid is also a major pest on niger and sucks the cell up sap from the tender parts of the plant. Due to its severe infestation the plant growth is stunted and seed production is badly affected. *Kharif* crop usually escapes severe damage due to heavy rainfall. However, in draught years late sour crop is severely attacked.

Distribution : India : Andhra Pradesh, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh.

Management : Quinalphos and oxy-demeton methyl (both 0.03%) when sprayed twice at an interval of 20 days against aphids are effective or sprays of endosulfan 35 EC or dimethoate 30 EC @ 800 ml and 750 ml per hectare respectively, at fortnightly interval give effective control of safflower aphid (Singh *et al.* 1988).

37. ***Uroleucon (Uromelan) compositae*** (Theobald)
Safflower aphid
(Fig. 421)

1915. *Dactynotus compositae* Theobald, *Bull. ent. Res.*, **6** : 123.

1961. *Dactynotus (Uromelan) compositae* (Theobold); Eastop, A study of the Aphididae (Homoptera) of West Africa, 20.

2001. *Uroleucon (Uromelan) compositae;* Chakrabarti and Sarkar, *J. Aphidol.*, **15**(1 & 2) : 27.

Diagnosis : Body spindle-shaped. Head dark brown with well developed lateral frontal tubercles, Antennae 6-segmented, subequal to body, a.s. III with many (20-90) protuberant secondary rhinaria, flagellar hairs 0.50-0.90 times as long as b.d.III. Rostrum reaches 3rd coxae, u.r.s. about 1.5 times as long as h.t.2, dorsal abdominal hairs longer than b.d.III and arising from dark scleroites. Siphunculi elongate, rather cylindrical, blackish, reticulated over distal 0.2–0.4 portion, about twice as long as dark cauda bearing usually 15-16 hairs.

Host plants : *Acalypha indica, Abuliton pannosum, Ageratum conyzoides; Blumea* sp., *Bidens* sp., *Calendula* sp., *Carthamus tinctorius, centaurea moschata; Cosmos* sp. *Convolvulus arvensis, Cocoalus hirshtus, Corchorus trilocularis, Cyperus rotundus,*

Chrysanthemum indicum, Datura fastulosa, Echinops echinatus, Inula cappa, Morremia gangetica, Enphorbia hypercifolia, E. geniculata, Gaillardia sp., *Launea pinnatifida, Parathemium hysterophorus, Phyllanthus maderaspatensis Rhychosia minima, Senecio sp. Vigna mungo, Zinnia* sp.

Management : Same as in *U. (U.) carthami.*

Remarks : Among 34 insect species infesting safflower in India, *Liroheucon (Liromelan) compositae* is the most destructive pest, which is distributed throughout India.

Symptoms and Damage : The adults and nymphs of the aphid suck the cell sap from tender shoots, veins of young leaves, peduncles of developing capitula on young shoots. As a result of severe infestation by the aphids, the plants become shiny blackish and plant growth is retarded resulting stunt in appearence, does not form seed and eventually may die.

Biology : Bhumannavar and Thontadarya (1983) studied the biology of the aphid. According to them, single female gives birth to 89 young individuals parthenogenetically. Nymphal stage is of four instars. Nymphal period, adult life span, prereproductive and reproductive periods lasted for 9, 15, 1 and 15 days respectively. According to Mallapur *et al.* (2002), the aphid appearence on the crop starts after 40 days on the population increase rapidly to reach the peak at 86 days and thereafter it declines. Similarly, the predator insects appear only after 55 days and their number gradually increases upto 100 days before decreasing. Parasitization is noticed only after 85 days and peacked at 114 days old crop. The peak period of the predalors follows immediately after pest's peak whereas like peak period of parasitization is at the end of aphid dominance period.

Natural enemy complex :

Parasite : *Pseudenaphis* sp. (Causes mummification of aphids).

Predator : *Cheilomenes sexmaculata* (Fabricius), *Chryoperla* spp., *Coccinella septempunctata* Linnaeus, *Micraspis discolor* (Fabr.)

Distribution : India : Haryana, Meghalaya, Karnataka, Orissa, South India, West Bengal.

Elsewhere : Africa, Mauritius, Taiwan.

Remarks : Safflower, *Carthamus tinctorius* is one of the important oil seed crops of India, having many commercial values in industry. Safflower is vulnerable to insect pest attack and among them *U. (Uromelan) compositae* is very serious, causing considerable economic loss. It was reported that about 16-60% yield losses were caused by this aphid in various safflower growing states. This aphid feeds mainly on the leaf, but under crowded conditions, it also spreads to undersurface of the leaves, thus reducing the yield or quality of the product to a great extent.

Management : As in *U. (Uromelan) carthami* (H.R.L.).

38. ***Uroleucon (Uroleucon) sonchi*** (Linnaeus)

1767. *Aphis sonchi* Linnaeus, *Syst. Nat.* (12th ed.), **1** : 735.

1997. *Uroleucon (Uroleucon) sonchi* (Linnaers) : G. Remaudiere and M. Remaudiere, Catalogue of the world Aphididae : 154.

2003. *Uroleucon (Uroleucon) sonchi* (Linnaeus) : L. K. Ghosh and R. C. Basu, Insecta : Hemiptera : Homoptera : Aphididae, *Fauna of Sikkim, State Fauna Series*, **9**(Pt 2) : 309.

Diagnosis (Aptera) : Body broadly elongate. Head dark brown, lateral frontal tubercles well developed with diverging inner sides. Antennae 6-segmented, about as long as or a little longer than body, a.s.III with about 20 secondary rhinaria, p.t. about 5 times as long as base VI, flagellar hairs about as long as b.d.III; u.r.s. a little shorter than h.t.2 with 8 secondary hairs. Abdominal tergum usually with small pigmented sclerites at bases of hairs; postsiphuncular sclerite present antesiphuncular sclerites present, longest hair on anterior tocgites about 1.5 times as long as b.d.III. Siphunculi subcylindrical times 1.5 b.d.III pigmented, distinctly reticulated on distal 0.2-0.4 portion. Cauda pale, elongated, gradually tapering distally, about half as long as siphunculi and bearing 20-30 hairs.

Host plants : *Alewrites moluccana, Artemesia* sp., *Carthamns tinctorius, Emilia sonchifolia, Gynura* sp. *Lactuca runcinata, Lactuca* sp., *Launacea* sp. *Rhododendron* sp. *Sonchus arvensis, Sonchus asper, Sonehus brachyatus, Sonchus oleraceus, Sonchus* spp., *Tricholepis elongata,*

Symptom and Damage : Both the nymphs and adults of this reddish brown aphid species infest on the apical shoots of the host plats. When infestation is severe, clusters of nymphs and adults may be seen covering whole plant. In case of severe infestation yield of aphid infested crops is reduced by 25-35%

Life cycle : Sexual reproduction is not known in India. The aphid reproduces parthenogenehically throughout the year. Each viviparous female gives birth to more than 50 young ones. Nymphal stage includes four instars. Nymphal period is 9 days and total adult life span is 15 days. The life cycle is completed is about 7-30 days.

Natural enemy complex :

Predator : *Menochilus sexmaculatus* (Fabricius) [Coccinellidae : Coleoptera], *Betasyrphus isaaci* (Bhatia) [Syrphidae : Diptera], *B. serarius* (Wiedmann) [Do], *Coccinella transversalis* Fabricins [Coccinellidae : Coleoptera]

Pathogen : Cardamom masaic or Katte disease ; Pumpkin mosaic, sonchus yellow vein mosaic ; Papaya mosaic.

Distribution : India : all over.

Elsewhere : Africa; Australia; Egypt; Europe; South America.

Management : As in *U compositae*

Subfamily DREPANOSIPHINAE

Genus 21. ***Chromaphis*** **Walker**

1870. *Chromaphis* Walker, *Zoologist,* **2**(5) : 2001.

Type species : *Lachnus juglandicola* Kaltenbach

Diagnosis : Head smooth, frons with median protuberance; frontal hairs mostly pointed at apices. Antennae 6-segmented, about half as long as body; p.t. shorter than base VI; eyes with ocular tubercles, pronotum with 2 pairs of spinal hairs besides anterior lateral or posterior lateral hairs; 8th tergite with 8-18 hairs. Siphunculi conical, truncate, flanged, with 2-3 hairs of 6th tergite appended to the base. Cauda with a distinct knob, with many hairs. Subanal plate slightly indented. Rudimentary gonaposphyses 2; first tarsal segments with 5 ventral or 2 dorsal hairs; empodial hairs flattened.

39. ***Chromaphis juglandicola*** (Kaltenbach) **Walnut aphid**

1843. *Lachnus juglandicola* Kaltenbach, *Monog. Fam. Pflanzenlause,* Aachen : 151.

1870. *Chromaphis juglandicola;* Walker, *Zoologist,* **5** : 2000.

1990. *Chromaphis juglandicola* : Ghosh, A.K. and Quednau, Fauna of India : Aphidoidea, pt.5, subfamily Drepanosiphinae, Zoological Survey of India : 51.

Diagnosis (Alata) : Body ellptical with frontal tubercle weekly developed. Epicranial suture absent. Dorsal body hairs 1.5-2.0 times as long as the b.d.III. Abdominal segment III 0.33-0.40 mm long as a.s.VI 0.18-0.20 mm long. Hind tibiac with longest hairs 2-2.5 times as long as apical width of tibia. Siphunculi pale, smooth, short, flangeless, with 2-3 hairs appended. Cauda knobbed, spinulose, with 11-12 hairs. Subanal plate weakly indented. First tarsal segments with 5 ventral and 2 dorsal hairs; tarsi spinulose; empodial hairs flattened. Wing venation normal.

Host plants : *Juglans regia.*

Symptoms and Damage : Both nymphs and adults infest the under surface of the leaves of host plant (*Juglans regia)* during May-October and when the infestation is heavy these aphids can cause damage to foliage and young fruits under Indian conditions.

Life cycle : These aphids usually feed on *Juglans* and lead autoecious life. In Indian conditions the species has been noted during May-June and again in October. The species usually reproduces parthenogenetically and sexuales are yet to be known in India.

Distribution : India : Jammu & Kashmir, Uttar Pradesh, Himachal Pradesh.

Elsewhere : Pakistan, Central Asia; Middle East; North America.

Genus 22. ***Therioaphis*** Walkar

1870. *Therioaphis* Walker, *Zoologist* (2)1 : 1999.
Type species : *Aphis ononidis* Kaltenbach

Diagnosis : Body elongate oval. Frons flat or slightly convex in the middle and with a dark transverse band as ventral side ; frontal hairs arranged in two pairs. Dorsal cephalic hairs arise from tuberculate bases. antennae 6-segmented, usually shorter, rarely as long as or longer than body; flagellum with spinulose imbrications ; secondary rhinaria transversely oval, non ciliated, restricted to a.s.III; p.t. subequal to or slightly longer than base VI. Eyes with ocular tubercles. u.r.s. usually shorter than h.t.2. Hairs on abdominal dorsum blunt or capitate; spinal hairs on 5th and 7th tergites laterally displaced; 8th tergite with 2-6 hairs. Siphunculi mostly truncate without distinct flange nor hair appended to base. Cauda constricted and with an elongate apical knob. Subanal plate deeply bilobed. Legs with forecoxae greatly enlarged; first tarsal segments with 5-6 ventral and 2 dorsal hairs.

40. ***Therioaphis trifolii*** (Monell)
Alfalfa Aphid
(Figs. 268-269)

1882. *Callipterus trifolii* Monell, *Can.Ent.*, **14** : 14.

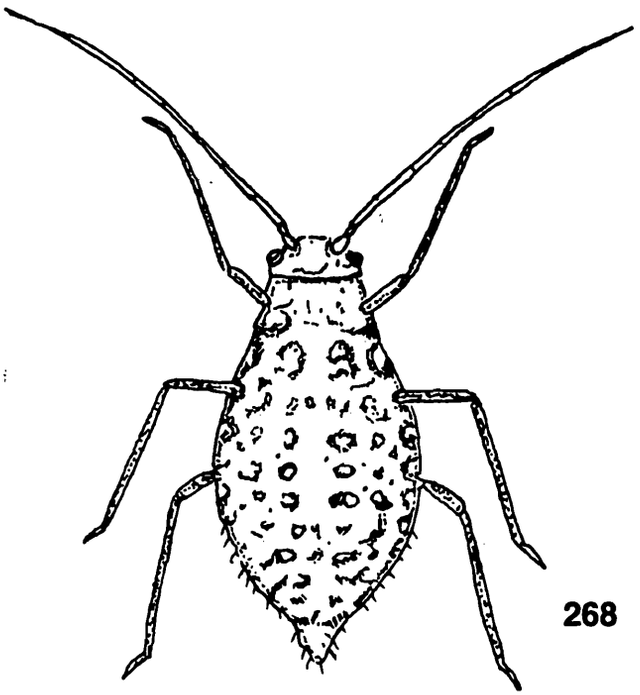
1918. *Callipterus trifolii* Das, B. *Mem. Indian Mus.*, **6** : 244.

1990. *Therioaphis trifolii* (Monell) : Ghosh, A.K. and Quednau, *Fauna of India* Homoplera : Aphidoidea, pt. 5, Subfam. Drepanosiphinae, Zool. Surv. India : 254.

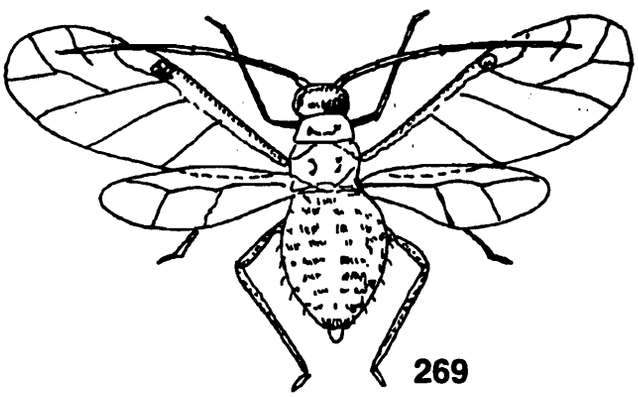
Diagnosis (Aptera) : Body stout, elongate oval. Frontal tubercles ill-developed. Discal hairs stout, on low elevations, shorter than b.d.III. Antennae 6-segmented, slightly shorter than body; a.s.III with 6-17 oval secondary rhinaria ; flagellar hairs short, less than half as long as b.d.III; p.t. about as long as or slightly longer than base VI. Rostrum reaches midcoxae, u.r.s. about half as long as h.t.2, bearing 4 accessory hairs. Abdomen on each tergite with one pair of marginal and 1-2 pairs of spinal and pleural brown sclerites. Dorsal hairs blunt or expanded at apices. Legs with fore coxae greatly enlarged; tibiae spinulose apically, first tarsal segments with 2 dorsal and 5-6 ventral hairs; cauda with elongate knob, spinulose, bearing two very long fine apical hairs besides a few shorter hairs. Subannal plate spinulose, bilobed. Wings with pterostigma bordered and with a black spot at its base.

Host plants : *Cyperus rotundus, Medicago lupulina, Medicago sativa, Trifolium alexandrium, Trifoliup* sp.

Symptom and Damage : Damage results from both nymphs and adults sucking sap from the leaves and stems of the host plants. The first evidence is seen as whitening of the leaf veins; curling, stunting, and yellowing and under heavy infestation, the plant will die. Also, excretion of copious quantities of honey dew by the aphid pest serves as the medium for the development of sooty fungus which causes complications in harvesting procedures and thereby production of good quality of hay is lowered.



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Figs. 268-269. *Therioaphis trifolii* (Monell) : 268. Apterous viviparous female; 269. Alate viviparous female.

Life cycle : The aphid reproduces parthenogenetically throughout the year. Each female may produce nearly 150 nymphs. The nymphs pass through four instars and mature in 1-2 weeks when temperatures are high and in 3-4 weeks when cool weather prevails. There may be 20 or more generations in a year. Sexual forms are unknown.

Natural-enemy-complex : *Parasites* : *Lipolexis gracilis, Trioxys* sp.

Predators : *Coccinella transversalis* sp., *C. septempunctata*

Distribution : India : Karnataka, Maharashtra.

Elsewhere : North and South America; Europe; Middle East ; Caucasus; Central Asia; China; Africa; Egypt; Austria; West Siberia.

Remarks : This aphid is a serious pest of alfalfa in several localities. It occurs in the entire lucerne growing belt of India. The aphid species is usually found singly or in a small group on the lower surface of the leaves of the host plants and jumps off when disturbed. It is not attended by ants but is actively predated by the coccinellid beetles during May to January in the lucerne group areas of India. Though the species is reported to remain active from the month of November to middle of April, it's peak actively is in the month of January.

Management : Coccinellid beetles, syrphid fly larvae, lacewing larvae, *Geocoris* bugs, minute pirate bugs (*Orius* sp.) damsel bugs, parasitic wasps, and fungus diseases often keep populations of this aphid in check.

At times it will be feasible to apply insecticides to check a rapid increase in aphid populations. Treatment in seedling plantings, parathion, malathion, diazinon, trithion, demeton and phosdrin are effective control chemicals. Phorate may give protection when used as a seed treatment.

Genus 23. ***Tinocalloides*** Basu

1969. *Tinocalloides* Basu, *Oriental Ins.*, **3** : 367.

Type species : *Tinocalloides montanus* Basu.

Diagnosis : Body elongated. Head with ill-developed frontal tubercles ; dorsal caphalic hairs fine, shorter than b.d.III. Antennae shorter than body, 6-segmented; secondary rhinaria narrowly oval, restricted to a.s.III; flagellar hairs fine, less than half as long as b.d.III; p.t. subequal to base of a.s.VI. Eyes with ocular tubereles. U.r.s. shorter than h.t.2, with 4 accessory hairs. Abdominal dorsum with segmentally separated spinopleural sclerites on 1st-7th tergites ; spinal hairs on 7th and 8th tergites longer than others. 8th tergite with 4-6 longer hairs. Siphunculi with a hair appended to apical part. Cauda short, constricted. Subanal plate bilobed. First tarsal segments with 5 ventral as 2 dorsal hairs ; empodial hairs flattened at apices. Wing venation normal. Wax pores present on appendages; front coxae somewhat elongate.

41. ***Tinocalloides montanus*** Basu

1969. *Tinocalloides* Basu, A. N., *Oriental Ins.*, **3** : 367.

1970. *Tuberodefectus eastopi* Kumar and Lavigne, *Pan Pacif. Ent.*, **46** : 120-124.

1990. *Tinocalloides montanus* Basu : Ghosh, A.K. and Quednau, Fauna of India : Aphidoidea, pt. V, Subfamily Drepanosiphinae, Zoological Survey of India : 287.

Diagnosis (Alata) : Body elongate oval. Head pale brown, scabrous; anterior discal hairs on a pair of very low elevations. Antennae 6-segmented, flagellum distinctly imbricated, flagellar hairs with acute apices, less than half as long as b.d.III, a.s.III. with 12-24 transversely oval to narrow elliptical secondary rhinaria; u.r.s. elongate, rather triangular, shorter than h.t.2, bearing 4-6 accessory hairs. Abdominal dorsum pale, dorsal hairs acute, usually as long as dorsal cephalic hairs; 8th tergite with 2-6 hairs being twice as long b.d.III. Siphunculi dark brown, truncated with a hair appended latero-subapically. Cauda short, knobbed, bearing 11-17 long hairs, subanal plate bilobed. legs with apices of tibia or tarsi dusky, apices of tibia spinulose; first tarsal segments with 5 ventral and 2 dorsal hairs; empodial hairs flattened. Fore wing with raidal sector curved and media twice-branched.

Host Plants : *Prunus cerasus, Prunus persica, Prunus* sp., *Prunus nepalensis, Prunus pudum.*

Symptoms and Damage : Both nymphs and adults feed near mid ribs of the leaves forming dense colonies. These are often visited by ants. The species is restricted to the plants of the genus *Prunus.*

Life cycle : Basu (1969) while describing the species from Kalimpong Hills in West Bengal mentioned that migration of alate viviparons females occurs towards mid November and that sexuales are produced on *Prunus*. The species leads an antoecious holocyclic life on *Prunus* in the temperate hill region of Northwest and Eastern India. Details of biology remain unknown.

Distribution : India : Arunachal Pradesh, Manipur, Meghalaya, West Bengal, Sikkim, N.W. Himalaya.

Management : Spray 500 ml. of malathion 50 EC or methyl demeton 25EC or 200 ml. of phosphamidon 85 wsc in 500 litres of water per ha.

Subfamily GREENIDEINAE

Genus 24. ***Schoutedenia*** Rubsaamen

1905. *Schoutedenia* Rubsaamen, *Marcellia,* **4** : 19.

Type species : *Schoutedenia ralumensis* Rubsaamen, 1905

42. ***Schoutedenia emblica*** (Patel and Kulkarni)

1952. *Cerciaphis emblica* Patel and Kulkarni, *Curr. Sci.,* **21**: 350.

1990. *Schoutedenia emblica* : Remaudiere, G. *Bull. Soc. ent. Fr.,* **94** : 9.

2000. *Schoutedenia emblica* : Ghosh, L. K. and Basu, R.C. *In* : *Fauna of Tripura, State Fauna Series,* **7**(Part-2) : 364.

Diagnosis (Aptera) : Head without frontal tubercle; dorsal cephalic hairs short, with blunt apices. Antennae 5-segmented about half as long as body; flagellum imbricated, a.s.III occasionally with a few small round secondary rhinaria; p.t. 0.4-0.7 times as long as base of last antennal segment. Rostrum reaches upto 2nd coxae, u.r.s. 0.7-0.8 times as long as h.t. Abdominal dorsum pale, eith non-spinular polygons, dorsal hairs sparse, short and with blunt apices; 7th tergite with a pair of pleurally placed finger-like processi with spinular imbrications. Siphunculi conical, broadest at base as a ring—like apex, with 3-4 short spinular interconnecting striae. Cauda oval, with 2 long and fine hairs. Femora or distal half with spinular imbrications; distal $^1/_3$rd region of tibiae also with imbrications; first tarsal segments with 3 hairs.

Host plants : *Phyllanthus emblica*

Biology : The aphid infests *phyllanthus emblica* in its range of distribution (eastern, western and southern India) and Nepal. Sexual forms were collected in antumn in southern India. This suggests that the species of aphid might be holocyclic at least in part of its range of distribution.

Distribution : India : Andhra Pradesh, Maharashtra, Meghalaya, Tamil Nadu, Tripura, West Bengal.

Elsewhere : Nepal.

Management : As in *Greenidea* (G.) *artocarpi*

Genus 25. ***Greenidea*** Schouteden

1905. *Greenidea* Schouteden, *Spolia Zeylan.*, **2** : 181.

Type species : *Schoutedenia artocarpi* Westwood.

Diagnosis : Body pear-shaped. Frons straight. Head smooth. Dorsal cephalic hairs long with acuminate apices. Antennae 6-segmented, shorter to longer than body; flagellum usually imbricated, flagellar hairs short and long, stiff or fine; apterae without secondary rhinarium; dorsum of abdomem pale, brown to dark brown, spinules usually present anteriorly, dorsal hairs variable in lengths and apices, stiff. Siphunculi usually cylindrical, elongated, covered with many long and short hairs with acuminate or branched apices, reticulated pattern of transversely hexagonal cells either on both surfaces or only one surface restricted near the base or extending faintly beyond excepting the apical portion which is covered with transverse rows of spinules. Cauda broadly rounded with a median stylus. Subanal plate broadly oval to semicircular; first tarsal joints with 7 ventral hairs.

43. ***Greenidea (Greenidea) artocarpi*** (Westwood)

1890. *Siphonophora artocarpi* Westwood, *Trans. Ent. Soc. Lord.*, pt 4 : 649.

1927. *Greenidea artocarpi* : George, *Proc. Asiat. Soc. Bengal,* **23** : 7.

1993. *Greenidea (Greenidea) artocarpi* (Westwood) : Ghosh, A.K. and Agarwala, *Fauna of India* : Aphidoidea, pt. 6. Subfamily Greenideinae : 176.

Diagnosis (Aptera) : Body elongated. Head flat and brown. Antennae 6- segmented; flagellum imbricated, flagellar hairs large, thick, with branched apices, longest hair on a.s.III a little over 2.5 times as long as b.d.III, p.t. 2.3-2.5 times as long as base VI. U.r.s. 1.7-2.0 times as long as h.t.2. Abdominal dorsum sclerotised, dorsal hairs irregularly placed, thick and shift, with branched apices, longest on anterior tergites about 3 times as long as b.d.III. 8th tergite with 2 finer and thinner hairs with acute apices. Siphunculi blackish brown, about half as long as body, with many hairs, the hairs near the base mostly furcated, those on distal half mostly with acute apices, spinuled in transverse rows. Cauda with a median process with about 8 hairs. Femora sparsely imbricated, more strongly towards the apex, tibiae striate.

Host Plants : *Artocarpus communis, A. heterophyllus, A. integrifolia, A. vulgaris*

Symptom and Damage : Both nymphs and adults suck the sap from tender shoots and leaves of host plant. The affected parts turn yellow and ultimately they get dried. The aphids secrete honey dew on which sooty mould develop which in turn hampers the photosynthesis of the plant due to which plant growth is arrested and yield becomes low.

Biology : The brownish aphids live on the under surface of tender leaves of the host plants. The pest species mainly reproduces anholocyclically particularly in the north east India as also elsewhere in this region. No sexual morph of this species is known from India although sexuales of some other species of the genus are on record (Ghosh, A. K. 1987)

Distribution : India : Meghalaya, South India.

Elsewhere : China; Sri Lanka.

Management : Spraying 0.03% dimethoate, phosphamidon or monocrotophes is effective.

Subfamily HORMAPHIDINAE

Genus 26. ***Cerataphis*** Lichtenstin

1882. *Cerataphis* Lichtenstin, *Annls. Soc. ent. Fr.* **(6)** : 2.

Type species : *Coccus lataniae* Boisduval

Diagnosis : Apterae aleurodiform. Body in apterae crenulated with single row of wax glands on the margin upto 7th tergite; frons with a pair of pointed horns. Alatae without crenulations or horns. Eyes in apterae of 3 facets, normal in alatae. Antennae 5-segmented sometimes 4-segmented in apterae, hardly one third the length of the body; secondary rhinaria rounded, finely ciliated; p.t. very short. U.r.s. without accessory hair. Dorsum in apterae often dark and rugulose. Abdomen with only 6 pairs of spiracles, those on 1st being absent. 8th abdominal tergite with 4-10 hairs. Siphunculi ring-like surrounded by a few hairs. Cauda slightly constricted at base with 4-17 hairs. Subanal plate bilobed. Subgenital plate with 6-8 hairs on anterior half and 12-14 hairs on posterior margin; dorsapical hairs on second tarsal segments on ampodial hairs long, funnel-shaped at apices.

44. ***Cerataphis palmae*** (Ghesquiere)

1934. *Aleurocanthus palmae* Ghesquiere, *Ann.de Geonbloux* **40** : 34.

1953. *Cerataphis variabilis* Hille Ris Lambers, *Agric. J. Fiji,* **24** : 3.

1988. *Cerataphis palmae* (Ghesquiere) : Ghosh, A.K., Fauna of India and the Adjacent countries, Homoptera, pt. 4, Subfamilies phloemyzinae, Anoeciinae and Hormaphidinae : 294.

Diagnosis (Aptera) : Body ovoid, dorsoventrally flattened with crenulate margin, head and thorax often fused. Head with a pair of anteriorly directed pointed horns being at least twice as long as a.s.II, venter of head with a pair of thick dagger-shaped spine-like hairs; Cephalothorax as also abdomen with crenulate margins formed of distinct wax gland cells. Antennae 4-5 segmented, p.t. 0.4-0.5 times as long as base of last antennal segment. U.r.s. 0.7-0.8 times as long as h.t.2 with 4 preapical hairs. Abdominal segments 1st-7th fused and free of 8th segment; dorsum with scattered wax pores and entire margin crenulated; 8th tergite with 14-16 round to oval wax gland cells. Siphunculi in elevated cones encircled by 3-6 hairs. Cauda with 4-6 hairs. Subanal plate indented; first tarsal segment with 4,3,2 hairs.

Host plants : *Areca catechu* in West Bengal and South India; *Calamus rotang* and *Cocos nucifera* in South India.

Symptom and damage : Both the nymphs and adults infest the lower surface of fronds of *Cocos nucifera* and in severe infestation, leaves become pale and black spots appear on the infested leaves.

Biology : The aphid infests stem of terminal shoot of *Calamus rotang* throughout the year and sometimes in large numbers and alates are produced in June and July (David 1958) ; on *Cocos nucifera* it infests in February and again in September (David op.cit) ; on *Areca catechu,* the species infests in large number the inflorescence, pathae and pinniae during May-June (Ghosh, A.K. 1988). Apparently the aphid reproduces parthenogenetically in the Indian conditions since no sexual form of it is known. Occasionally it is attended by ants.

Distribution : India : Karnataka, Kerala, Tamil Nadu, West Bengal;

Elsewhere : Sri Lanka; Thailand; Malayasia; Papua; Solomon Island; Fiji; Tropical Africa; British Guinea; Colombia; Dominica; Pucrto Rico; Jamaica; Trinidad.

Genus 27. ***Ceratovacuna*** Zehntner

1897. *Ceratovacuna* Zehntner, *Archif. Java Suikerindust.,* **5** : 553.

Type species : *Ceratovacuna lanigera* Zehntner

Diagnosis : Body rather oval. Head fused with prothorax in apterae and bears a pair of frontal horns being distinct in apterae but reduced in alatae. Antennae 4-5 segmented in apterae, always 5-segmented in alatae; p.t. never more than half as long as base of last segment. Eyes of 3 facets in apterae. U.r.s. shorter than h.t.2, without any accessory hairs. Abdominal dorsum pale but often sclerotic in areas of wax gland cell groups; 8th tergite with a spinopleural wax gland cell groups; abdominal dorsum in alatae with variable spinopleural sclerotic bands, specially on postsiphuncular region. Siphunculi poriform. Cauda restricted at base, with fine hairs. Subanal plate bilobed. F.T.C. 4 : 3 : 2 or 3 : 2 : 2. Dorsoapical hairs on second tarsal segments expanded at apices.

45. ***Ceratovacuna lanigera*** Zehntner

1897. *Ceratovacuna lanigera* Zehntner, *Meded. Profeslex java (N.S.),* **33** : 29.

1912. *Oregma lanigera* : van der Goot, *Overgedrukt uit. het.* Tijd. *v. Ent.,* ***L.V.*** : 321.

1931. *Ceratovacuna lanigera* : Takaharshi, *Aphididae of Formosa,* **6** : 95.

1988. *Ceratovcuna lanigera* : Ghosh, A.K. *Fauna of India, Hornoptera* : *Aphidoidea* pt. **4,** Zoological Survey of India : 315.

Diagnosis : Body oval. Head on prothorax fused; dorsal caphalic hairs fine, acute at apices, longer than frontal horns which are acute, divergent, bearing 6-10 very short hairs upto 0.08 mm long. Antennae 4-5 segmented, pale brown with apical segments darker; flagellum gradually more distinctly inbricated, flagellar hairs sparse, longest hair 0.9-1.4 times as long as b.d.III; p.t. about half as long as base of last antennal segment; u.r.s. about half as long as h.t.2. Dorsum of abdomen pale, bearing fine irregular sculpturing, dorsal hairs 1.0-1.8 times as long as b.d.III; 7th and 8th tergites each with 7 spinal hairs. Wax glands may be present laterally on meso on metanotum and almost always present on 1st-7th tergites; 8th tergite with a median wax gland on pale brown spino pleural area. Siphunculi on slightly elevated cones. Cauda transversely oval, bearing 11-12 hairs. Subanal plate bilobed. First tarsal segments with 4 : 3 : 2 or 3 : 3 : 2 hairs, dorsoapical hairs on second tarsal segments expended apically.

Host plants : *Bambusa aurandinacea* : *Bambusa* spp., *Grassam* sp., *Ophismenus* sp., *Saccharum officinarum*; *Themeda vitosa* sp.; *Xylosma longifolia ;* indet. plants of Combritaceae; indet plants of Poaceae.

Symptom and Damage : The pest species has been noted to initiate infestation on the host plats from under surface on leaves around the midrib and the spread over the entire surface covered with flocculent waxy secretion. Honeydew secretion often covers the upper surface of lower leaves leading to growth of sooty molds. Both nymphs and adults infest the plants. Sometimes the aphid spread is so rapid that it invades all over the area of sugarcane plantations and it becomes a matter of serious concern to apply immediate control measures. As a result of heavy infestation of the aphid on sugarcane leaves and draining out of the cell sap, the leaves turn yellow and finally dry up due to continuous sucking of the cell sap. The aphids reproduce fast and constituted heavy colonies. It is estimated that about 20-22 nymphs are delivered by a single mature female which in trun resume to reproduction within 6 days. Upto 8000 aphids are seen on a single leaf during heavy infestation (Kulkarni and Bastawade 2003).

Diagnosis : The aphid usually reproduces asexually in the Indian conditions. It undergoes four instar to become adult. Normally apterous viviparous females are produced. Both apterous and alate viviparous females occur almost in every infestation. According to Kulkarni and Bastawade (2003) first instar larva is 0.07 mm long and

0.27–0.38 mm wide. The colour is pale yellow or pale green. The very active nymphs bear a pair of long frontal processes on head. Second instar is 1.23 mm long and 0.30–0.46 mm wide; the 3rd instar is 1.89 mm long and 0.46–1.07mm wide. Adults measure 2.01 mm long and 0.65–1.28 mm wide. The 3rd instar onwards the aphid develops white soft wooly fibrous cover on the abdomen which eventually covers entire body of the aphid and the closely placed adults appear under continuous white patches on the ventral side of the leaves of sugarcane. The infestation is found usually along the sides of the midrib.

Life cycle : The species enjoys anholocyclic life cycle throughout India. Here, it has been known to occur during the months of October-March on *Saccharum officinarum* in north eastern region and also in sugarcane growing area ofUttar Pradesh and southern region (Maharashtra). Only viviparae are known. Detailed biology of the species is yet to be studied.

Natural enemy-complex :

Predator : *Chrysoperla caryni* (Neuroptera : Chrysopidae); *Macrosyrphns confrator* (Wiedmann) [Diptera : Syrphidae]; *Conobothra (Dipha) aphidivora* (Lepidoptera).

Distribution : India : Arunachal Pradesh, Assam, Maharashtra, Manipur, Meghalaya, Sikkim, Tripura, Uttar Pradesh, West Bengal;

Elsewhere : Sri Lanka; Indonesia; Formosa; Japan; Philippines.

Remarks : The aphid though recorded from Assam, Arunachal Pradesh, Uttar Pradesh, Tripura or West Bengal, from Indian regions, was never found in Maharashtra till then. It is found to service the dry and hottest months of the year on both the apterous and alate viviparons forms in the state. Till 2002, sugarcane was supposed to be the safest crop from the insect attack though some insects were known to attack. But unfortunately, in 2002, the aphid species (*C. lanigera)* suddenly emerged out to be a serious pest as even attained the epidemic level (Kulkarni or Bastawade 2002). Incidentally, a few farmers committed suicide due to complete failure of sugarcane crop as a result of devastative attack of the aphid in the districts of Maharashtra.

Management

1. This pest breeds fast and can spread over large areas in very short time. Control measures should be adopted immediately and constant vigil is required to notice its occurrence in the field.
2. Cultivation of sugarcane be done by adopting broad ridges and double belt pattern. This helps in adopting control measures.
3. Healthy sugarcane should be used for plantation, which should be immersed in a solution of 300ml Melathion + 100L water. Infected leaves should be burnt after plantation.
4. Nitrogenous fertilizers are observed to promote infestation.

5. Infected green leaves should not be transported to healthy fields (Those are used as fodder).
6. 35 EC Endosulphon 1ml + 25 EC Metasistox 2 ml/L be sprayed
7. 35 EC Endosulphon 1ml + 75% Asifet powder (soluble) should be sprayed. 400L water is necessary for 1 Ha. Sugarcane.
8. 2% Methyl Parathion Powder 40 Kg./Ha. should be dusted using powder dusters in grown up surgarcane.
9. Chemical applications are to be repeated after 15 days.

Subfamily LACHNINAE

Genus 28. ***Nippolachnus*** Matsumnsa

1917. *Nippolachnus* Matsumura, *Coll. agric. Tohoku imp. Univ.*, **7**(6) : 382

Type species : *Nippolachnus piri* Matsumura

Diagnosis : Body broadly oval. Head with median suture, dorsal cephalic hairs long, fine, about 6 times as long as b.d.III. Eyes without ocular tubercles. Antennae 6-segmented, apterae usually with a few secondary rhinaria on a.s.III-VI, alatae with oval secondary rhinaria on a.s.III-VI, p.t. about half as long as base VI. Rostrum reaches near base of hind coxae, u.r.s. 0.6-0.8 times as long as h.t.2 and with 10-20 secondary hairs. Tergum pale, membraneous sometimes with spinoplenral bands on 8th tergite in apterae, in alatae often with spinal sclerotic pattern. Siphnnculi on pale to dark hairy cones. Cauda bears many fine hairs. Legs pigmented, long and slender, with many fine hairs. Wings hyaline, pterostigma sometimes dark.

46. ***Nippolachnus piri*** Matsumnra

1917. *Nippolachmns piri* Matsumura, *J. Coll. Agric. Tohoku Univ.*, **7** (6) : 382.

1982. *Nippolachnus piri* Malsumara; Ghosh, A.K. Fauna of India, Homoptera : sphidoidea, pt.2, subfamily Lachninae Zool. Surv. India : 118.

Diagnosis : Body elongate, pale. Head with median suture, hairs on frons and vertex long and fine, longest hair 5-6 times as long as b.d.III. Eyes without ocular tubercles. antennae 6-segmented, flagellar hairs fine, on antennal segment VI the part basad the primary rhinarium not much longer, sometimes even shorter than the part distad the primary rhinarium; the later part with several hairs besides the 4-5 terminal spines. Last rostral segment about 0.17-0.22 mm long, 0.71-0.85 times of h.t.2. Siphnnculi on hair-bearing cones. Cauda pale, bearing many fine hairs. First tarsal segments with 9-11 hairs. Legs in apterae pale, at most with the apices of the tibiae brown. Alatae with a dorsal sclerotic patch on abdomen, with simple or once, abnormally twice, furcated media in the fore wings and with 5-12 rhinaria more or less in a row on a.s.III.

Host plants : *Pyrus khasianum, Pyrus communis, Pyrus* sp. *Quercus* sp.

Natural enemy : Predator : *Chilochorus rubidus* Hope [Coccinellidae : Coleoptera]

Distribution : India : Meghalaya, West Bengal.

Elsewhere : Korea; Japan; Taiwan and Malaya.

Remarks : No Parasites has apparently been recorded for the species. No ant is found to be associated with this aphid.

Genus 29. ***Pyrolachnus*** Basu

1968. *Pyrolachnus* Basu, A.N. and Hille Ris Lambers, *Ent. Berichten,* **28** : 13.

Type species : *Lachnus pyri* Buckton, 1899

Diagnosis : Body broadly oval, with numerous hairs being considerably longer than b.d.III. Antennae also hairy, 6-segmented. Eyes with triommadia. Rostrum with subdivided rather blunt last segment. Abdominal dorsum pale with inter segmental sclerites or "Muskelplatten", occasionally with a great many scleroites. Siphunculi with pigmented ones. Wings not maculate; pterostigma much longer than its maximum width, not reaching the tip of the wing, sector radii nearly straight; media twice-branched.

47. ***Pyrolachnus pyri*** (Buckton)

1899. *Lachnus pyri* Buckton, *Indian Mus. Notes,* 4(5) : 274.

1928. *Dilachnus krishni* George, *J. Proc.Asiat. Soc. Beng.,* **23** : 7.

1957. *Lachnus krishni,* David, *Indian J. Ent.,* **19**: 171.

1968. *Pyrolachnus pyri,* Basu, A.N. and Hille Ris Lambers, *Ent. Ber. amst.,* **28** : 13.

1982. *Pyrolachnus pyri,* Ghosh, A.K. *Fauna of India,* Aphidoidea, pt. 2, Subfam Lachninae, Zool. Surv. India : 131.

Diagnosis (Aptera) : Body large (4-5 mm). Head brown sclerotic with median suture, with many fine hairs on frons and vertex. Antennae 6-segmented, pale brown, darker on a.s.V and VI, flagellum rather smooth, a.s.III with 0-3 secondary rhinaria, IV with 3-7 similar rhinaria, flagellar hairs with acute apices, p.t. about half as long as base VI. Rostrum reaches siphunculi, u.r.s. bearing about 10 secondary hairs and about half as long as h.t.2. Dorsum of abdomen with some scattered dark brown 'muskelplatten' besides broad sclerotic spiracular plates, dorsal hairs with acute apices, longest hair being 1.5-2.0 times as long as b.d.III. Siphunculi on dark sclerotic cones. Cauda dark, sclerotic, with many fine hairs. Legs darker on basal segments and apices of tibiae and tarsi, rest yellowish, hind tibia much longer than the others. Wings not maculate, pterostigma of forewing not reaching tip of wings, radial sector rather straight, media twice-branched.

Host plants : *Pyrus communis, Pyrus* spp.

Symptom and damage : The aphid infests stem and young shoots and in some infestation could be heavy as recorded in South India (David 1957) where this species has also been seen to infest apple trees in the months of April-May. In eastern states of India, it appears in some localities during February-May, on the stem of pear trees but the infestation never becomes heavy,

Biology : Not known.

Natural enemy-complex : Parasitised apterae have been noted sporadically in Meghalaya region.

Distribution : India : Meghalaya (Shillong), Tamil Nadu (Nilgiri Hills), West Bengal (Darjeeling district).

Elsewhere : Sri Lanka.

Subfamily PEMPHIGINAE

Genus 30. ***Eriosoma*** Leach

1818. *Eriosoma* Leach, W.E., *Trans. Hort. Soc. Lord.,* **3** : 60.

Type species : *Eriosoma mali* Leach = *Aphis lanigera* Hausmann.

Diagnosis : Head smooth, with or without wax glands, facets surrounding a central space, antennae in apterous exules 5-segmented, as long as the body, in alatae 6-segmented, secondary rhinaria absent in apterae, annular in alatae, primary rhinaria ciliated; hairs on flagellum inconspicuous, upto 0.050 mm long; p.t. shorter than base of last antennal segment. Eyes in apterae of three ommatidia, large in alatae. u.r.s. nearly equal to 1.5 times as long as second segment of hind tarsus and bearing 8–16 accessory hairs. Thorax with segmental wax gland groups in apterae. Abdominal dorsum pale, membraneous in apterae, bearing paired, segmental, spinal and marginal wax gland groups; in alatae, dorsum may be dark, sclerotic and without wax glands; cephalic, thoracic, and abdominal wax gland groups, without any hairs; 8th tergite with 6–8 hairs. Siphunculi present as mere ring or on slightly elevated base, bearing a few hairs. Cauda rounded, usually bearing 2–4 hairs. Subanal plate rounded. Empodial hairs about as long as the tarsal claws. Wing veins often dark, media of the forewing once-branched, hind wing with both obliques. F.T.C. 3 : 3 : 3.

48. ***Eriosoma lanigerum*** (Hausmann)
(Figs. 270–276)

1802. *Aphis lanigerum* Hausmann, J.F.L., *Illigers Mng. Insekt.,* **4**(3-4) : 440.

1818. *Eriosoma lanigerum,* Becker, Geo, G., *Bull. Univ. Arkan. Agr. Exp. Stn.,* **154** : 3.

1831. *Myzoxylus mali* Blot, F., *Mem. Soc. R. Agric. Com. Can.,* **3** : 332.

1909 *Schizoneura lanigerum, Lefroy,* H.M., Indian Insect Life, 748 pp.

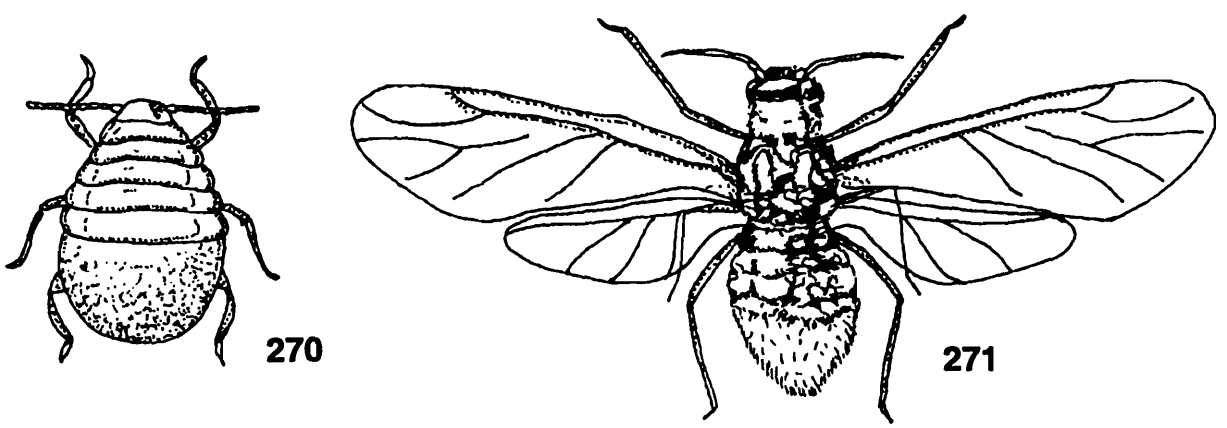
1943 *Eriosoma lanigerum,* Fotedar, and Kapur, *Curr. Sci.,* **12** : 84.

1953 *Eriosoma lanigerum,* Cottier, W., *Bull. N. Z. Dep. Scient. Ind. Res.* 106-332.

1984. *Eriosoma lanigerum,* Ghosh, A.K. *Fauna of India, Homoptera* : *Aphidoidea,* Subfamily Pemphiginae, Zoological survey of India, Calcutta : 25.

Apterous viviparous female (Fig. 270) : Body about 2mm long, dusky, reddish brown covered with white flocuous secretion. Head with 6-10 dorsal wax plates, with a clear central space surrounded by 6-10 cells. Antennae (Fig. 273) pale yellow, 6-segmented, 0.21–0.24 times as long as the body; flagellum with fine spinulose striae; segment III much longer than IV + V taken together. flagellar hairs sparse, on segment III 0.006-0.01 mm. long, 0.37-0.40 times b.d.III; p.t. 0.35-0.40 times a s long as base of antennal segment VI. Rostrum reaches mid-coxae; u.r.s. (Fig. 274) 1.40-1.56∞ ht 2 and bears 7-10 accessory hairs. Thoracic tergum with 4 wax plates on each of the segments. Abdominal dorsum (Fig. 275) pale, bearing 4 wax plates (2 spinal and marginal) on each of 1st-7th tergites ; 8th tergite with 2 small spinal wax plates; hairs on abdominal dorsum fine, 0.02-0.03 mm. long. 0.62-1.2 times as long as 6.d.III. Siphunculi present as mere pore, surrounded by a few hairs. Cauda small, semilunar, with 2 hairs. Subanal plate with 32-34 hairs. Subgenital plate with 16-21 hairs. Legs pale brown; hairs on femora and tibiae fine, longest one on hind tibiae 0.7-0.8∞ as long as the diameter at the middle of the tibiae ; first tarsal segments with 3, 3, 3 hairs.

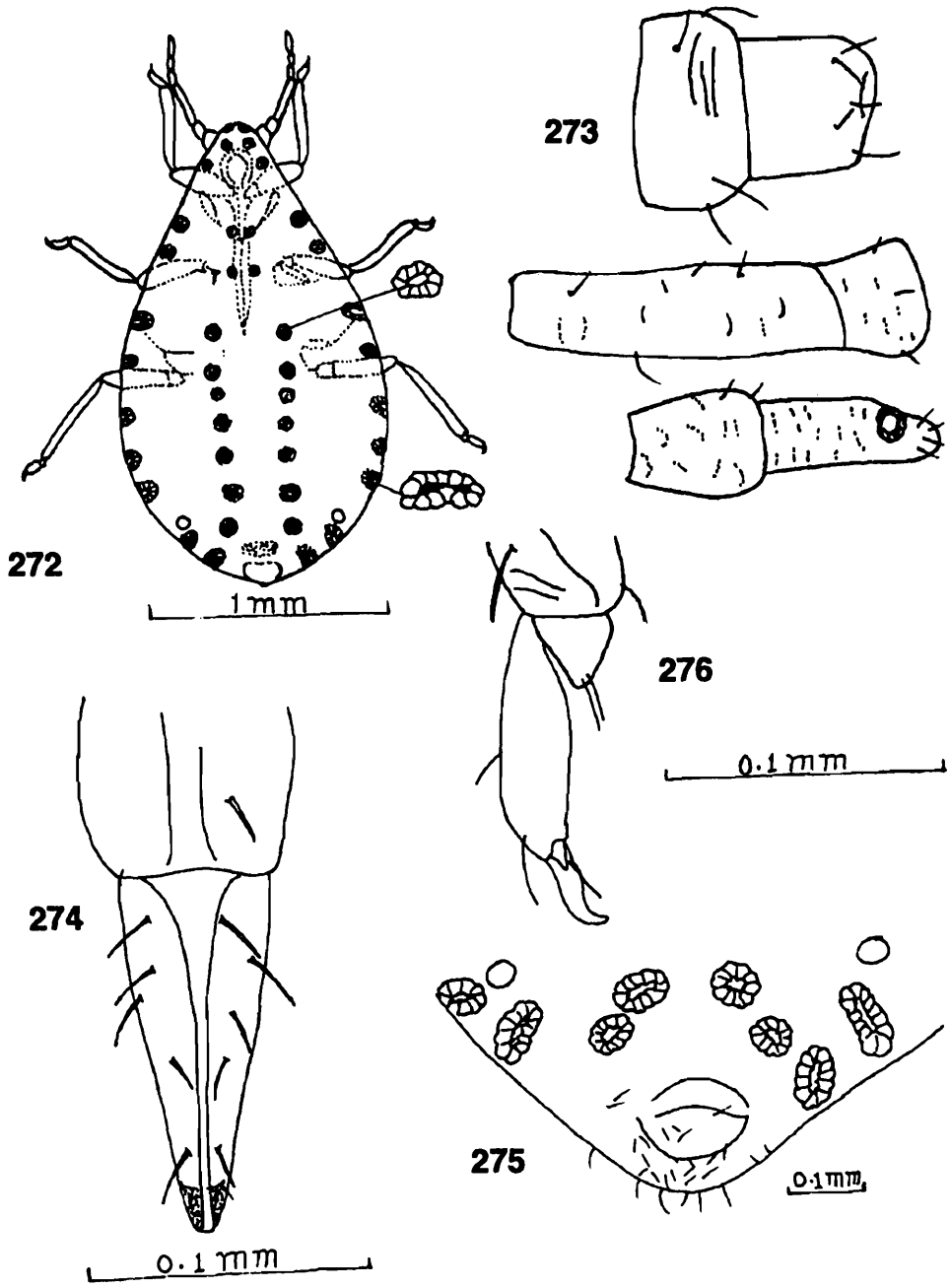
Alate viviparous female (Fig. 271) : Body elongate (measuring about 1.7 mm). Head flat, smooth; dorsal cephalic hairs minute. Antennae 6-segmented, 0.40 times as long as the body; a.s. III longer than IV + V + VI taken together and with 19-20 linear secondary rhinaria; a.s. IV with 4-6, V with and basal part of VI with a single secondary rhinarium; base of segment III imbricated, rest of the flagellum with fine spinulose imbrications; flagellar hairs fine, on segment III, 0.33-0.83 times as long



Figs. 270-271. *Eriosoma lanigerum* (Hausmann) : 270. Apterous viviparous female; 271. Alate viviparous female.

as b.d. III; p.t. about 0.28 times as long as base VI. Rostrum reaches mid coxae; u.r.s. 1.3-1.4 times as long as h.t.2 and bears about 10 accessory hairs. Abdominal dorsum with paired marginal wax plates on 1st–8th tergites.

Biology : It originally, a heteroecious one had a cycle involving alternation between Elm trees and Apples and also other Rosaceae ; but the heteroecious holocycle is now only known to exist in North America where, along with *Eriosoma americanum* (Riley), *E. craetegi* (Oestland), and *E. rileyi* (Thomas), it is known to feed on *Ulmus americana* during April to July and on *Pyrus malus* between June and October. In



Figs. 272-276. *Eriosoma lanigerum* (Hausmann) : 272. Apterous viviparous female; 273. Antenna; 274. Ultimate rostral segment; 275. Posterior abdominal dorsum (portion) showing wax glands; 276. Hind tarsus.

most other parts of the World, where the species is now distributed, it remains confined to a monoecious cycle (holocycle or anholocycle) on *Pyrus malus*. Described by Husmann (1802), the species was found well settled in India as far back as in 1891 and is now widely known as major apple-pest in all Apple growing areas in the North and in the southern part. Fotedar and Kapur (1943) described in brief about its life cycle in Kashmir. According to them, apterae on apple, produces alate forms in May-July which disappear after July and sexuparous alatae return to the host plant during August-November in large number and produce arostrate gamic forms. The female ovoidy light brown, lays egg (0.32 mm long) near the crown of the root of the apple tree. Fotedar and Kapur (*op. cit.*) who described its life cycle in Kashmir for the first time mentioned that sexupara lay. 4-7 nymphs during October-November during a span of 6 days, which turn into male and ovipara; each of these moults 4 times. Male is short-lived (about 12 days) and the ovipara survives for about 20 days. The ovipara dies shortly after laying a single egg.

Host plants : *Cestrum nocturnum, Cotoneaster* sp. *Malus* sp., *Pyrus buccata, Pyrus communis, Pyrus malus, Pyrus polycarpa, Pyrus sylvestris, Pyrus* sp.

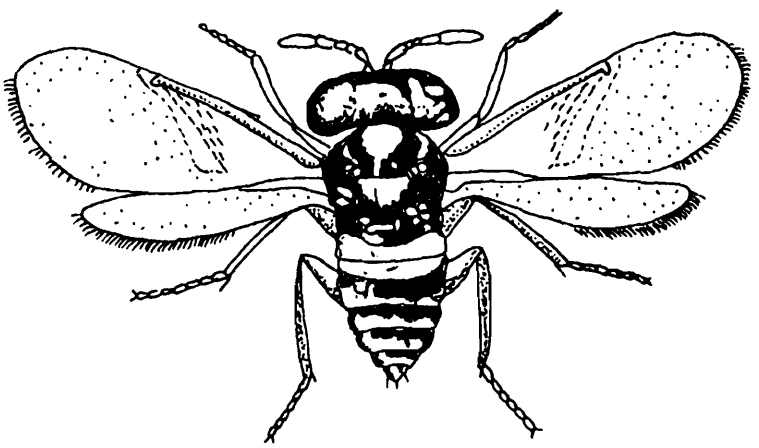
Natural enemy-complex :

Parasitoid : *Aphelinus mali* (Haldman) (Fig. 277) [Hymenoptera : Aphelinidae]-most effective parasitoid.

Predators : *Adalia tetraspilota* (Hope), *Adonia variegata,* Mulsant, *Ballia eucharis, Chiloconis brijugus, Coccinella septempunctata* Linnaeus, *Exochomas uropygialis* Mulsant, *Hippodamia variegata* Goeze, *Hormonia* sp. *Oenopia conglobata* (Linnaeus), *Pharoscymus flexibilis* (Mulsant) [Coleoptera : Coccinellidae]. *Ephisyrphus balteatus* De Geer, *Metasyrphus confrater* (Wied.) [Diptera : Syrphidae]; *chrysoperla carnea* (Steph.) [Neuroptera : Chrysopidae] [*Source* : Omkar and Pervez, 2000].

Distribution : India : widely distributed.

Elsewhere : Cosmopolitan.



Figs. 277. *Aphelinus mali* (Hald.) : Effective parasite of woolly aphid.

Remarks : The woolly aphid native of Eastern USA has been recored in India in 1889 at conoor in South India (Misra 1920). Since then, it has spread to the entire apple growing areas of the country and has assumed serious dimension causing heavy damage to apple plants. The aphid sucks sap from the plant tissues causing an abnormal growth (knots) or gall-like swellings on infested parts *viz.*, twigs, branches, roots, and other parts. As a result, the growth of apple plant ceases. Some affected plants may die out. This a very destructive pest found on variety of fruit plants of the family Rosaceae in many parts of the world. It is common in N-W India and certain parts of South India. It is found on masses covered with coatings of fine cottony material. After removal of woolly covering material the aphid appears purplish in colour. Big knots or gall-like swellings appear on the affected parts. The infested plants become sickly and stunted in growth and the yield of fruit is adversely affected. Some affected plants may die out.

According to Pruthi (1969) the aphids breed asexually, each female producing about 125 young ones, which reach maturity in one or two weeks in summer but take much longer time during winter. Along with wingless viviparous female winged female are also produced during July to October; these migrate and spread to other trees. In Kashmir males are also found, though rarely, and there is sexual reproduction also.

The pest can occur in two phases or forms, the aerial and subterranean, depending on climatic condition. Some of the aerial forms migrate to the roots during mid-winter, but there is only partial migration from roots to stems during May in H.P. (Kulu valley). In Kashmir the root form is not generally met with. According to Hausmann (1902) the species was found well settled in India as far back in 1891 and is now widely known as major apple-pest in all apple growing areas in the Northeast and in the southern part. Baker (1915) has given a detailed account of biology of the woolly apple aphid. Woolly waxy deposition over the body of the aphid is often noticed on the stem of the apple tree.

Management

(i) *Bio*logical control of the aphid plays important role and it can be achieved by the release of biocontrol agent of an exotic parasite, *Aphelinus mali* (Hald.) [Hymenoptera]

(ii) To select healthy plants from nursery and then before planting in the orchard treat then with chloropyriphos or fenitrothion 0.05%.

(iii) To check the pest species during summer, spray of 500 ml of nicotine sulphate 40 Ec or 250 ml of menazon 100 EC or 800 ml of malathion 50 EC in 500 litres of water per ha. is recommended. In presence of the biocontrol agent *Aphelinus mali* (Parasite), insecticidal spray should be avoided.

Genus 31. *Geoica* Hart

1894. *Geoica* Hart, C.A., *Rep.*, III. *St. Ent.*, **18** : 101.

Type-species : *Geoica squamosa* Hart = *Pemphigus urticularius* Passerini.

Diagnosis : Body globular. Head distinctly separated from prothorax, somewhat reticulated over dorsum in apterae or wrinkled in alatae; cephalic hairs, in apterae broadened at apices Antennae usually shorter and 5-segmented in apterae and 6 segmented in alatae; flagellum faintly imbricated; apterae without secondary rhinaria, alatae with small round to oval, protruberant secondary rhinaria on segment III-VI primary and accessory rhinaria on segments V and VI strongly ciliated in apterae but non-ciliated or partly ciliated in alatae; hairs on the flagellum similar to those on dorsum of head. Eyes of 3 facets in apterae, large and normal in alatae. U.r.s. always longer than and may be upto nearly twice as long as h.t.2. Abdominal dorsum pale in apterae, with separate or confluent marginal and spinopleural sclerotic bands in alatae; 7th and 8th tergites with sclerotic bands in both apterae and alatae; hairs on the dorsum of abdomen with expanded apices. Wax glands usually absent. Spiracles large, rounded, on dark plates. Siphunculi absent. 8th abdominal segment enclosing cauda and subanal plate, in the form of an inverted horse-shoe; cauda bearing 5-20 hairs : subanal plate bearing uniformly distributed even-sized hairs. Subgenital plate with 4 hairs on anterior portion and about 16 along pesterior margin. Legs with faintly indicated trochanters; dorso-apical hairs on second tarsal segments with incrassate apices; first tarsal segment with 3,3, 3 hairs or 3, 3, 2 hairs; empodial hairs fine, short and 0.25-0.33 times as long as the claws. Media of forewing simple, cubitus and anal fused basally; hind wings with both obliques, faint and sometimes inconspicuous.

45. ***Geoica lucifuga*** (Zehntner)
(Figs. 278-283)

1898. *Tetraneura lucifuga* Zehntner, L., *Arch. Suikerind. Ned. Ind.,* **6** : 555.

1917. *Serataphis lucifuga*, van der Goot. P., *Contrib. Fauna Indes Neerl.,* **1**(3) : 262.

1921. *Geoica lucifuga,* Takahashi, *R. Agric. Exp. St. Formosa Spec. Rept.,* **20** : 96.

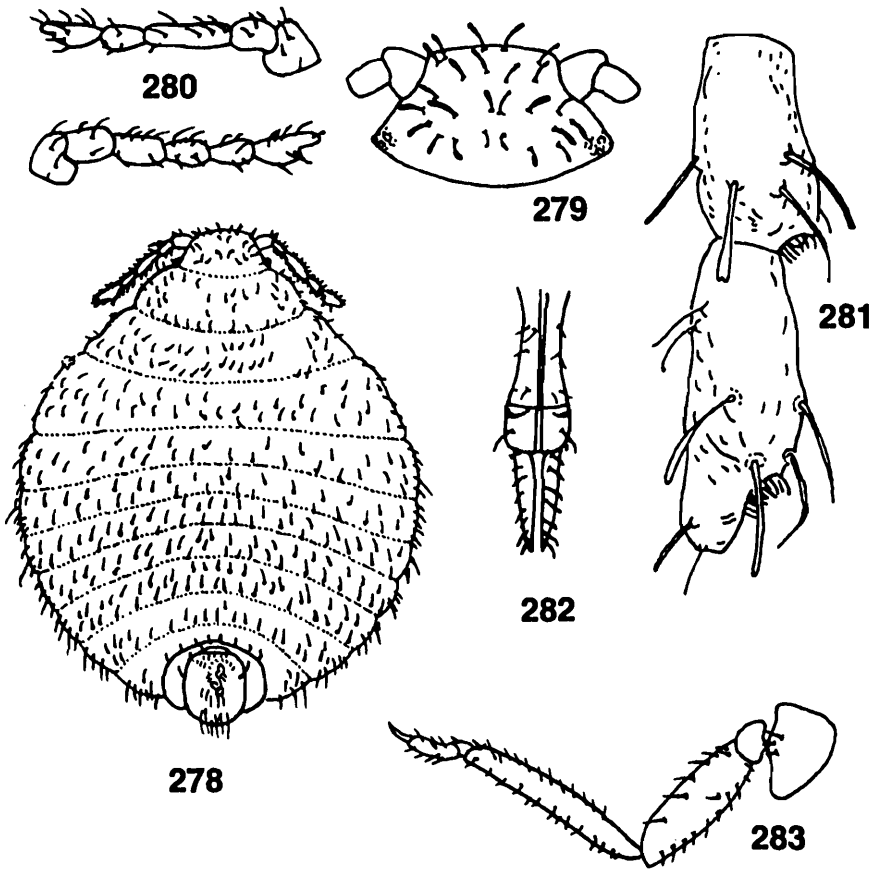
Diagnosis : (Aptera) : Body large globular (Fig. 278), brown, strongly pubescent. Head (Fig. 279) brown, without any tubercle, dorsum of head smoother in the median region, rest somewhat stippled, or reticulated; dorsal cephalic hairs conspicuous, fan-shaped. Antennae (Fig. 280) almost concolourous with the head, 5-segmented, segment I, II, IV subequal, segment III nearly twice as long as the formers; hairs on antennal segments I and II with blunt or incrassate apices, occasionally fan-shaped; hairs on the flagellum may be bent, spatulate or with acuminate apices, on antennal segment III, primary rhinaria circular, protruberant and strongly ciliated; processus terminalis (Fig. 281) usually 0.18-0.20 times as the base of last antennal segment. Eyes of 3 facets. Rostrum (Fig. 282) extends little beyond hind coxae, u.r.s. about as long as h.t.2 and bears 4-6 accessory hairs. Abdomen pale brown with a pattern of reticulation; hairs on the dorsum of abdomen mostly fan-shaped or spatulate and serrated at apices, the marginal hairs being usually considerably thinner than the spinals, 7th tergite with a number of stout hairs, 8th tergite in the form of inverted horse-shoe and usually bearing 6-8 hairs with acute to acuminate apices, these being 0.08-0.14

mm. long, 1.1-3 as long as the mentioned diameter. Siphunculi absent. Cauda small. Subanal plate very large, rectangular with about 14-16 thick hairs arranged in the longitudinal row, besides 25-30 shorter fine hairs. Subanal plate very large, rectangular with about 14-16 thick hairs arranged in the longitudinal rows, besides 25-30 shorter fine hairs. Subgenital plate with 20 hairs in two groups. Legs (Fig. 283) dark brown, femora and tibiae smooth on margin. First tarsal segment with 3, 3, 3 hairs. Empodial hairs about 0.25-0.30 as long as the claws.

Host Plants :

Andropogon vulgare, Bothriochloa sp., *Carex sp., Cynodon dactylon, Cyperas rotundus, Dichanthium* sp., *Dichanthiu mannulatum, Eleusine coracana, Eleusine indica, Eragrostis nigra, Inperata arundinaceae, Oryza sativa, Paspalum commessoni, Paspalum commestatum, Paspatodium flavodium, Poa annua, Poa* sp. *Saccharum officinarum, Solanum tuberosum, Sorghum helipense, Sporobotus* spp., *Triticum vulgare,* indet plants of Poaceae. Indet. plants of Cyperaceae, Indet. Grasses.

Symptom and Damage : Both the nymphs and adults of the species suck the sap of host plant. As a result of severe infestation, the vitality of the plant is lost. As a result, the plants become stunted in growth, the leaves become dry and ultimately the plant dies.



Figs. 278-283. *Geoica lucifuga* (Zehntner) : 278. Apterous viviparous female; 279. Head; 280. Antenna; 281. Antenna enlarged; 282. Ultimate rostral segment; 283. Leg.

Life cycle : The original holocycle of all *Geoica* Hert is believed to be involved in alteration between Poaceae/Cyperaceae but *G. lucifuga* is now known to lead an anholocyclic paracycle on Poaceae and Cyperaceae in most of the parts of its distributional range. The Poaceous hosts include roots of several economic crops *viz.* maize, wheat, rice, barley sugarcane. According to Ghosh, A.K. (1984) in the region of N-E India apterae appear to be common throughout the year on the roots of grasses growing in semidry to sandy loam soil upto an altitude of 2200 m, the colonies are formed at depth between .25-7 cm.

Natural enemy complex : *Predator* : *Harmonia octomaculata* (Fabr.) [Coccinellidae : Coleopbera]. Ants always attend the aphids.

Distribution : India : Manipur, Meghalaya, Sikkim, West Bengal;

Elsewhere : Australia; Central Asia; China, Java; Middle East (Egypt, Israel), Malaya; Pakistan; Philippines; Sri Lanka.

Remarks : The apterous viviparous females of this species show variation even in the same colony being similar in the morphometric level in the nature of body hairs. Some members possess hairs of different types of apices and the other with only furcated and/or fan-shaped apices. The pale or dark brown globular aphids usually colonise under soil level. When the heavily infested host plant is extracted from soil, the aphids look like a bunch of grapes attached to the roots when ants are usually noticed to attend the aphids.

Genus 32. ***Pemphigus* Hartig**

1839. *Pemphigus* Harig, Jber Fortschr, Forstwiss u. forstl. naturl in Jahre 1836 and 1837, 1(4) : 645.

Type species : Aphis bursaria Linnalua (designated by Fitch, 1855, p. 73).

Diagnosis : Body oval, antennae 0.1-0.3 times as long as body, 5-6 segmented in apterae and 6- segmented in alatae; secondary rhinaria absent in apterae, present (annular) in alate migrants ; a.s.III with atmost 15 secondary rhinaria and other segments with less than 10 secondary rhinaria being nonciliated. U.r.s usually about half as long as h.t.2 and without any accessory hairs. Thorax with wax glands. Abdominal dorsum with 6 rows of longitudinal wax glands. Spiracles on 1st and 2nd abdominal tergites placed wide apart. Dorsal abdominal hairs usually long and fine. 8th abdominal tergite with 2-8 hairs. Siphnculi apparently absent. Cauda rounded with 2-5 hairs. Subgenital plate with many hairs arranged is two groups. Legs with tibiae and tarsi usually smooth but tarsi may be ventrally spinulose. 1st tarsal segments with 2-4 hairs. Empodial hairs about half as long as the claws. Fore wings with median simple, hind wings with both obliques.

50. ***Pemphigus immunis* Buckton**

1896. *Pemphigus immunis* Buckton, *Indian Mus. Notcs,* 4 : 51.

1896. *Pemphigus bursarius ;* Lichtenstein, *J. Monog. des. pucerons du peuplier,* Montpellier : 29.

1984. *Pemphigus immunis* : Ghosh, A.K. Fauna of India : Aphidoidea, Part III Subkmily pamphiginae : 195.

Diagnosis (Apterae) : Body suboval. Head distinctly scterotic, dark on vertex. antennae 4-segmented, pale except on segment IV flagellar hair minute, sparse; primary rhinaria round, ciliated ; p.t. extremely short, with 5 preapical setae. U.r.s. about half as long as h.t.2. and without any accessory hair. Dorsum of abdomen pale, with 6 wax plates on 1st–6th tergites, 4 on 7th tergite. Abdominal hairs fine, about 0.2 mm long and 0.6 times as long as b.d.III. Siphunculi absent. Cauda small with a few fine, stiff hairs. Subanal plate with about 30 hairs. Subgenital plate with about 25 hairs; Legs with trochanters fused with femora; 1st tarsal segments with 2, 2, 2 hairs.

Host Plants : *Populus nigra, Populus ciliata, Populus euphratica, Populus tremula.*

Symptom and Damage : The species causes damage to the host plant by producing malformations in the form of Galls.

Life cycle : Not much work on the biology and life cycle of the aphid is on record in India. Roberti (1938) has dealt with the biology of *P. immunis* in detail from Europe.

Habib on Ghani (1970) reported their observation on phenology of *P. immunis* in Pakistan. According to them, sexuparae and sexuales were collected in December, from under the cracked bark and old galls of *Populus nigra;* yellowish white eggs hatch in April-May and larvae initiate formation of gall as tiny protuberances on twigs; fundatrigeniae emerge from May-June and continue to emerge till July-August. However, they observed that *P. nigra* growing above *c.* 2000 m was not infested by the species.

Natural enemy-complex : Parasite : *Aphelinus nikolskajae* Jashnosh [Hymenoptera]

Distribution : India : Northwestern Part.

Elsewhere : Africa (North); Asia Central and Southwest; Europe (western), Middle East.

Genus 33. ***Tetraneura*** Hartig

1841. *Tetraneura* Hartig, Germar's *z. Ent.,* **3** : 336.

Type species : Aphis ulmi Linnaeus, 1750.

Diagnosis : Head usually smooth, with a dorsal median suture, lateral tubercles absent. Antennae, 0.10-0.33 times as long as the body, shorter and 3-6 segmented in apterae, in alatae usually 6-segmented, usually segments III and V are equal in length; secondary rhinaria absent in apterae, annular and present on segment III (7-32), IV (2-10), V (3-28) in alatae ; primary rhinaria ciliated. u.r.s. short, blunt bearing

2-32 accessory hairs and may be much shorter than to as long as h.t.2. Abdominal dorsum smooth or feebly reticulated, with a brown transverse intersegmental band between 7th and 8th tergites. Spiracles those on 1st and 2nd tergites placed wide apart. Wax glands variably present on head and abdomen. Siphunculi mere ring-like or present as elevated cones. Cauda rounded and bearing 2-6 hairs, 8th tergite with 2-12 hairs. Subanal plate dark. Subgenital plate with dense pubescence on posterior margin. Legs with trochanters often indistinctly fused with femora, tarsi 1-segmented in apterae but normal and 2-segmented in alatae; tarsi densely spinulose; dorso-apical hairs on second tarsal segment as long as or longer than the claw and empodial hair nearly equal to or longer than the claws. Forewings with media simple, hind wings with 1-2 oblique veins. First tarsal segments with 3, 2, 2 or 3, 3, 2 or 4, 2, 2 hairs.

Key to the subgenera of *Tetraneura*

Tarsal claws unequal, at least in hind legs of embryos and 1st instar nymph ..... *Indotetraneura* Chanrabarti and Maity

– Tarsal claws never unequal on the same tarsal segment, enlarged on hind tarsal segment ..... *Tetraneurella* H.R.L.

Key to the species of *Tetraneura*

8th abdominal tergite with 6 hairs; caudal hairs 4; subanal plate with 10-14 hairs; whitish to yellowish white in life ..... *javensis*

– 8th abdominal tergite with 2 hairs; caudal hairs 2; subanal plate with 4 hairs; dirty to dark brown in life ..... *nigriabdominalis*

51. **Tetraneura (Indotetraneura) javensis** van der Goot

1917. *Tetraneura javensis* van der goot, P. *Contr. Faune Ind. Neerl,* 1(3) : 260.

1927. *Tetraneura cynodontis coimbatorensis* George, *J. Asiat. Soc. Bent.* (N. S.), **23** : 9.

1968-69. *Tetraneura (Tetraneurella) javensis,* : Hille Ris Lambers, *Boll. zool. agr. Bachic.,* Ser. II, **9** : 49.

1978. *Tetraneura (Indotetraneura) javensis,* Chakrabarti, and Maity, *Entomon,* **3**(2) : 269.

1984. *Tetraneura (Indotetraneura) javensis* v.d.G., Ghosh, A.K. *Fauna of India,* Aphidoidea p.t.3, Subfam. Pemphiginae : 95.

Apterous viviparous female : Head pale, without median suture; dorsal cephalic hairs fine, up to 0.080-0.085 mm long, about twice as long as b.d.III. Antennae usually 4-segmented; segment I with 3-5 stout hairs, II with 7-9, III with 18-22 and IV with 3-4 hairs besides terminal spines ; hairs on segment III, about 0.40-1.2 times as long as the basal diameter of the segment; p.t. spinulose, 0.33 times as long as the base of segment IV; u.r.s. blunt, 1.2-1.7 times as long as the hind tarsus, and bears 8

accessory hairs. Thoracic and abdominal segments with conspicuous marginal hairs, 2-3 pairs per segment, of these shorter ones 0.04 mm. long, longer ones 0.14 mm. long, equal to or upto 4.0-5.0 times as long as basal diameter of antennal segment III; 8th tergite with 6 hairs up to 0.07-0.08 mm. long. Ventrolateral wax glands large, consisting of a large cell surrounded by smaller cells; spinal and pleural wax glands much smaller. Siphunculi small, truncate with dark sclerotic flange, Cauda dusky, bearing 4 hairs. Legs stout, bearing many short hairs, longest one on hind tibiae, 0.033-0.046 mm. long, 0.35-0.70 times as long as the diameter of the middle of the tibiae; empodial hair a little longer than the claws.

Colour–Whitish to yellowish white in life (v.d. Goot, 1917).

Alate viviparous female (emigrants from galls of *Ulmus,* after H.R.L., 1968-69) : Head with a pair of strongly rimmed wax plate (0.030 mm. in diameter); dorsal cephalic hairs 0.016-0.040 mm. long. antennae 5-6 segmented, less than 0.33 times as long as the body, apically spinulose, antennal segment III with 11-14 secondary rhinaria, segment IV with 3-5 and V with 4-7 similar rhinaria; p.t. about 0.50 times as long as base of last antennal segment; u.r.s half as long as h.t.2 and bears 5-6 accessory hairs. Wax glands not discernible. 8th abdominal tergite with 8-10 hairs. Siphunculi apparently absent. Cauda with 4 hairs. Legs short, hairs on hind tibiae 0.020-0.022 mm. long.

Host plants : *Andropogon unlgare, Capillipedium* sp., *Eleusine coracana, Oryza sativa, Panicum javanicum, Panicum millaceum, Saccharum officinarum, Setaria italica,* indet grasses.

Distribution : India : Southern part ("Mysore").

Elsewhere : Java; Pakistan.

Remarks : The aphid was known from the roots of Sugarcane in South India; George (1927) described it as a subspecies of *Tetranenra cynodontis* from Coimbatore. His description was based on alatae from poaceous host. Chakrabarti and Maity (1978) nominated *Javensis* as type of subgenus *Indotetraneura* on the basis of asymmetrical hind tarsal claws. Hille Ris Lambers (1968-69) while redescribing the species correlated the alatae collected from galls of *Ulmns* have also been collected in N.W. India (Ghosh, A.K. 1984).

Management : As in *T. (Tetraneurella) nigriabdominalis.*

52. **Tetraneura (Tetraneurella) nigriabdominalis** (Sasaki)
(Figs. 285–287)

1899. *Schizoneura nigriabdominalis* Sasaki, Manual of Insect Pests of Crops in Japan (in Japanese), 435.

1917. *Tetraneura fusiformis,* Matsumura, a collection of essays for Mr. Yasushi Nawa, Gifu, **3** : 74.

1921. *Dryopeia hirsuta* Baker, *Monthly Bull. Calif. Dep. agric.,* **10** : 159.

1923. *Tetraneura myzae* van der Goot, in van Heurn., *Meded, Inst. plantenziekten Batavia,* **61** : 41.

1924. *Pemphigus agrimoniae* Shinji, *Zool. Mag. Tokyo,* **35**(431) : 371.

1968-69.*Tetraneura (Tetranueirella) nigriabdominalis,* Hille Ris Lambers, *Boll. Zool. agr. Bachic.,* Ser. II, **9** : 52.

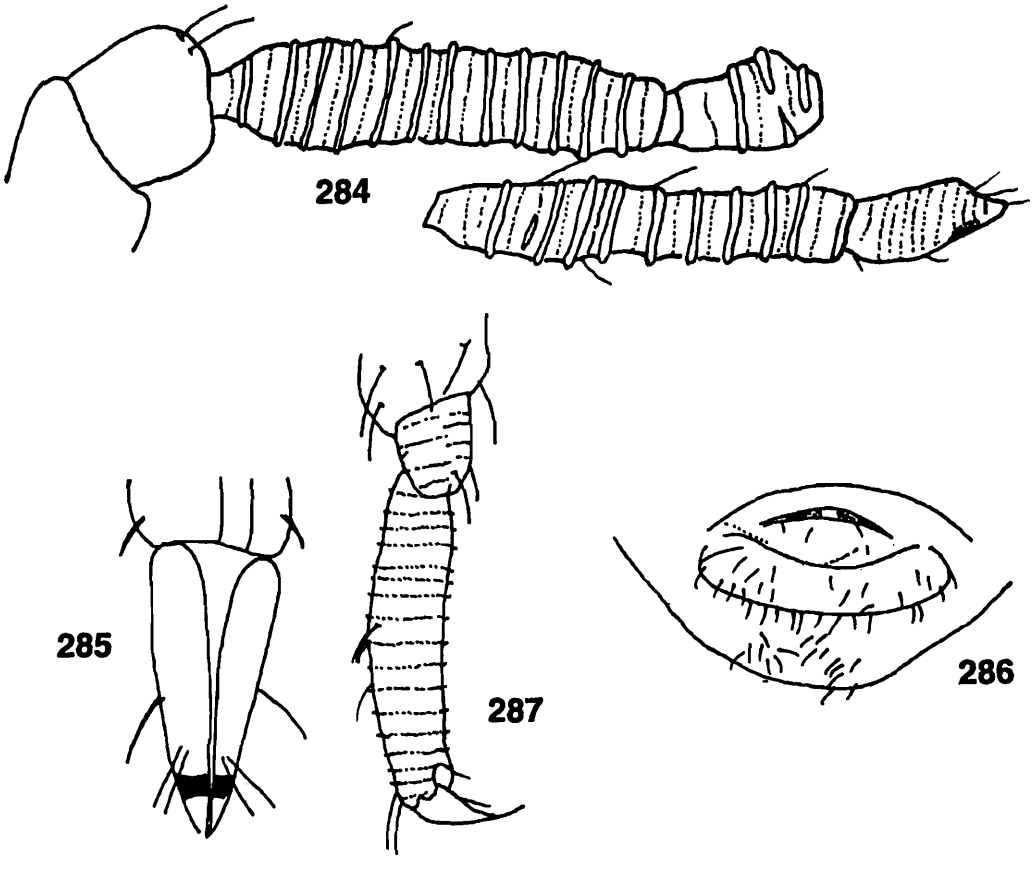
1978. *Tetraneura nigriabdominalis,* Raychaudhuri, D.N., Pal and Ghosh, M.R., *Entomon,* **3**(2) : 258.

1980. *Tetraneura nigriabdominalis,* Raychudhuri, D.N., Pal and Ghosh, A. K., Aphids of North East India and Bhutan, 430.

1984. *Tetraneura nigriabdominalis* (Sasaki), Ghosh, A.K., *Fauna of India* : Aphidoidea, pt. 3, subfamily Pemphiginae : III : 111.

Apterous viviparous female–(Exules) : Head smooth or feebly scabrous; dorsal cephalic hairs subacute, sparse, upto 90–100μ long and twice as long as b.d.III. Antennae (Fig. 284) 3-5 segmented, darker at apices, 0.15-0.21 times as long as the body; segment I with 2-4 stout, hooked hairs, 40-70 long and a minute hair, segment II with 3-4 similar stout hairs, segment III with 0-3 small hairs 2μ long and segment IV with 15-20 hairs (0.023-0.045mm long), 0.63-1.27 times as long as the basal diameter of the segment, last two antennal segments spinulose; primary rhinaria ciliated; last antennal segment usually with 2-3 small hairs (0.01 mm. long). U.r.s. (Fig. 285) obtuse, usually with 4 accessory hairs and 1.5-1.6 times as long as the hind tarsus. Abdominal dorsum pale to pale brown, with a sclerotic transverse band on each of 7th and 8th tergite; hairs on the abdominal dorsum with variable apices, marginal hairs long and thick with blunt, swollen or subacute apices, 0.130-0.215mm. long, 4.0-6.5 times as long as b.d.III, spinal and pleural hairs distinctly thinner and much shorter on anterior tergites, but appear much longer on 7th and 8th tergites; 7th tergite with 4 spinopleural hairs (about 0.050 mm long) between the paired marginal hairs; 8th tergite with 2 thick hairs (0.146-0.165 mm long); wax plate usually composed of several long and small gland cells, very variable in nature; ventro-lateral wax plate with both large and small cells. Spihunculi on slightly elevated sclerotic cones. Cauda brown, with a pair of hairs. Subanal plate (Fig. 286) with 4 hairs (0.040-0.073 mm long) besides some smaller hairs; gonapophyses with more than 10 hairs, in each lobe. Legs with hairs on femora and tibiae fine, longest one on hind tibiae 0.033-0.035 mm long; 2nd joint of hind larsus much younger.

Alate viviparous female : Head brown, sclerotic ; dorsal cephalic hairs 0.024-0.040 mm long, 1.2-3.0 times as long as b.d.III. Antennae 6-segmented, III with 6-13 hairs, those on segment III 0.013-0.020 mm.long, 0.80-1.25 times as long as b.d.III, flagellum gradually more denesely spinulose from segment IV apicad; antennal segment III with 11-15, IV with 2-4 and V with 8-12 secondary rhinaria; p.t. 0.60-0.70 times as long as base VI. U.r.s. with spinules, 0.64-0.80 times as long as h.t.2 and bears 6-7



Figs. 284-286. *Tetraneura nigriabdominalis* (Sasaki) : 284. Antenna; 285. Ultimate rostral segment; 286. Posterior portion of abdomen; 287. Segments of hind tarsus.

accessory hairs. Abdominal dorsum pale dorsally, finely spinulose ventrally; spinopleural hairs on the dorsum of abdomen with subacute apices on 1st-7th tergites, marginal hairs fine, much longer, 8th tergite with 2 hairs (0.097-0.106 mm); large paired marginal wax plates present on 1st-7th segment, spinal wax plates much smaller. Siphunculi with dark, sclerotic rim. Cauda with 2 hairs. Subanal plate with 24-28 hairs. Gonapophyses with 32-38 hairs. Legs brown to dark brown, feebly spinulose over femora and tibiae, densely so over tarsi; empodial hair fine, 0.036-0.40 mm. long, subequal, about as long as the claws. Forewings with media obsolete at base and cubitus and anal fused at base.

Host Plants : Andropogon aciculatus, A halepense, A. halli, A. vulgare, Axonopus compresus, Brachieria remosa, Brachieria sp., *Capillipedium parviflorum, Capillipedium* spp., *Cenchus setigerus, Chiochne semeteres, Chnysnthemum* spp., *Chrysopogon aciculatus, Cymlopogon martini, Cynodon dactylon. Cynodon* spp., *Cyperus rotundus, Dactyloctenium aegypticum, Dichanthium annulatum, Digitaria* spp., *Echinochloa rolonum, Eleusine coracana, E. indica, Erachiarus remosa, Eragrostis gangetica, E. miturrupta, Eragrostis nigra, E. terella, Ficus* sp., *Imperata arundinacea, I. cylindrica, Inula cappa, Iseilema laxum, Musa paradisi, Nicotiana* spp., *Oplismenes burmanni, Oryza sativa, Panicum maximum, P. riliaceum, paspalum commensoonii, Paspalum conjugatum, Paspalum dialtum, Paspalum* sp., *Pennisetum cenchoides,*

P. purpureum, Pisum sativum, Pegonenthuim paniceum, Polopogon fugax, Polypogon monspeliensis, Populus spp., *Rootus onii, Saccharum officinarum, Schima nervosum, Setaria glauca, Setaria intermedia, Setaria italica, Setaria pallido-fusca, Syndrella nodifolia, Triticum vulgare, Urochloa helopus. Zea mays.*

Symptom and Damage : Both nymphs and adults of this pest species suck plant sap through the rice roots of the rice growing areas of India. Sometimes leaves are also infested. The nymphs and adults of the aphid remove plant sap through the roots and cause yellowing of the leaves and stunted plants. In severe cases, plants wilt and die. It's incidences are found in Andhra Pradesh and Rajasthan during rabi seasons. These minute, pink and globular aphids remain in colonies feeding on the freshly formed roots of ragi plants. The external evidence of the incidence of these aphids is gradual fading away of badly infested plants in the presence of black ants (*Camponotus compressus)* visiting the roots of the host plant. When such plant is pulled out, colonies of the aphids can be seen entangled with the roots. The infestation prevails up to the flowering shape. In South India irrigated ragi is affected by the aphids seriously during May-July. The ants usually excavate the soil and provide facilities for the aphid to multiply and infest the roots.

Life cycle : The species reproduces parthenogenetically throughout the year on several grasses. The alate viviparous females that are produced after two or three generations of apterous viviparous forms are responsible for dispersal of the aphid. The alate viviparons morphs are carried to the field by wind currents. These when settle on the leaf blade lay young individuals on the leaves. The nymphs subsequently move to the roots near soil and ultimately find their way to the roots. The black ants help them to make colony in the roots near the soil.

Pathogen : Eleusine mosaic

Distribution : India : widely distributed.

Elsewhere : Cosmopolitan except Europe.

Remarks : The collection of the fundatrices of *T. nigriabdominalis* on *Ulmus* in Uttar Pradesh was made from bladder-like greenish galls during June, 1978, but the alate emigrant from the galls as also sexuales, have not been collected in the region (A.K.Ghosh, 1984). The aphid is widespread in Indian region, being recorded from both northern and southern India and infestation on young rice plant may sometimes be very harmful. In the hill region of eastern India this aphid infests roots of Poaceae growing in dry sandy to wet clay soil, throughout the year (Pal, 1975). Hille Ris Lambers (1968-69) described in details, adult and embryos of this species and recognised 4 distinct groups of material from different geographical areas, which differ in the chaetotaxy of adults and embryos; Raychaudhuri *et al.* (1978, 1980) mentioned that specimens from India exhibit a variable number of hairs on 8th tergite of abdomen (2-6).

Management : Mixing crude oil emulsion in irrigated water or drenching the soil with 0.05% carbaryl or 0.04% phospamidon @ 2000 litres/ha is recommended to control infestation of the aphid.

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INSECTA : HOMOPTERA : ALEYRODIDAE

The whiteflies are small phytophagous insects belonging to the family Aleyrodidae of Suborder Homoptera. These are small inconspicuous insects which are not true flies but are plant bugs. The adult insects have a pair of flowry wings which are usually white, with a few veins. The eggs are laid on leaf surface (Figs. 433, 434) The immature stages are always sessile and the anus is situated dorsally in both adults and larvae. The 1st instar larvae are quite active with functional legs and antennae. The legs and antennae of the 2nd, 3rd and 4th instar larvae are atrophied and the instars are sessile. The adult develops from 4th instar usually referred to 'pupal stage' which plays an important role in taxonomy of this group.

The family Aleyrodidae is classified into three sub-families viz., Udamoselinae, Aleurodicinae and Aleyrodinae. The subfamily Aleyrodicinae is more primitive than the larger and most widespread subfamily Aleyrodinae.

The whiteflies are economically important pests of crops and ornamental plants. They constitute an important group of insect, some of which are efficient vector to transmit several plant viral diseases particularly in tropical regions including India (Nene 1972, Costa 1975). More than 23 viruses are known to be transmitted by the Aleyrodids. But information on whitefly-virus relationship are rather meagre as compared those on aphids. Whiteflies mainly belonging to nine species have been reported to dessiminate virus diseases in plants. The species are : i) *Bemisia tabaci,* ii) *B. tuberculata,* iii) *Aleurotrachelus socialis,* iv) *Trialeurodes natalensis,* v) *T. abutilonea,* vi) *T. vaporariorum,* vii) *B. gossypiperda,* viii) *B. golding* and ix) *B. conspicua.* Out of these, *Bemisia tabaci* (Gennadius) is said to be responsibile for transmitting most of the viruses caused by white fly.

The world Aleyrodidae as revealed by Mound and Halsey (1978) include about 1156 species in 126 genera.

In India, taxonomic studies on Aleyrodidae are few. So far, 166 species belonging to 38 genera are known from India (Maskell 1895; Buckton 1900; Peal 1903; Quaintance and Baker 1913-1917, Misra 1920; Dozier 1928; Corbet 1935; 1939; Singh 1931, 1938; 1940; 1945; Rao 1958; David and Subramanian 1976; David and Jesudassan 1987; David & Subramanian 1987, 1990; Takahashi 1932, 1950; Jesudassan and David 1991).

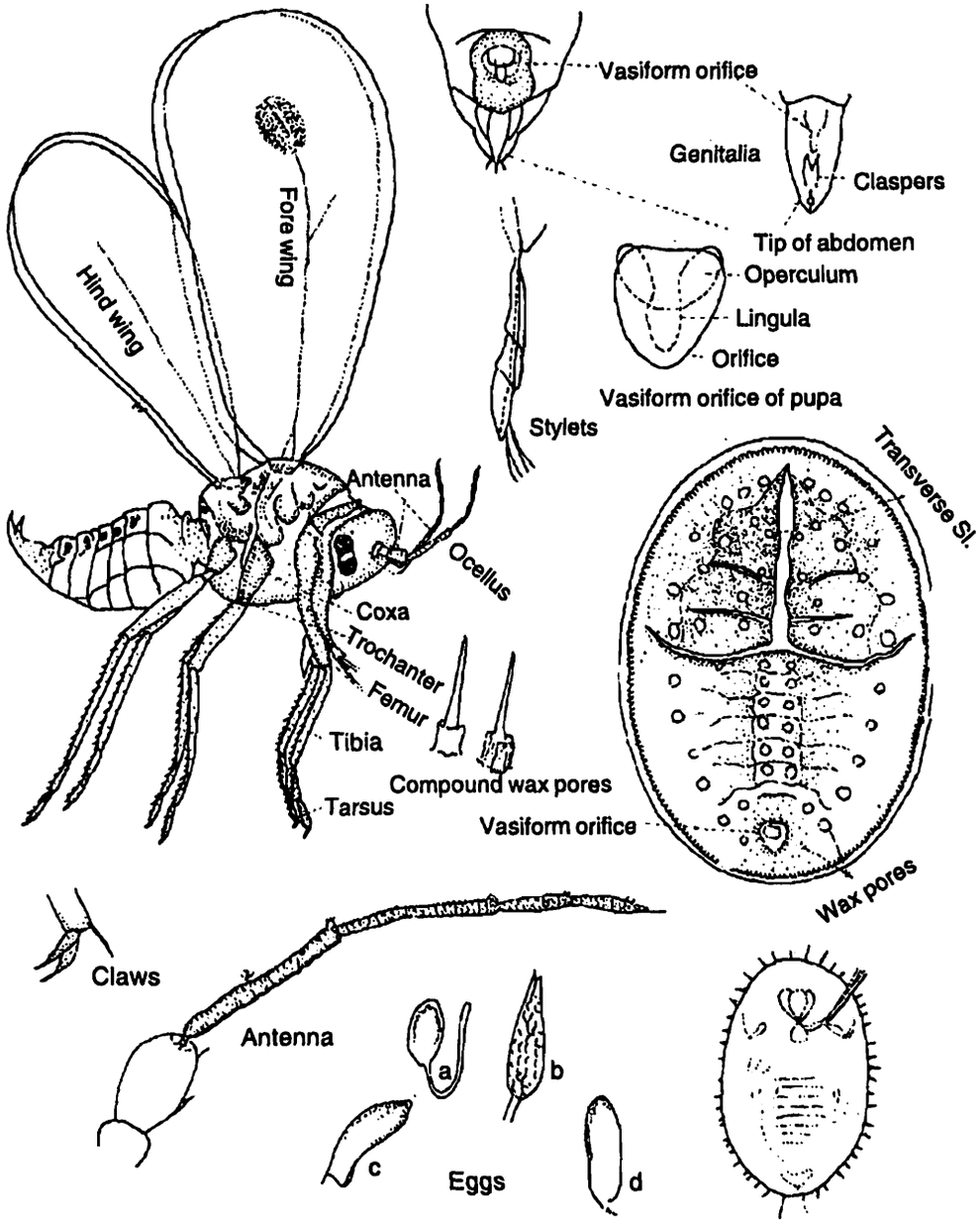
GENERAL DIAGNOSIS

The adult aleyrodids or white flies are very small insects characterised by two equal pairs of whitish, opaque, clouded or banded wings; 7-segmented antennae; two ocelli, one near the front of each compound eye; rostrum three-segmented; tarsi two-

segmented with a spiniform or pad-like compodium between the claws. Among four larval instars the last or pupal instar being of considerable value in determination of species for possession of many striking characterstics in the 'pupal case' of it. The accompanying diagrams (Figs. 288, 289) giving the structural features of a generalised aleyrodid appears self explanatory.

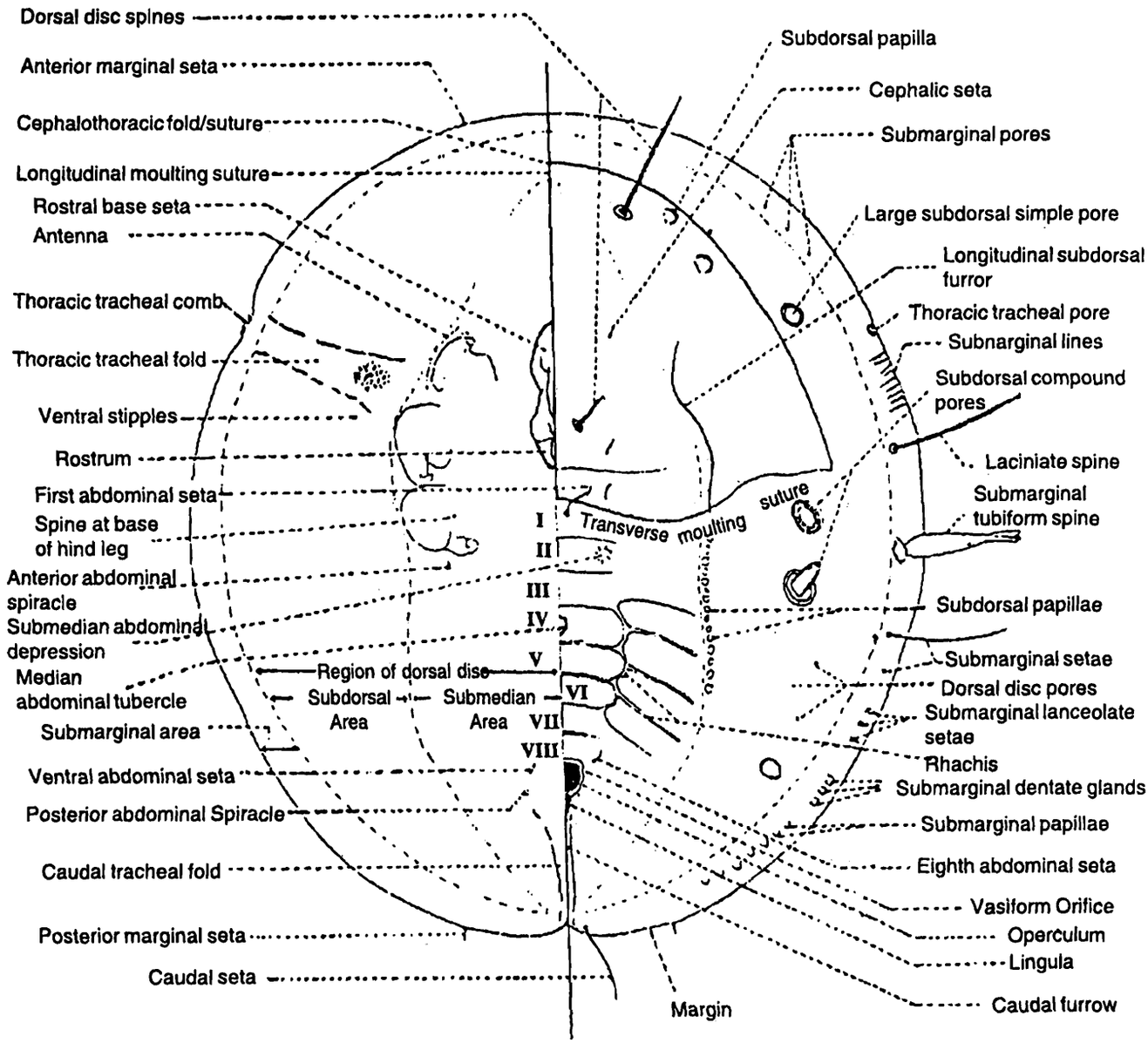
MATERIAL AND METHODS

The dry specimens are moistened by sprinkling water on the leaf surface. The moistened pupal cases from which adults have emerged are removed carefully from the leaf surface with a very fine needle.



Figs. 288. Morphological details of a whitefly

The specimens are treated with 10% KOH or NaOH and heated gently for 10-15 minutes where as the dark specimens are allowed to remain in the KOH or NaOH for 12-36 hours till they are decolorised. Specimens which are very dark are required to be bleached in hydrogen peroxide. The specimens are then transferred to glacial acetic acid which neutralises the action of alkali and also removes wax. If required these specimens are cleared by gently pressing them with a fine bent needle. These colourless specimens are stained in acid fuchsin and again transferred to glacial accetic acid for dehydration and removal of excess stain. Dark specimens are generally not stained. They are finally cleared in carboxylol (a mixture of cabolic acid & Xylol at 1 : 3) for 10-15 minutes, then taken to clove oil and after about 5 minutes mounted in DPX or Canada balsom keeping the dorsal side above.



Figs. 289. A schematic diagram of whitefly pupal case with morphological terminology indicated (After Jesudasan & David 1991)

MORPHOLOGY & TERMINOLOGY

(Figs. 288, 289)

The most important characteristic feature from the taxonomic view point of aleyroid is the vasiform orifice which opens on the dorsal surface of the last abdominal segment. It is a conspicuous opening provided with an operculum and situated within the orifice & beneath the operculum is a tongue or strap-shaped organ known as lingula.

The latter in some species is covered by the operculum and in others it projects beyond it. The anus opens within the orifice at the base of the lingula. The honey dew issues through the anus and accumulate on the lingula.

SYSTEMATIC ACCOUNT

Family ALEYRODIDAE

Subfamily I. ALEYRODINAE

Tribe I. ALEUROCANTHINI

Genus 1. ***Aleurocanthus*** Quaintance and Baker

1. *Aleurocanthus spiniferus* (Quaintance)
2. *A. woglumi* Ashby

Tribe II. ALEUROLOBINI

Genus 2. ***Aleurolobus*** Quaintance and Baker

3. *Aleurolobus barodensis* (Maskell)

Tribe III. BEMISINI

Genus 3. ***Bemisia*** Quaintance and Baker

4. *Bemisia tabaci* (Gennadius)

Tribe IV. DIALEURODINI

Genus 4. ***Dialeurodes*** Cockerell

5. *Dialeurodes cardamomi* David and Subramaniam
6. *D. citri* Ashmead
7. *D. kirkaldy* (Kotinsky)

Tribe V. NEOMASKELLINI

Genus 5. ***Neomaskellia*** Quaintanee and Baker

8. *Neomaskellia bergii* Signoret

Genus 6. ***Trialeurodes*** Cockerell

9. *T. ricini* (Misra)
10. *Trialeurodes vaporariorum* (Westwood)

Genus 7. ***Aleurodicus***

11. *Aleurodicus dispersus* Russell

Family ALEYRODIDAE

Key to genera

1. Vasiform orifice transversely elliptical, elongated, lingula extremely short, submargin with a row of long setae; dorsum without pores or papillae ..... ***Neomaskellia***

– Vasiform orifice not transversely elliptical, dorsum with relatively a few simple pores 2

2. At least one of the characters *viz.* thoracic tracheal folds, combs or pores; caudal tracheal folds, present 3

– Above characters absent; vasiform orifice elevated, small rounded; lingula hidden, dorsum with many prominent spines ..... ***Aleurocanthus***

3. Possessing thoracic and caudal folds and/or pores 4

– Possessing thoracic and caudal folds and/or combs of teeth 5

4. 7th abdominal segment not shorter than 6th; vasiform orifice usually small, lingula concealed ..... ***Dialeurodes***

– 7th abdominal segment shorter than 6th; vasiform orifice elongately triangular, operculum subcordate to transversely elliptical; lingula spatulate with a pair of terminal setae ..... ***Bemisia***

5. Submargin separated from dorsal disc by a suture-like line; vasiform orifice surrounded by a trilobed figure; lingula hidden ..... ***Aleurolobus***

– Submargin not separated from dorsal disc, with a row of large papalla-like spores; lingula exposed ..... ***Trialeurodes***

Genus 1. ***Aleurocanthus*** Quaintance & Baker

Type species : *Aleyrodes spiniferus* Quaintance, *Canad. Ent.*, **35** : 61-64.

Diagnosis : The genus is characteriesed by the pupal cases possessing many prominent spines on the dorsum and the elevated vasiform orifice. The operculum is rounded or subcordate and the lingula is hidden.

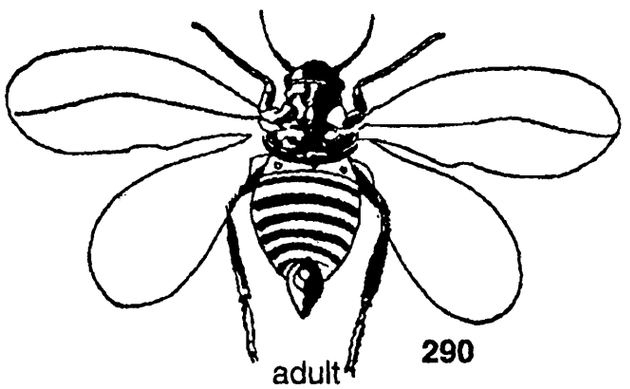
Key to the species of *Aleurocanthus*

Presence of distinct regular row of capitate setae; vasiform orifice circular.... ..... *woglumi*

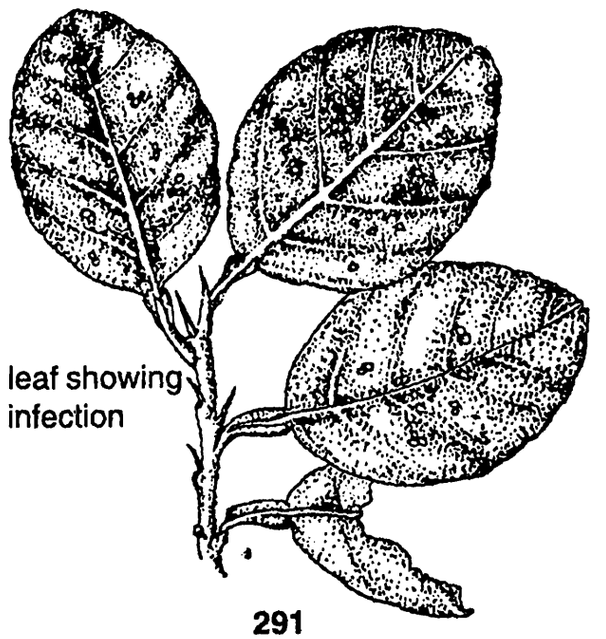
– Presence of irregular row of capitate setae just above the submarginal row of spines ..... *spiniferus*

1. ***Aleurocanthus spiniferus*** (Quaintance)
(Figs. 290-293)

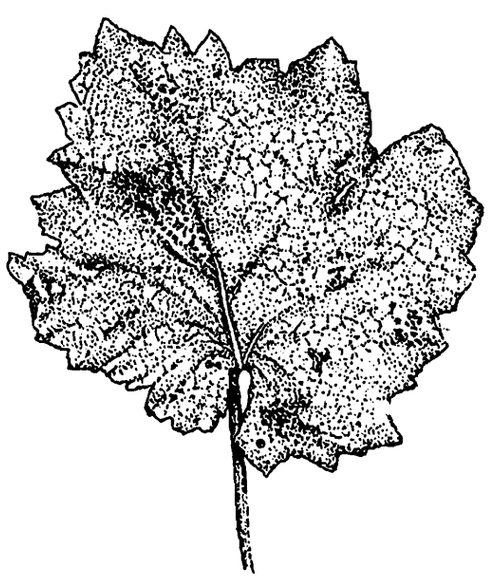
1903. *Aleurodes spinifera* Quaintance, *Canad. Ent.*, **35** : 63.



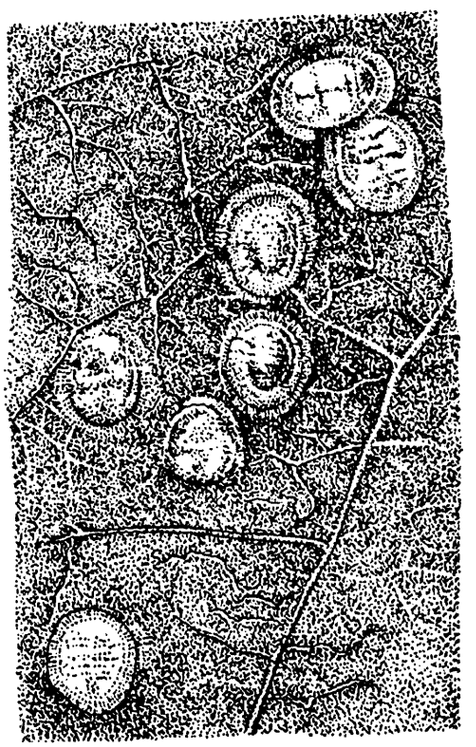
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Figs. 290-293. *Aleurocanthus spiniferus* (Quaintance) : 290. Adult; 291. *A. spiniferus* showing infestation on hosts plant; 292. Infesting leaf of Grape vine; 293. Infestation magnified.

1914. *Aleurocanthus spiniferus* (Quaintance) : Quaintance and Baker, *U. S. Dept. Agric., Bur. Ent., Techn. Ser.,* **27**(2) : 102.

1931. *Aleurocanthus rosae* Singh, *Mem. Dept. Agric. India, Ent. Ser.,* **12** : 70.

1976. *Aleurocanthus spiniferus* (Quaintance) : David and Subramaniam, *Rec. zool. Surv. India,* **70** : 153.

1991. *Aleurocanthus spiniferus* (Quaintance) : Jesudassan and David, *Oriental Ins.,* **25** : 252.

1994. *Aleurocanthus spiniferus* (Quaintance) : Biswas and Ghosh, L. K., *Fauna of West Bengal, State Fauna Series,* **3**(Part-3) : 119. Zool. Surv. India.

Diagnosis : Presence of irregular row of capitate hairs just above the submarginal row of spines. Abdominal dorsum without shades of brown patch; cephalothorax with 13 pairs of spines, dorsal surface with 29 pairs of spines; submarginal area without any linear ridge, operculum without marking, pupal case black.

Host plants : *Citrus*, Rose and Grape vine.

Biology : The adult pest is pale yellow in colour with dark-red, medially constructed eye. Female has an acute ovipositor while male has a pair of claspers. The female lays eggs singly and scatters them irregularly on the lower surface of leaves. It lays about 200 yellow-coloured eggs which are glued to the underside of the leaves by a short stalk. The eggs hatch within two weeks. A little later the young nymphs fix themselves up at one place and persists in feeding there. There are 3 nymphal and 1 pupal instar in summer and winter. Emergence of adult takes place after passing through pupal stage. The whiteflies live not beyond 8 days.

Distribution : Widely distributed in India.

Elsewhere : Japan, Kenya, Tanzania, Uganda, Mauritius, China, Hongkong, Sri Lanka, Taiwan, Thailand, Vietnam, Marianas Is., Brunei, Malaya, Philippines, Sumatra, Caroline Is., Hawaii.

2. *Aleurocanthus woglumi* Ashby
Citrus Blackfly
(Fig. 294)

1917. *Aleurocanthus woglumi* Ashby, *Proc. U. S. natn. Mus.* **51** : 336, 355.

1976. *Aleurocanthus woglumi* Ashby : David and Subramaniam, *Rec. zool. Surv. India,* **70** : 156.

Diagnosis : Pupal case black in colour; submargin with less number of spines; operculum without markings; submarginal area with linear ridges, vasiform orifice circular. The adult fly is dark orange with smoky wings and fore wings with 4 whitish areas of irregular shape. The females are about 1.2 mm, the males are 0.8 mm long. The nymphs are scale-like, shiny black and spiny and are bordered by a white fringe of wax.

Host plants : Orange (*Citrus* sp.) Sapota (*Achras zapota*) Pommello (*Citrus* sp.), Sweet orange *(Morinda tinctoria)* and Malta *(Murraya koenigii)*.

This is commonly known as the Citrus Blackfly and is a well-known serious pest of citrus in many parts of the world. In India, this is widely distributed species found infesting citrus heavily.

Symptom and Damage : Both adults and the nymphs suck plant sap reducing the vitality of trees. It results in the curling of leaves and also the premature fall of flower buds and the developing fruits.

Biology : The matured insects emerge in March-April and the females lay yellowish brown oval-shaped eggs on broad leaves. There may be 15-22 eggs in a cluster. The eggs hatch in 7-14 days and the nymphs on emergence start feeding on cell-sap. They pass through 4 nymphal instars and the nymphal stage is completed in 38-60 days. They pupate on the leaf surface and this stage lasts for 100-131 days. The pupa is oval, black and its dorsum is arched with long black spines, and the margins are with rounded black teeth. There are two distinct broods in a year. The first brood adults emerge in March-April and those of the second brood emerge in July-October.

Natural enemies complex : Parasites : *Encarsia divergens* Silv., *E. merceti* Silv., *Eretmocenus serius* Silo (Hymenoptera : Aphelinidae).

Remarks : In the nymphal stages, the citrus blackfly is a serious pest especially in sweet orange, *Morinda tinctoria* and malta, *Murraya keoenigii*. Also, Mango, Guava, Pear, Plum, Grapevine etc. are attacked. Apart from India the pest is also reported from Sri Lanka, the Philippines, Jamaica, Kingston, Cuba and Bahamas.

Genus 2. ***Aleurolobus*** Quaintance and Baker

1903. *Aleurolobus* Quaintance and Baker, *Can. Ent.*, **34** : 61.

Type species : *Aleurolobus marlatti* (Quaintance), 1903, *Can. Ent.*, **34** : 61.

Diagnosis : Pupal case usually dark brown to blackish; margin toothed, with moderately developed wax tubes; submarginal area separated from dorsal disc by suture-like lines, minute pores present on dorsum; tracheal folds in most cases obscure or wanting but in some evident, terminating on margin in a few specialised teeth, vasiform orifice subcordate, operculum similarly shaped almost filling the orifice and obscuring the lingula. A trilobed figure surrounding the orifice quite characteristic.

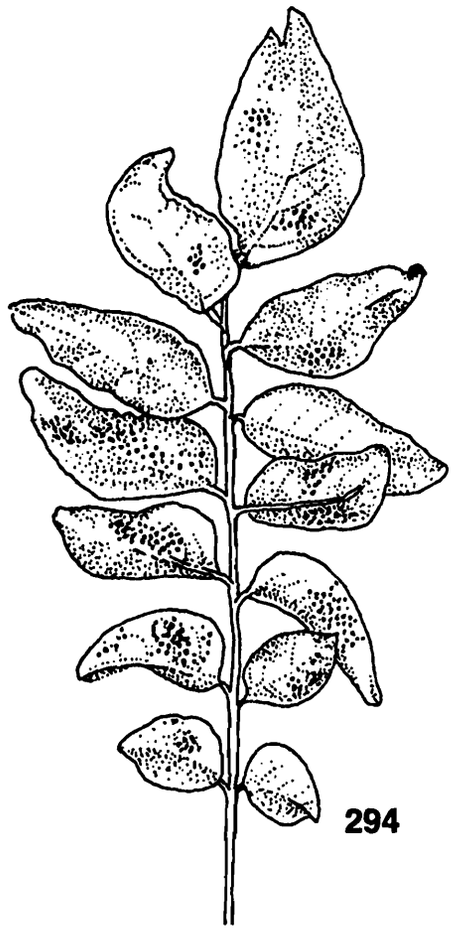
3. ***Aleurolobus barodensis*** (Maskell)
Sugarcane whitefly
(Fig. 295)

1896. *Aleurodes barodensis* Maskell, *Trans. N. Zealand Inst.*, **28** : 424.

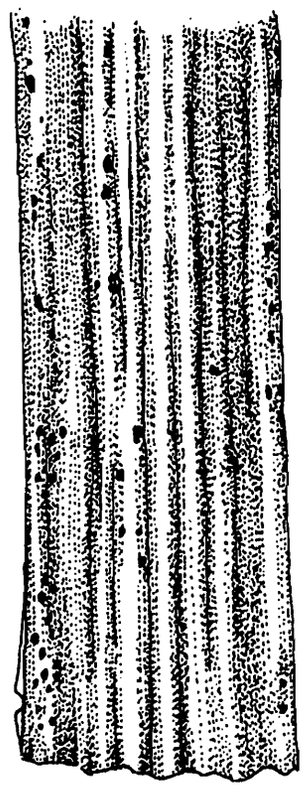
1897. *Aleurodes longicornis* Zehntner, *Archief Java Suikerind,* **5** : 381.

1902. *Aleurodes barodensis* Cickerell, *Proc. Acad. nat. Sci. Philka.*, 281.

1917. *Aleurolobus barodensis* (Maskell), Quaintance and Baker, *Proc. U. S. natn. Mus.*, **51** : 359.



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Figs. 294-295. 294. *Aleurocanthus woglumi* Ashby, infesting leaf of *Murraya koenigii*; 295. *Aleurolobus barodensis* (Maskell) on *Saccharum officinarum*

1976. *Aleurolobus barodensis* (Maskell) : David and Subramaniam, *Rec. zool. Surv. India*, **70** : 159.

1991. *Aleurolobus borodensis* (Maskell) : Jesudassan and David, *Oriental Ins.* **25** : 270

1994. *Aleurolobus borodensis* (Maskell) : Biswas and Ghosh, L. K., *Fauna of West Bengal, State Fauna Series*, **3** : 119. Zool. Surv. India.

Diagnosis : Submarginal area without prominent setae; thoracic trachaeal folds hardly discernible; pupal case very elongate, elliptical, dense black; margin with a fringe of long snow-white wax rods; dorsum dusted with white powdery meal.

Host plants : *Saccharum officinarum*, *Erianthus arundinaceum* and *E. ciliaris*.

Symptom and Damage : The nymphs cause damage by sucking the cell sap of the host plant with the help of their piercing and sucking type of mouth parts. The grown up nymphs are about 3 mm long, oval or flattened and scale-like in appearence, thus remaining sticking to the same spot on a leaf. These insects are black and have a silvery grey waxy coating on the body. Adults are small, delicate, pale-yellow, about 3 mm long as their wings have a white mealy appearence, mottled with black dots. The affected leaves develop yellow streaks and the leaves become pale green in

appearence. Thus, vitality of the plants is reduced. As a result, the quality and quantity of the production of "gur" becomes poor. A black mould develops on the honeydew excreted by the pest species. Thus, it interferes with proper functioning of the leaves and reduces the quality of fodder.

Biology : The species breeds almost throughout the year except during winter. Winged adults appear in the spring and soon after emergence, they copulate for 30-40 seconds. The female lays 60-65 creamy white conical eggs which are glued to the surface of leaves. The eggs are found in a single file. The eggs hatch in 8-10 days. On emergence, the pale yellow young nymphs move away from egg-shell to find a suitable place for feeding. They feed with the help of piercing mouth parts. They complete their development in 25-30 days after 4 instars. The pupal stage lasts for 10-11 days and the adults, on emergence, live for 24-28 hours. The insect pest completes 9 generations in a year and in March-April, they migrate from the old to the new host plants.

Natural enemies complex : (Order Hymenoptera : Family Aphelinidae) *Azotus delhiensis* Lall; *Encarsia issaci* Mani; *E. muliyali* Mani; *Eretmocerus delhiensis* Mani.

Among all the natural enemies, *Azotus* plays major role in controlling the pest. It kills more than 50% pupae of the pest species.

Distribution : Throughout India.

Elsewhere : Pakistan, Taiwan, Philippines, Malaya, Java.

Genus 3. ***Bemisia*** Quaintance and Baker, 1914

Type species : *Aleyrodes inconspicua* Quaintance, 1900, *U.S. Dept. Agric. Div. Ent. Bull.*, **8**, Tech. Ser. : 1-64.

Diagnosis : Presence of elongate triangular vasiform orifice, usually with an exposed triangular lingula tip. A series of subdorsal setae present, these setae may be often overlooked when small, but are occasionally long and stout.

4. ***Bemisia tabaci*** (Gennadius, 1889)
Cotton whitefly/Sweet potato whitefly
(Fig. 296)

1889. *Aleyrodes tabaci* Gennadius, *Ellenike Geogia* (Greek *Agriculture*) (*Athens*) : (1)-3.

1900. *Aleyrodes inconspicua* Quaintance, *U.S. Dept. Agr. Div. Ent., Tech Ser.* **8** : 28-29.

1914. *Bemisia inconspicua* (Quaintance) : Quaintance and Baker, *U.S. Dept. Agr., Bur. Ent. Tech. Ser.* **27** : 99-100.

1928. *Bemisia costa-limai* Bondar, *Aleyrodideos do Brasil* (2nd *Contrib.*) : 27-29.

1928. *Bemisia signata* Bondar, *Aleyrodideos do Brasil (2nd contrib.)* 29-30.

1928. *Bemisia behiana* Bondar, 1928. *Aleyrodidoes do Brasil* (*2nd contrib.*) 30-31.

1929. *Bemisia gossypiperda* Misra and Lamba, *Agr. Res. Inst. Pusa, Bull.* No. **196** : 7.

1933. *Bemisia hibisci* Takahashi, *Dept. Agro Gov. Res. Inst. Formosa Rot.*, **60** : 17-18.

1934. *Bemisia gossypiperda* Mistra and Lamba var. *mosaicivectura* Ghesquiere, *Ann. de Gembloux* (*Bruxelles*), 30-31.

1934. *Bemisia longispina* Priesner and Hosny, *Egypt. Min. Agr., Tech. and Scien. Service* (*Ent. sec.*) *Bul.* **139** : 6.

1935. *Bemisia goldingi* Corbett, *Ann. Mag. nat. Hist.* (ser 10), **16** : 249-250.

1935. *Bemisia nigeriensis* Corbett, *Ann. Mag. nat. Hist.* (ser. 10) **16** : 250-252.

1936. *Bemisia rhodesiansis* Corbett, *Proc. R. ent. Soc. London* (B) **5** : 22.

1936. *Bemisia tabaci* (Gennadius), Takahashi, *Tenthredo* **1**(2) : 110-111.

1976. *Bemisia tabaci* (Gennadius) : David and Subramaniam, *Rec. zool. Surv. India*, **70** : 182.

1997. *Bemisia tabaci* (Gennadius) : Atwal and Dhaliwal, *Agricultural pests of South Asia and their management* : 226.

Diagnosis : Elongate dorsal setae vary in number (including usual 13 pairs of dorsal setae) from none to 7 pairs depending upon the hairy or glabrous nature of leaf of host plant. Pupal case elongately elliptic, devoid of waxy sceretion, without sublateral longitudinal tuberculate lines.

Symptom and Damage : The young ones and adults remain in colonies on the undersurface of the leaves and suck the sap. Due to continuous feeding, chlorotic spots develop on the leaves which later coalesce. The leaves become brittle and finally drop from the plants prematurely in addition to the direct damage the honeydew excreted by this insect drops on the upper surface of lower leaves as in the case of aphids and favours the development of sooty mould fungus. This interferes with photosynthesis of leaves.

Biology : The adult whitefly is a 'moth-like' tiny soft-bodied insect measuring 1.0 mm in length having yellowish body with transparent waxy wings dusted with milky white powder. Adults are seen in large numbers on the under surface of the terminal leaves as they prefer younger leaves for feeding and breeding. The female white fly is slightly bigger than the male.

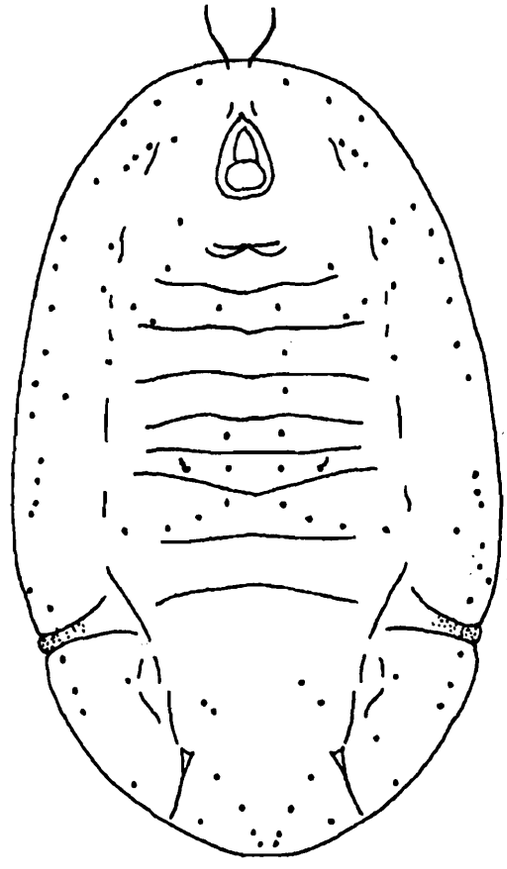
The female lays the eggs almost invariably on the under-surface of leaves mostly on the top and middle leaves of plant. The eggs are inserted in such a way that they are almost perpendicular to the leaf surface. The eggs have short fine subterminal stalks which are inserted into the leaf tissue.

A female lays 200-300 eggs either singly or in groups. Oviposition period ranges from 2 to 12 days. Freshly laid eggs are light yellow in colour and they turn brown to dark brown before hatching. Incubation period ranges from 3 to 5 days. In Punjab this varies from 3 to 73 days on cotton depending upon the season; 3 to 5 days in April-September, 5 to 17 days in Ocotober-November, 7 to 16 days in February-

March, 33 days in April-September, and from October onwards ranges from 17 to 73 days. Maximum hatchability is seen at 30-35°. Extreme high temperature results in the mortality of eggs.

There are four nymphal instars. The fourth instar is called the pupa. The immature stages except the first instar (crawler) are always sessile and the anus is situated dorsally in both nymphs and adults. Metamorphosis of white flies approaches the holometabolous type with a transit pupal stage. The first instar nymph is minute and flattened in appearance with bristles on margin and pale yellow in colour. It is provided with relatively well developed long legs and antennae, immediately upon hatching, it wanders in search of suitable site for feeding by crawling about on the under surface of leaf on which it hatched. Once the crawler finds a suitable feeding site, it inserts its mouth parts for feeding, loses its legs and antennae, secretes waxy filaments at the edge of the body and becomes sessile.

The second and third nymphal stages are elliptical in shape, and pale greenish yellow to deep-yellow in colour with 2-3 pairs of bristles. The nymphal period lasts for 9 to 14 days and extends upto 77 days in winter. The pupa is flat when freshly formed, later become slightly convex subelliptical and light yellow to dark yellow in colour. This pest being polyphagous, varies in the appearance of its pupal case depending on the host plants on which it develops. The generic classification of white



Figs. 296. Pupal case of *Bemisia tabaci*

flies is based on structure of the fourth instar, the so called pupa. During the advance stage of development the reddish eye of the developing adult can be seen below the transparent pupal skin. The outer covering of the so called pupa or pupal case is nothing but the body wall of the fourth instar nymph. The pupal period lasts for 2-8 days. The fully developed adults emerge through an inverted 'T' split rupture of the dorsal wall of the pupa. Sooner the adult starts to powder itself with white waxy powder secreted by the wax glands. The life cycle is completed within 13 to 20 days and may extend upto 107 days in winter depending upon temperature. About 12-15 overlapping generations may be noticed in a year.

Sexual reproduction is the general rule but parthenogensis occur to some extent. Males develop from unfertilized eggs whereas from the fertilized eggs both the sexes develop. Mating occurs within a day after emergence. Adults copulate several times. The preoviposition period is 2-3 days. Adult longevity is 10-20 days and males are short lived. Adults can fly to short distances, but wind can disperse them to several kilometers.

Host plants : It is a polyphagous pest species and has extremely wide host rage. It breeds and feeds on over 300 host plants of cultivated and non cultivated species. The important among them are cotton, brinjal, tobacco, sunflower, Lady's finger, tapioca, potato, sweet potato, tomato, pulses, cabbage, rape seed, radish, clusterbean, pea, melon, water melon, cucumber ribbed ground, coriander, *Achyranthes aspera, Ageratum conyzoides, Althea rosea, Bierhaevia diffusa, Carthamus tinctorus, C. oxycantha, Celosia* sp., *Chenopodium album, Cleome viscosa, Clerodendron infortunatum, Convolvulus arvensis, Corchorus tridens, C. trilocularis, Datura alba, Digera arvensis, Eclipta erecta, Euphorbia pilulifera. E. prostrata, Ipomoea* sp., *Launia aspleanifolia, Linum usitatissimum, Lippia geminata, Medicago denticulata, Melilotus parviflora, Nyctanthes arbortristis, Phyllanthus* sp., *Physalis peruviana, Sida cordifolia, Solanum nigrum, S. xanthocarpum, Sonchus oleraceus, S. arvensis, Trewia nudiflora, Trichosenthes dioica, Zinnia elegans, etc.*

Natural enemies complex : Several species of aphelinid parasites play major role in suppressing the population build up. The important ones are *Eretmocerus massi* (Hymenoptera : Aphilinidae) parasitising more than 30% older nymphs and pupae of this pest. *Chrysoperla* sp. and *Brumus* sp. (Coccinellidae) also prey upon its nymphs and adults. The natural parasitism was found to be as high as 85 per cent. The parasitised whitefly nymphs can be identified by observing the parasitic grub developing inside the transparent nymph. The parasitised pupae are dark brown to black in colour. The pupal case of whiteflies from which the parasites have emerged can be recognised by an irregular circular hole which is chewed out by the emerging adult parasite.

The eggs and first instar nymphs are preyed by the phytoseiid mite *Amblyseius* sp. The lace wing bug *Chrysopa* spp. and the coccinellids, *Brumus* sp. and *Scymnus* sp. are predaceous on nymphs and adults of white fly.

Distribution : It is distributed throughout the north-western and western regions of the Indian subcontinent.

Elsewhere : Palaearctic, Ethiopian, Madagascar, Oriental, Australian, Pacific and Neotropical regions.

Remarks : The white fly is well-known as a pest of cotton, tobacco and cassava, and also as a vector of virus diseases of crops including the leaf curl disease of tobacco, the vein clearing disease of Okra and the leaf curl of sesame, chilli; leaf curl, leaf crumple of cotton, cowpea yellow fleck, *Dolichos lab-lab* yellow mosaic, Groundnut yellow mosaic, Jatropha leaf curl, Jute yellow mosaic, Papaya leaf curl, Pigeonpea yellow mosaic, Pumpkin yellow vein mosaic, Soybean yellow mosaic, Sunflower mosaic, Tomato leaf curl, Tomato yellow mosaic, Tobacco leaf curl, Zinnia leaf curl etc. It was established by a few workers (*loc. cit.*) that in some aleyrodids considerable variations could occur in the structural details of setae, papillae, vasiform orifice, etc. in relation to hairy or glabrous nature of leaves of hosts, and as a result of detailed study a number of species of *Bemisia* were synonymised by Russell (1957). Apart from cotton the pest attacks other plants such as cabbage, cauliflower, mustard, melon, potato, brinjal, okra and some other weeds. These days, the species is recognised as pest of national importance due to its severe infestationon in cotton in Andhra Pradesh, Maharashtra, Tamil Nadu and the Punjab. Though it is not a serious pest of groundnut, its severity on this crop has been recorded at Delhi (Jayanthi *et al.* 1993). It's heavy population is observed to inflict considerable damage to both *kharif* and summer groundnut under Orissa conditions (Anonymous, 1993, 1994).

Management : Application of various insecticides against whiteflies prove effective control on cotton through monocrotophos and quinalphos (Atwal and Dhaliwal, 1997). Endosulfan, monocrotophos, methyl demeton on soybean (Sontakke and Mishra, 1992) and monocrotophos and abamectin on brinjal (Srinivasan and Sundara Babu 1998) also give better result against this pest. Neem based pesticide super neemol was found very effective against whitefly on cotton (Vadodaria *et al.* 1998) when synthetic pyrethroids were used for the better control of ballworms in cotton, population of whitefly was found to increase enormously. Repeated use of synthetic pyrethrids on brinjal caused severe increase of whitefly population (Sontakke 1992).Therefore, selective insecticides should be applied and the predators are to be conserved for the effective control of the whitefly pest.

Genus 4. ***Dialeurodes*** Cockerell, 1902

Type species : *Aleyrodes citri* Ashmead, 1885, *Florida Dispatch.* n.s., 11(ex Quaintance and Baker, 1917).

Diagnosis : Pupal case with well developed tracheal pores usually with internal teeth and tracheal folds with many fine tubercles. Vasiform orifice small, often with a row of teeth within its caudal margin; lingula concealed, 7th abdominal segment as long as 6th.

Key to the species of *Dialeurodes*

1. Tracheal folds tuberculate or dotted or with semicircular markings 2
– Trachaeal folds not showing as above; dorsal disc with rounded papillae; 14 pairs of subdorsal capitate setae of which 7 pairs on abdominal region .... *cardamomi*
2. Vasiform orifice almost circular; operculum semicircular; caudal margin of orifice with short acute irregular teeth ..... *citri*
– Vasiform orifice cordate, somewhat rounded; operculum similarly shaped but indented on lateral margins; caudal margin of orifice with 16-18 well defined fimbriae or teeth ..... *kirkaldyia*

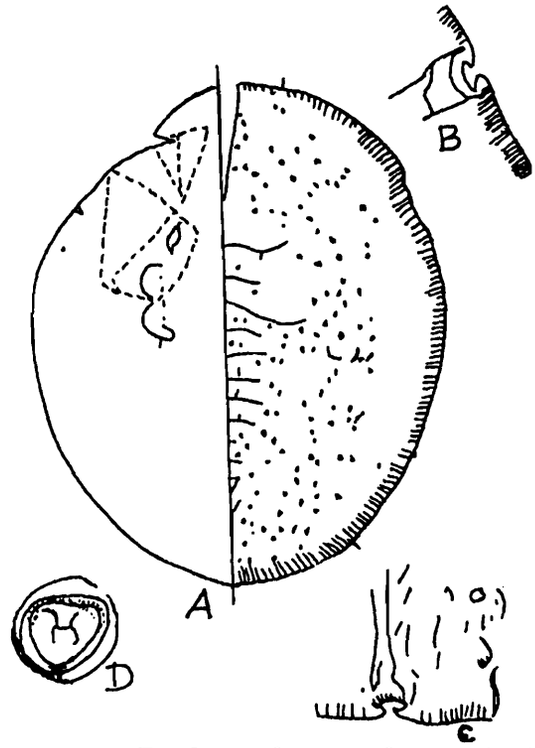
5. ***Dialeurodes cardamomi*** David and Subramaniam (Fig. 297)

1976. *Dialeurodes cardamomi* David and Subramaniam, *Rec. zool. Surv. India*, **70** (1-4) : 187.

Diagnosis : Pupal case pale white, elliptic, thin and flattened. Margin-CAP slightly crenulate, paired pointed anterior and posterior marginal setae, 21-23μ long. Thoracic and caudal pores distinct and invaginated without any comb or teeth. Dorsal surface—A pair of cephalic capitate setae, 10μ long and a pair of eighth abdominal capitate setae, 8μ long, caudad of vasiform orifice. Setae on first abdominal segment absent. Dorsal disc with numerous very short rounded papillae. Capitate setae fourteen pairs, arranged in a row on subdorsum. Submargin with radial striations extending from marginal crenulations. Thoracic transverse suture not reaching margin; abdominal segments distinct.

Vasiform orifice small, subcordate, as long as wide founded on the hind margin. Operculum wider than long; narrower at the distal part, covers over half the orifice exposing a little of setose lingula tip. Caudal furrow distinct and narrow.

Ventral surface : A pair of ventral abdominal pointed setae. Thoracic tracheal folds faintly discernible. First abdominal and posterior spiracles distinct. Antennal tip reaches base of prothoracic legs, a minute seta 16μ long, at base of each of meso- and metathoracic legs. (Adopted from David and Subramaniam 1976).



Figs. 297. *Dialeurodes cardamomi*. A. Pupal case, B. Thoracic tracheal pore, C. Caudal tracheal pore, D. Vasiform orifice

Host plant : *Eletteria cardamomum* (Cardamom).

Symptom and Damage : The nymphs and adults of the insect remain in colonies on lower leaf surface and suck sap. As a result, chlorotic patches appear on leaves which coalesce. Gradually, leaves turn yellow and get dried, resulting in reduced plant growth and poor yield. The nymphs secrete a sticky "honey dew" which drops on to lower leaves. On these, black sooty mould develops which inhibits the photosynthesis of the leaves.

Biology : Females lay eggs on lower surface of leaves. Eggs are cylindrical microscopic and are inserted into the leaf tissue by means of pedicel. Eggs when freshly laid, are pale yellow in colour which gradually turns to brown.

There are four nymphal stages including the 4th instar, the pupa. First stage larva, soon after emergence from egg, crawls over leaf surface in search of suitable feeding sites. It is very small, flattened in appearence, pale yellow in colour and bears a few bristles on its body margin. Once it pierces its slylet into leaf tissue for feeding, it becomes incapable of movement and the succeeding states of its life cycle are completed at the same site. Legs and antennae degenerate after the first moult.

The next two nymphal instars are elliptical and pale greenish to greenish yellow. During the advanced stages of its development, reddish eyes of the developing adult can be seen through the pupal skin. Puparia which adhere to the leaves after adult emergence, appear as scaly patches on lower surface of affected leaves.

Life cycle is completed within 2–3 weeks depending upon weather parameters. Hot humid climate is favourable for its multiplication. With the onset of monsoon, the insect gets automatically reduced in number.

Natural enemy complex : *Encarsia* sp. (Hymenoptera : Aphelinidae) is reported to be a nymphal parasite.

Distribution : Widely distributed in South India.

6. ***Dialeurodes citri*** (Ashmead)
Citrus whitefly

1885. *Aleyrodes citri* Ashmead, *Insect Life Wash.*, **7** : 323.

1916. *Dialeurodes citri* (Ashmead) : Quaintance and Baker, *J. agric. Res.*, **6** : 469.

1978. *Dialeurodes citri* (Ashmead) : Mound and Halsey, *In.* Whitefly of the world, Brit. Mus. (Nat. Hist.) and John Wiley & Sons; 133.

Diagnosis : Minute insects, measuring 1.02-1.50 mm, the males being smaller than the females. Head somewhat pointed. Antennae 6-segmented, basal joint thick and stout and the last segment terminating into a sharp point. Eyes transparent, red and kidney-shaped, with the lower half covered over the bristles. Wings more than twice as long as body and extend beyond the tip of the abdomen. Both body and the wings

completely covered with a white powder. Nymphs pale yellow, with purple eyes and their body is marginally fringed with bristles. Pupa broadly oval, pale yellow with an orange or yellow band near the middle of the body.

Host plants : *Ardisia humilis* (N.O. Myrsinaceae), *Jasminum sambac* (N.O. Oleaceae); *Ricinus communis* (N.O. Euphorbiaceae).

Symptom and Damage : The pest species damages in the larval and adult stages. As a result of sucking the cell-sap the leaves curl over and fall off. The sooty mould develops as a result of excretion of the honey dew by the nymphs. As such, it interferes the photosynthesis. Thus, the pest–infested plants suffer from stunty growth.

Biology : Although the pest is practically active throughout the year, the pupae are found from October to February and in June-July. The adults emerge from the pupae in February. The female lays eggs singly on the undersurface of young leaves. A single female may lay 200 eggs or more during its life time lasting from 7-10 days. In case of severe infestation, there may be as many as 2,000 eggs on a single leaf during March-April and August-September. The eggs hatch after 10-20 days. The larva on emergence crawls and after a few hours it inserts its proboscis into the succulent portion of the plant. The larvae remain on the spot in a stationary condition and later transform themselves into pupae. A nymph is full-fed in 25-71 days and subsequently changes into pupa. The adults after emergence settle on the undersurface of leaves. The insects are commonly found in spring and early antumn. All the stages are found from March to August.

Natural enemy-complex : *Encarsia lahorensis* (Howard) and *E. citufila* Silv. belonging to family Aphelinidae (Hymenoptera) are major parasitoids on this insect. Moreover, a number of predators are known to feed on the eggs and nymphs of this pest insect. The predators are : *Brumoides suturalis* (Fabricius), *Cryptognatha flavescens* Motsch, *Verania cardoni* Weire.

Distribution : The pest is very widely distributed in India.

Elsewhere : America, China, Mexico, Pakistan, Sri Lanka, Taiwan, Thailand and Vietnam.

Remarks : Although it is a pest of Citrus, the insect prefers to feed on certain deciduous plants. It is often seen on these trees in very large numbers but are not found in autumn when the leaves are shed. The insect is often found in association with other whiteflies species namely *Dialeurodes citrifolii* (Morgan), *Aleurocanthus husani* (Corbitt), *Aleurocanthus spinifers* (Quaintance) etc.

7. ***Dialeurodes kirkaldyi*** (Kotinsky), 1907

1907. *Aleyrodes kirkaldyi* Kotinsky, *Bd. Comm. Agric. and Forestry, Div. Ent., Hawaii, Bull.*, **2** : 95

1914. *Dialeurodes kirkaldyi* (Kotinsky), Quaintance and Baker, *U.S. Dept. Agric., Bur. Ent. Tech. Ser.* **27**(2) : 98.

1934. *Dialeurodes kirkaldyi* (Kotinsky), Priesner and Hosny, *Ministry of Agric. Egypt. Tech. and Sci. Service, Ent. Sect. Bull.* No. **139** : 2.

1976. *Dialeurodes kirkaldy* (Kotinsky) : David and Subramaniam, *Rec. zool. Surv. India,* **70**(1-4) : 192.

Diagnosis : Antennae slender, finger-like tip extending slightly beyond base of foreleg; all the four pairs of spiracles visible; Meso and metathoracic legs with a minute seta at base. Margin of pupal case toothed; margin with 12 pairs of setae, trachaeal folds tuberculate or dotted or with semicircular markings; operculum filling the orifice obscuring the lingula; vasiform orifice cordate, somewhat rounded, operculum similarly shaped but indented on lateral margins; caudal margin orifice with 16-18 well defined fimbriae or teeth; dorsal disc with a few scattered minute pores; ventral abdominal setae 14.

Host plants : *Jasminum auriculatum., Ficus religiosa.*

Distribution : Throughout southern India.

Elsewhere : Pakistan, Sri Lanka, Myanmar, China, Marienas islands, Taiwan, Philippines, Malaya, Australia, Caroline Is., Tuamotu, New Caledonia, Hawaiian Is., U.S.A., Cuba, Japan, Trinidad, Guyana.

Remarks : The species is a well known pest of Jasmine all over the world. It is abundantly found in South India where the pest is found to cause serious damage to this flowering shrub. The pest species in general appearance is close to *Dialeurolonga ambilaensis* Takahashi but can be separated in having a row of minute pores on submargin and in the structure of vasiform orifice.

Genus 5. ***Neomaskellia*** Quaintance and Baker, 1913

Type species : *Aleyrodes comata* Maskell, 1896.

The most diagnostic feature of the species under genus is possession of transversely oval vasiform orifice with a very short operculum exposing a broader than long lingula.

8. ***Neomaskellia bergii*** (Signoret, 1868)
Sugarcane spotted fly

1867. *Aleyrodes bergii* Signoret, *Soc. Ent. France, Ann.* **IV, 8** : 395.

1914. *Neomaskellia bergii* (Signoret), Quaintance and Baker, *U. S. Dept. Agric. Bur. Ent. Tech. Ser.,* **27**(2) : 104.

1976. *Neomaskellia bergii* (Signoret) : David and Subramaniam, *Rec. zool. Surv. India,* **70**(1-4) : 203.

Host plants : Sugarcane (*Saccharum officinarum*) *Sorghum vulgare, Cenchrus ciliaris, Setaria italica.*

Symptom and Damage : The nymphs suck plant sap and in case of severe attack, cause stunting of canes and drying of leaves.

Biology : This pest is most active on sugarcane during September-October. The female lays 120-150 eggs in circular or semi-circular masses on the underside of the leaves during an oviposition period of 2-3 days. The freshly laid white egg is elliptical in shape and it turns black later on. The eggs hatch in 2-3 days. There are four moultings during larval period of 5-7 days and the life-cycle is completed in 15-18 days in September and 18-25 days from October onwards.

Natural enemies complex : The puparia are attacked to the extent of 45 per cent by parasities, *Eretmocerus delhiensis* Mani, *Encarsia neomaskelliae* Prasad and *E. isasci* Mani (Aphelinidae). The parasitized puparia turn dark in colour and can easily be distinguished from non-parasitized ones.

Predator : *Scymnus* sp. (Order : Coleoptera).

Distribution : Throughout India.

Elsewhere : Sri Lanka, Bangladesh, Thailand, Taiwan, Java, the Philippines, Reno, Manila, Mauritius, Fiji, Borneo, Sudan, Uganda, Tanzania, South Africa, Malawi, Caroline Is., New Zealand, Samoa, Tahiti, Australia, Zambia, Nigeria, Cameroun, Sao Tome, Congo, Zaire, Japan.

Remarks : The pest is injurious in the nymphal stage only and apart from sugarcane it also attacks sorghum. The nymphs are pale brown to dark in colour and are covered with white wax. The adult flies are pale brown with black markings on the forewings. The hind wings are short, thin and more or less transparent. This is a well known pest species found in Sugarcane in the Tropics from Mauritius to the Pacific. It is the most wide spread species in India.

Genus 6. ***Trialeurodes*** Cockerell, 1902

Type species : *Aleurodes pergandei* Quaintance, 1900, *Bull. U. S. Bur. Ent.*, **8** : 1-43.

Diagnosis : Presence of submarginal papillae with wax secreting pores and trilobed lingula in the cordate orifice. Also, the dorsal surface of pupa is usually elevated from the leaf surface and a vertical waxy palisade is evident.

Key to the species of *Trialeurodes*

Submarginal papillae all equal in size; papillae absent on subdorsum .... *ricini*

– Submarginal papillae not all equal in size; subdorsal papillae variable in number ..... *vaporariorum*

9. *Trialeurodes ricini* (Misra), 1923
Castor whitefly

1923. *Aleyrodes ricini* Misra, *Proc. 5th ent. Mtg. Pusa*, 129-135.

1931. *Trialeurodes ricini* (Misra) : Singh, *Mem. Dept. Agric. India,* Ent. Ser. **12**(1) : 46.

1976. *Trialeurodes ricini* (Misra) : David and Subramaniam, *Rec. zool. Surv. India*, **70**(1-4) : 215.

Diagnosis : Pupal case 0.62-0.63 mm long and 0.39-0.40 mm wide. Margin irregularly crenulate with 25 crenulations in 0.1 mm. Tracheal pore areas strongly marked by narrowness and depth of 6-8 crenulations. Anterior and posterior marginal setae 11-14μ long. Dorsal surface–Submarginal papillae, 68-73 evident; dorsal setae 3 pairs–cephalic setae 22, first abdominal setae 19; eightth abdominal setae lateral of anterior margin of operculum, 14 long. A pair of submarginal caudal setae 25μ long. Seventh abdominal segment medially very much shortened. Fasiform orifice with fine teeth internally on posterior margin and lateral walls; 50μ long, 50μ wide; operculum 28μ long, 30μ wide; lingula with a pair of setae subapically, exposed. Ventral surface–two thick conical setae at base of legs. All the four pairs of spiracles evident.

Host plants : *Achras zapota, Brevnia rhamnoides, Ricinus communis, Euphorbia* sp., *Murraya koenigii, Phyllanthus* sp., *Rosa* sp., *Anona glabra* and *Gossypium hirsutum.*

Distribution : India : Pusa (Bihar), Nadiad (Bombay), Baroda, Bhagalpur, Hyderabad (Andhra Pradesh), Coimbatore and Madras (Tamil Nadu). Also knwon from Middle East, Malaya.

Symptom and Damage : As a result of sucking of sap by the nymphs the leaves show yellow patches initially. Later on, there is a gradual drying of the leaves and ultimately the plants die.

Life-cycle : This pest is active from February to November. The eggs are laid in small clusters on the undersurface of tender leaves. On emergence, the nymphs attach themselves to leaves and become full-grown after four moultings. The life-cycle is completed in 19-21 days during July, August and September.

Natural enemies-complex : The lady birds, *Cryptognatha flavescens* Motsch., *Brumoides suturalis* (Fabricius) and *Sticholotis* sp. (Coccinellidae); a drosophilid fly, *Acletoxenus indica* (Drosophilidae) and the lygaeid bug, *Geocoris bicolor* Fabricius (Lygaeidae) are predacious on the nymphs of this pest. *Encarsia lahorensis* Howard and *Aphelinus fuscipennis* (Aphelinidae) parasitize the nymphs.

Remarks : The castor whitefly has been reported from India and Pakistan. It is primarily a pest of castor but the nymphs also feed on the leaves and stems of *Breynia rhamnoides* and *Achras zapota*. The nymphs are transluscent, light yellow in colour and are covered with thick waxen filaments. The adults are pale yellow with white wings covered with waxy powder.

Management : Spray 1.70 litres of dimethoate 30EC or 1.25 litres of malathion 50EC or 500 ml of fenitrothion 50EC in 1250 litres of water per ha.

10. ***Trialeurodes vaporariorum*** (Westwood), 1856
(Fig. 298)

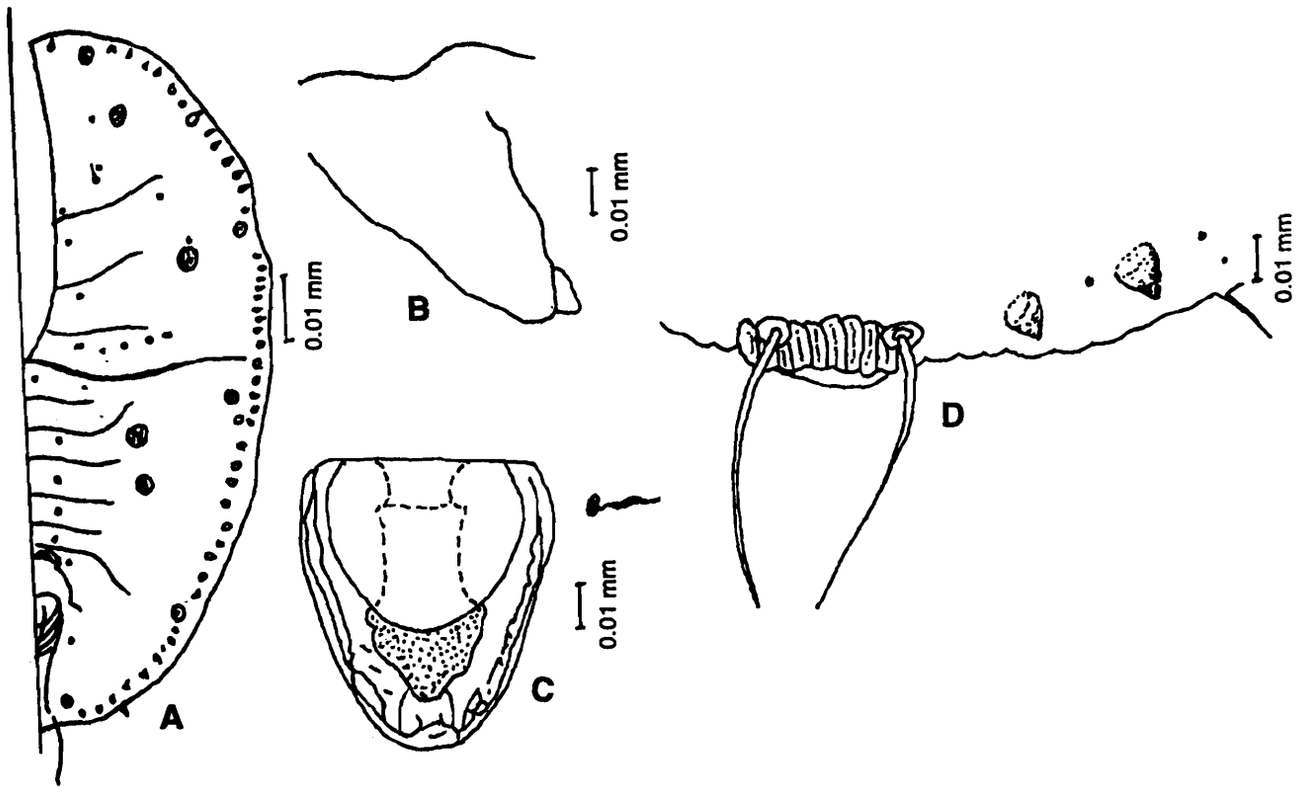
1856. *Aleurodes vaporariorum* Westwood, 1856, *Odnr's Chron*, **1856** : 852.

1914. *Asterochiton vaporariorum* (Westwood), Quaintance and Baker, *Tech. Ser. Bur. Ent. U. S.* **27**(11) : 95-114.

1948. *Trialeurodes vaporariorum* (Westwood), Russell, *Misc. Publs. U. S. Dept. Agric.* **635** : 85.

1976. *Trialeurodes vaporariorum* (Westwood) : Mound and Halsey, *In* White Fly of the World, British Mus. *(Nat. Hist)* : 219.

Pupal case : Length 0.78-0.83 mm, width 0.48-0.53 mm. *Dorsal surface* : Submarginal papillae more than 50; 6 large pairs are evident–2 pairs on cephalic region, 1 on prothoracic segment, 1 just posterior to transverse moulting suture, and 1 each on sixth and eighth abdominal segments; submarginal disc pores mostly distad of papillae, a few usually mesad or laterd. Four pairs of subdorsal papillae, one pair on each of cephalic, mesothoracic and third and fourth abdominal segments evident; papillae directed vertically, nearly uniform in size. *Ventral surface*–A minute seta at base of meso- and metathoracic legs present. (After David and Subramaniam, 1976.)



Figs. 298. *Trialeurodes vaporariorum* : A. Pupal case, B. Mesothoracic leg, C. Vasiform orifice, D. Caudal tracheal end.

Host Plant : *Solanum tuberosum.*

Distribution : In India the species is usually found in Southern India.

Remarks : Detailed study on life-cycle of the species is not known in India. This greenhouse whitefly is known to have a wide range of hosts (Russel 1963) and has been noticed to infest *Solanum tuberosum* (Potato) in the Nilgiris in South India.

Management : Same as in case of *T. ricini.*

11. ***Aleurodicus dispersus*** Russell
(Mealy whitefly/Spiralling whitefly)
(Figs. 433, 434)

This whitefly pest is commonly known as "Spiralling whitefly" due to its egg laying habit in which the eggs are deposited on a loose spiral with waxy outgrowths resembling fingerprints. The whitefly had its origin in Central America. It was reported from Sri Lanka in 1989 on guava and has since been reported on over 50 plants in country (Chandrasekara, 1990). This pest was recorded on cassava at Trivandrum (Palanisami *et al.* 1995) and on 24 hosts including guava, mulbery, papaya, coconut, cashew and banana from Calicut in Kerala upto Kanyakumari in Tamilnadu (David and Regu 1995). Most likely that the pest got introduced into the Southern-most regions of India from Sri Lanka. The pest species is seen to increase drastically in summer and decrease after the premonsoon showers (Ranjith *et al.* 1996). Nymphs of *A. dispersus* secrete white waxy outgrowths over their body causing a white mealy cover resembling mealy bug and it is very often confused for mealy bugs. The pest is spreading at an alarming rate onto newer locations and host plants in Southern India specially in Kerala.

This is highly polyphagous pest infesting lower surface of leaves of host plants. Outbreak of *A. dispersus* in 1995 and 1996 was observed and 72 host plants were recorded. Of these, 45 are cultivated (Prathapan, 1996).

Host Plants : *Abelmoschus esculentus; Acalypha hispida; A. indica; A. wilkesiana; Ailanthus malabarica; Anacardium occidentale; Anona squamosa; Antigonon leptopus; Artocarpus hirsuta; Bauhinia purpurea; Bixa orellana; Bridelia retusa; Cajanus cajan; Calopogonium muconoides; Calotropis gigantea; Calycopteris floribunda; Canna indica; Capacium annuum; C. frutescens; Cardiospermum halicacabum; Careya arborea; Carica papaya; Centrocema pubescens; Chrysophyllum cainito; Clerodendron thomsonae; Coccinia indica; Cocos nucifera; Dahlia* sp.; *Datura.* sp. *Dillenia pentagyna; Enterolabium saman; Eugenia jambolana; Euphorbia geniculata, E. pulcherrima; Excoecaia agallocha; Ficus elasticoa, F. gibbosa, F. glomerata; Ipomoea muricata; Tatropha* sp.; *Macaranga peltata; Malavaviscus arboreus; Manihot glaziovii, M. utilissima; Morus alba; Musa* sp.; *Pithecolobium bulci; Plumeria acuminata; Plumbago*

ceylonica; Polyalthia longifolia; Pongmia glabra; Psidium guajava; Quisqualis indica; Ricinus communis; Rosa sp.; *Santhim album; Salvia* sp.; *Sauropus androgynus; Sida acuta; Sida* sp. *Solanum melongena, S. nigrum; Spathoglotis* sp.; *Tecomaria capensis; Tectona grandis; Terminalia catappa; Urena lobata; Vitex altissima; Zizyphus jajuba, Zizyphus oenoplia.*

Apart from above, the following is the list of additional host records of the mealy whitefly (*A. dispersus)* from Kerala State :

Crop plants : Pepper, Tomato, Brinjal, Curry leaf, Custard apple, Jack, Chekurmanis, Kokam, Capsicum. *Ornamentals* : Balsam, Poinsettia, Dahlia, Heliconia, Sanchezia, Acalypha, Rangoon creeper, Bauhinia; *Trees* : Teak, Ceara rubber, Boddi; *Weed plants* : Sunberry, Glyricidia (Ranjith *et al.* 1996).

Natural enemies complex : Aphlinid parasitoid *Encarsia haitiensis* (Hymenoptera : Aphelinidae); Spiders.

Distribution : India : Southern part (widely distributed).

Elsewhere : Sri Lanka, U. S. A.

Management : Chemical control of the pest is difficult and its effectiveness questionable (Wijeskara and Kudagamage, 1990). Therefore, it is important to identify the natural enemies and also introduce natural enemies from its native homeland. Many spider species are seen to prey the pest species but due to its polyphagous nature, an effective control by them is not expected. Ideal way to reduce the impact of the pest appears to be biological control with the help of the parasitoid *Encarisia haitiensis* (Hymenoptera).

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INSECTA : HEMIPTERA : HOMOPTERA : CERCOPOIDEA

The Cercopids or the "Frog hoppers" or "Cuckoospits" or "Spittle bugs" are one of the economically important insects belonging to Auchenorhynchous Homoptera. These are jumping insects; usually brown or grey and sometimes variously coloured.

The group is characterised chiefly by two ocelli on vertex; hind tibiae with stout teeth and with short spines at the tip usually with a series or circlet of spines at apex; hind coxa short and conical. The nymphs live on grasses of spittle-like froth on the arial shoots of plants or underground at the roofs of plants in cavities filled with froth. Postclypeus greatly expanded, hind coxae mobile, short, conical, tegmina opaque.

These insects feed on shrubs and herbaceous plants. The nymphs remain inside a frothy spittle mass resting head downward on the plant. That is why they are called "Spittle bugs" which are often seen in meadows, on grasses along rice fields. In each frothy matter brownish or greenish nymphs are seen.

The group is represented by about 2368 species belonging to 326 genera in the world (Animal Resources of India, State of the Art, 1991). In India, nearly 200 species belonging to 40 genera are known through the works of Gardiner, 1974; Atkinson, 1885(a,b); Distant 1908, 1916; Lallemand, 1949, Metcalf, 1960, 1962(a,b); Dutta and Ghosh 1976 and Biswas, Ghosh and Basu 1994; Biswas, Ghosh and Ghosh 1998; Biswas and Ghosh 2003. The classification is chiefly followed after Distant (1908-1916) and Lallemand (1949).

MATERIAL AND METHOD

Cercopids, like most other hemipteran insects, are phytophagous in habit and feed on agricultural crops, vegetables etc. They are usually collected by sweeping with the help of insect net or by light trap at night.

The collected materials are killed in a killing jar using benzene or specimens chloroform vapour and preserved dry with paradichlorobenzene and naphthelene. The specimens are kept in the insect envelope and labelled properly mentioning locality, altitude, date of collection, name of collector, ecological notes etc. In laboratory, the specimens are set, pinned and mounted to display properly for easy handling under the binocular microscope during the process of identification.

SYSTEMATIC ACCOUNT

Superfamily CERCOPOIDEA

Family I. •APHROPHORIDAE

Genus 1. ***Clovia*** Stal

1. *Clovia lineaticollis* Mots.

2. *Clovia puncta* (Walker)

Genus 2. ***Poophilus*** Stal

3. *Poophilus costalis* (Walker)

Family II. CERCOPIDAE

Genus 3. ***Cosmoscarta*** Stal

4. *Cosmoscarta naiteara* Distant
5. *Cosmoscarta thoracica* Distant

Genus 4. ***Eoscarta*** Bredd.

6. *Eoscarta nilgiriensis* (Distant)

Genus 5. ***Phymatostetha*** Stal

7. *Phymatostetha deschamsi* Lethiery

Family III. MACHAEROTIDAE

Genus 6. ***Machaerota*** Burmeister

8. *Machaerota ensifera* Burmeister
9. *Machaerota planitiae* Distant

Genus 7. ***Machaeropsis*** Melichar

10. *Machaeropsis valida* Melichar

Key to families of the superfamily CERCOPOIDEA

1(2). Anterior margin of pronotum rounded or angulate; eyes moderately transverse 3

2(1). Anterior margin of pronotum straight; eyes equally long as broad ..... CERCOPIDAE

3(4). Scutellum strongly elevated, posteriorly compressed, armed with a long apical spine ..... MACHAEROTIDAE

4(3) Scutellum flat, triangular ..... APHROPHORIDAE

Family I. APHROPHORIDAE

Key to the genera of family APHROPHORIDAE

Face more or less convexly produced; clypeus slightly passing the apices of the anterior coxae ..... ***Poophilus***

– Face more or less flattened, not convexly produced ..... ***Clovia***

Genus 1 ***Clovia*** Stal

1866. *Clovia* Stal, *Hem. Afr.* **4** : 75.

Type species : Clovia bigoti Sign.

Diagnosis : Body somewhat oblong, head anteriorly or subangularly rounded and as broad as pronotum, flat above, anterior margin of the lobes of the vertex acute, face somewhat convex; clypeus moderately produced at apex; pronotum sexangular, with the anterior lateral margins usually very short, parallel, or very slightly diverging backward; scutellum longer than broad; tegmina with the commissural margin beyond apex of clavus subangulated or a little rounded.

Key to species of genus *Clovia*

1. Head a little shorter than the medial length of pronotum; with some very indistinct darker longitudinal lines ..... *puncta*

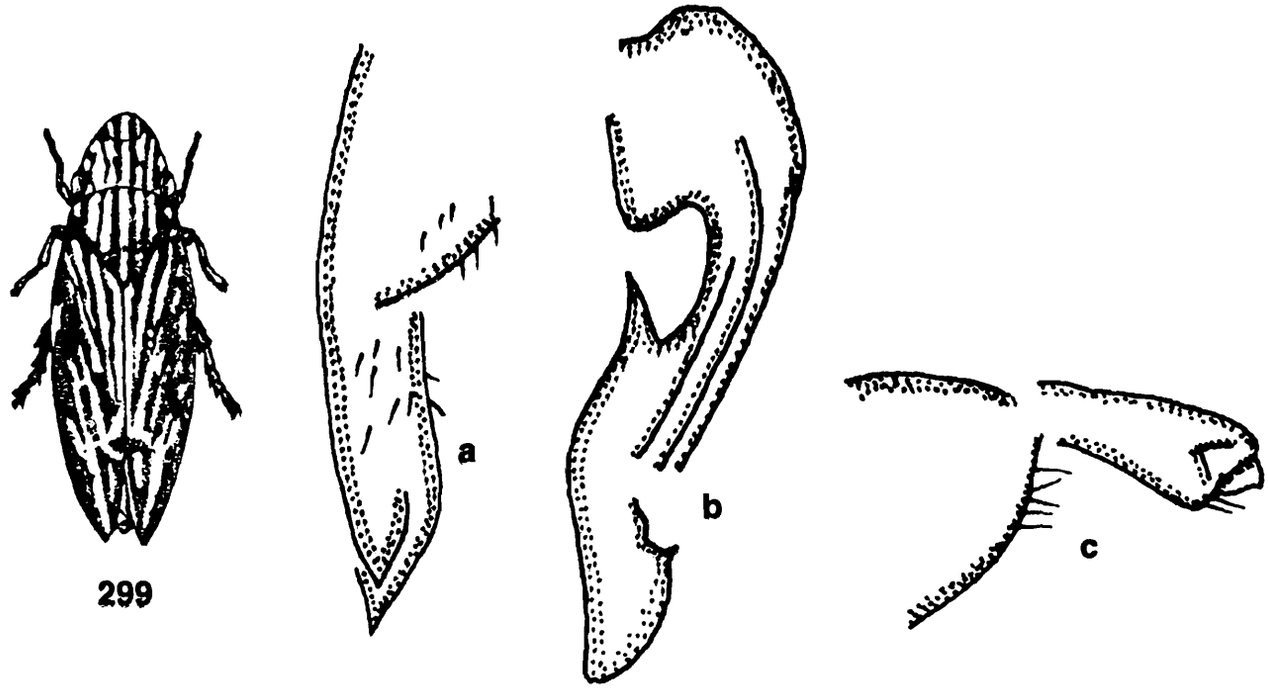
— Head about as long as the medial length of pronotum ..... *lineaticollis*

1. *Clovia lineaticollis* Motschulsky
(Fig. 299)

1859. *Aphrophora lineaticollis* Motschulsky, *Etud. Ent* : 110.

1908. *Clovia lineaticollis* : Distant, *Fauna Brit. India,* **4** : 95.

Diagnosis : Body elliptical, chestnutbrown above, with fine longitudinal fasciae between the eyes, continued posteriorly through pronotum, scutellum and basal area of tegmina; tegmina with a large costal spot before middle, the veins and two longitudinal fasciae on apical area ochraceous; head as long as pronotum; tegmina



Figs. 299. *Clovia lineaticollis* Motsch. a. male plate; b. paramere; c. aedeagus.

about 2½ times as broad; legs pale ochraceous; *Genitalia* : Male plate as figured (Fig. 299a); paramere (Fig. 299b): apical ¼ and stylar shaft slightly constricted, broadened apically, apical margin truncate with a short triangulate structure. Aedeagus (Fig. 299C) deeply notched at inner apical third, lateral margin deeply excavate followed by a short anteriorly directed pointed process (Fig. 299C).

Length : 10 mm.

Distribution : India.

Elsewhere : Sri Lanka.

Remarks : The species causes curling up of tender foliage of Jackfruit (*Artocarpus heterophyllus*)

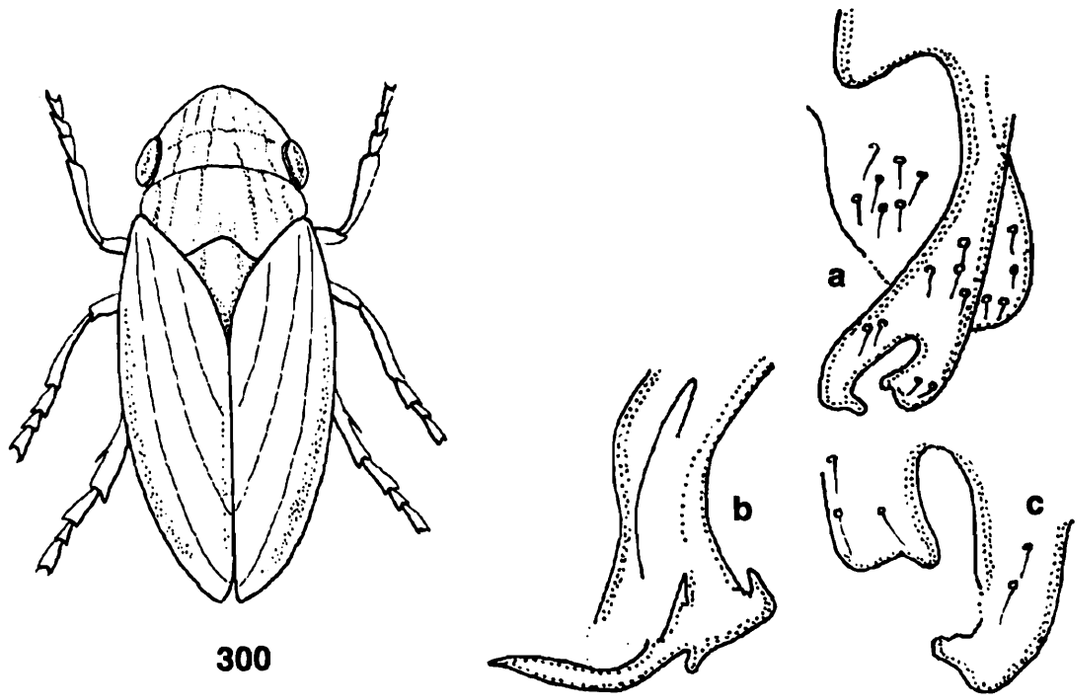
2. ***Clovia puncta*** (Walker)
(Fig. 300)

1851. *Ptyelus puncta* Walker, *Hist. Hem.*, **3** : 718.

1908. *Clovia puncta* : Distant, *Fauna Brit. India*, **4** : 94

1994. *Clovia puncta* : Biswas, Ghosh & Basu, *Fauna of West Bengal, State Fauna Series*, 3(Part 5) : 18.

2000. *Clovia puncta* : Ghosh, Biswas and Ghosh, Insecta : Hemiptera : Cercopoidea : Cicadelloidea : Cicadoidea and Fulgoroidea. In : *Fauna of Tripura, State Fauna Series*, 7(Part-2), Zool. Surv. India : 320.



300

Figs. 300. *Clovia puncta* Walker : a. Male plate; b. Stylar shaft modifed; c. Aedeagus.

Diagnosis : Pale brown insect; head a little shorter than the medial length of pronotum; face piceous, its lateral margins and lateral margins of sternum greyish; sternum with a piceous spot behind each anterior coxa; anterior margin of face with a black spot on each side, tegmina with a small black spot at posterior angle of inner margin, anterior margin of face pale ochraceous, with a black spot on each side, pronotum with some very indistinct darker longitudinal lines. *Genitalia* : ♂ plate (Fig. 300a) simple, oblong; stylar shaft (Fig. 300b) bilobed, distinctly spanner-shaped apically, inner lobe pointed laterally, outer lobe bidented, both lobes with tuft of string bristles. Aedeagus (Fig. 300c) rod-shaped, sinuate medically, posterolaterally with a furrow and with a hook-shaped stout sharp apical process directed laterocephalad.

Length : 6 mm.

Distribution : India : Bihar, Gujarat, Maharashtra, Madhya Pradesh, Sikkim, Tripura, West Bengal.

Elsewhere : Oriental; Ethiopian and Australasian regions; China; Hongkong; Japan; Java.

Remarks : The species is characterised in having body of uniform pale colouration above and with black spot near the apex of inner margin to tegmina. It has been reported to cause typical leaf yellowing in rice in India and other countries like Japan, Taiwan. In South India, it also occurs on *Santalum album.*

Genus 2 ***Poophilus*** Stål

1866. *Poophilus* Stal, *Hem. Afr.*, **4** : 72.

Types species : Poophilus actuosus Stål

Diagnosis : Head subangularly rounded, a little narrower than the pronotum, anterior margin acute; apex of the clypeus slightly passing the apices of the anterior coxae; ocelli equally separated from each other than from eyes. Pronotum with anterior margin broadly rounded, tegmina apically narrowed, costal margin rounded; wings broader than tegmina.

3. ***Poophilus costalis*** (Walker)
(Fig. 301)

1851. *Ptyelus costalis* Walker, *List of specimens of Homopterous ins. in the Coll. of the Brit. Mus.*, **3** : 707.

1885. *Poophilus costalis* : Atkinson, *Asiatic Soc. Bengal Jour.*, **54** : 144.

1908. *Poophilus costalis* : Distant, *Fauna Brit. India,* **4** : 86.

1994. *Poophilus costalis* : Biswas, Ghosh and Basu, Insecta : Hemiptera : Homoptera : Cercopidae. *In* : *Fauna of West Bengal, State Fauna Series,* **3**(part 5) : 14. Z.S.I.

2000. *Poophilus costalis* : Ghosh, Biswas and Ghosh, Insecta : Hemiptera : Cercopoidae,

Cicadelloidea, Cicadoidea and Fulgoroidea. *In* : *Fauna of Tripura, State Fauna Series,* 7(part 2) : 320. Zool. Surv. India.

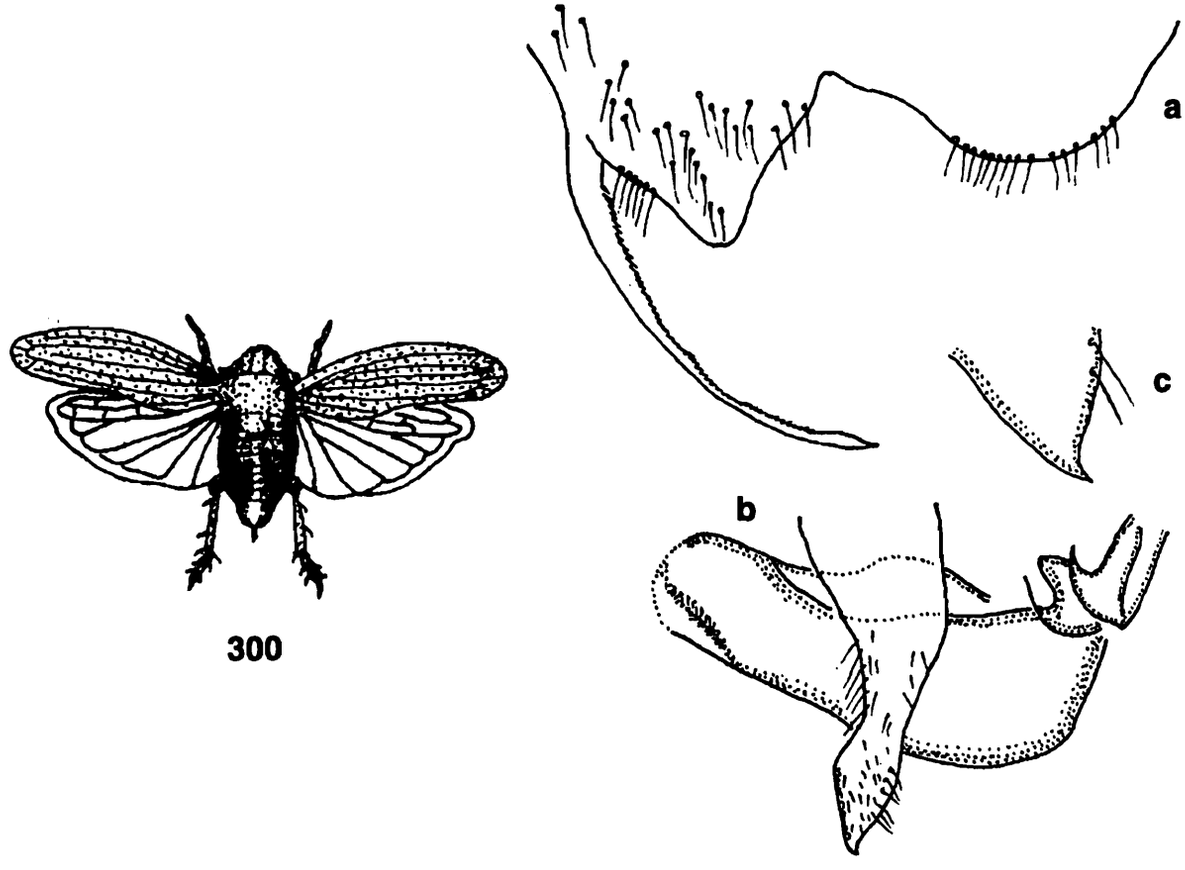
Diagnosis : Brownish yellow; central and apical margin of vertex with five very small black spots; disc of the sternum, anterior and the intermediate legs brownish black to black with a reddish tinge, but apices of the femora pale; tegmina with costal margin pale which becomes broader on apical area. *Genitalia* : Style : Stylar shaft stout, truncate, its apex feebly pointed and curved laterally. Male plate densely setose, posterior margin rotundate; pygofer (Fig. 301a) stout, posterior margin triangulate, an elongate slender, flagelliform process originating each side from inner margin; paramere (Fig. 301b): basal ¾ broader, stylar shaft stout, subtruncate, apex feebly pointed (Fig. 301c); aedeagus robust with a pair of hook-shaped processes originating from middle of shaft.

Length : 9-10 mm.

Distribution : India : Gujarat, Maharashtra, Mysore, West Bengal.

Elsewhere : Africa, China, Japan, Malaya, Philippines, Siam, Singapore.

Remarks : The species has been reported to cause leaf yellowing in rice in India. It is more prevalent in Southern India.



Figs. 301. ***Poophilus costalis*** (Walker) : a. pygofer; b. paramere; c. apex of paramere magnified.

Family II. CERCOPIDAE

Key to the genera of family CERCOPIDAE

1(2) Face with a longitudinal furrow ..... ***Eoscarta***

2(1) Face without a furrow 3

3(4) Pronotum with the posterior lateral margins straight and sinuate, it's greatest width a little more than half of its length ..... ***Phymatostetha***

4(3) Pronotum with the posterior lateral margins not sinuate, its greatest width about two third of its length ..... ***Cosmoscarta***

Genus 3. *Cosmoscarta* Stål, 1869

1869. *Cosmoscarta* Stål, *Hem. Fabr.* ii : 11.

Type species : *Cosmoscarta heros* Fabricius.

Diagnosis : Body elongately oval; head, pronotum, scutellum and sternum bluish black; front very large and tumid, obtuse, extended on the facial side almost to the eyes, without longitudinal furrow; posterior tibiae with a strong spine beyond the middle and a small spine at base; tegmina with distinct markings.

Key to species of *Cosmoscarta*

1. Larger in size; posterior tibiae with a short spine near base and a long one beyond middle ..... *naiteara*

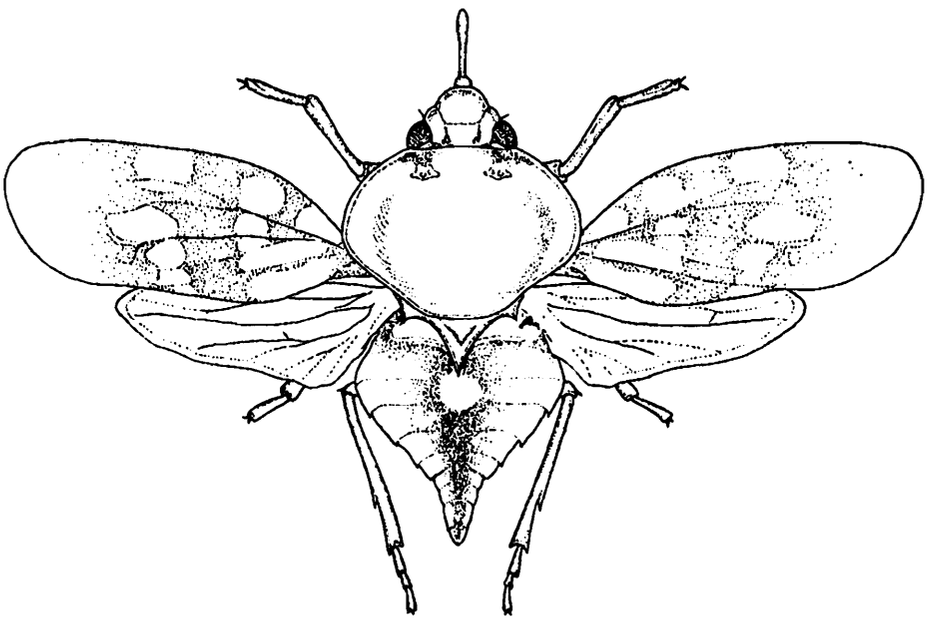
— Smaller in size; posterior tibiae with a very short spine near base and long spine before middle ..... *thoracica*

4. *Cosmoscarta naiteara* Distant
(Figs. 302, 436)

1900. *Cosmoscarta naiteara* Distant, *Tr. E. S.* t. ix, fl : 668.

1908. *Cosmoscarta naiteara* : Distant, *Fauna Brit. India,* **4** : 142.

Diagnosis : Head with two basal spots, transversely impressed infront of eyes, pronotum also with two rounded spots on anterior area; apical part of scutellum body and legs bluish black; pronotum wrinkled and punctate, longitudinally centrally carinate on anterior half; scutellum foveate at base, transversely wrinkled on lateral and apical areas; face globose and wrinkled on apical area; rostrum reaches 2nd coxae; tegmina piceous, basal third ochraceous with the veins as a transverse spot on discoidal area piceous, with macular ochraceous fascia at about one third from apex; wings smoky hyaline; tegmina about 2½ times longer than broad; legs bluish black, posterior tibiae with a short spine near base and a long spine beyond middle.



Figs. 302. *Cosmoscarta naiteara* Distant

Length : 40-48 mm (Expanded tegmina)

Distribution : India : Southern part.

Remarks : The species is one of the minor pests in the country. Not much known about its biology in India.

5. ***Cosmoscarta thoracica*** Distant
Banded spittle Bug
(Fig. 303)

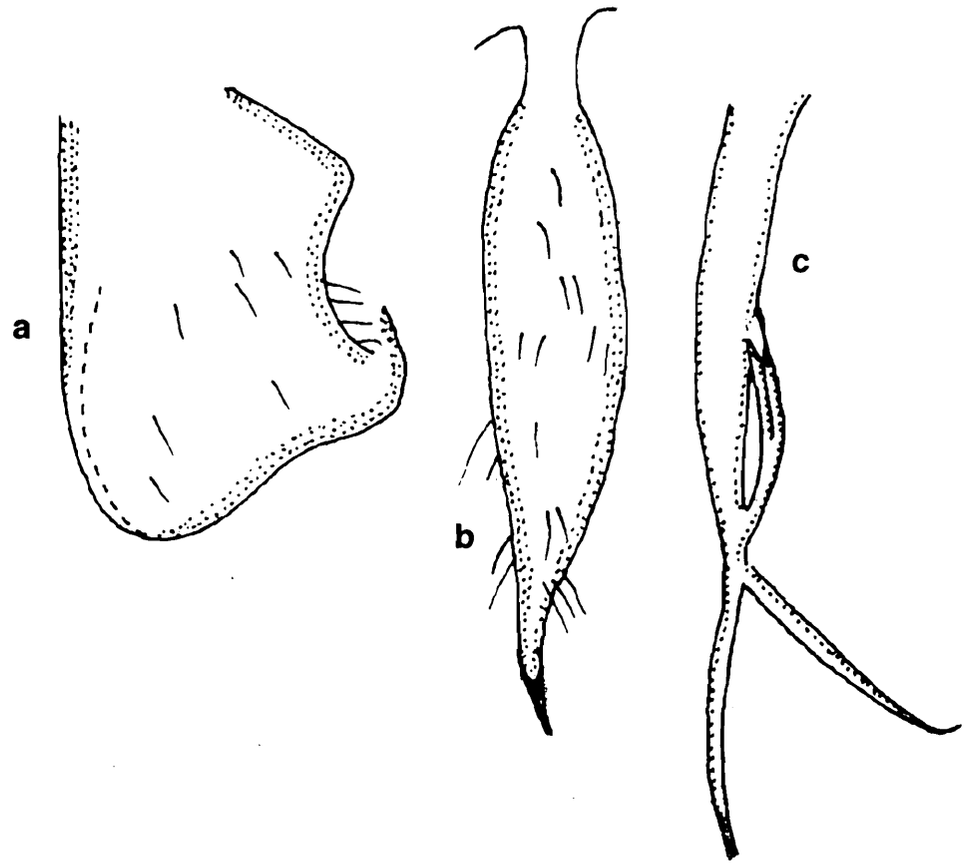
1900. *Cosmoscarta thoracica* Distant, *Tr. E.S., :* 680

1908. *Cosmoscarta thoracica* : Distant, *Fauna Brit. India,* **4** : 138.

1912. *Cosmoscarta thoracica* : Lallemand, *Gen. Insects,* 143 : 137.

1994. *Cosmoscarta thoracica* : Biswas, Ghosh and Basu, Insecta : Hemiptera : Cercopidae. *In* : *Fauna of West Bengal, State Fauna Series,* **3** (Pt. 5) : 12. Zoological Survey of India.

Diagnosis : Body elongated oval, head black; pronotum ochraceous and a very broad fascia between the lateral angles of pronotum; scutellum ochraceous, black at base; tegmina black with three transverse ochraceous fasciae, one at the base, one about one third from the base and the other before apical area; pronotum thickly and finely punctate; face with a broad central impunctate impression; rostrum reaching 2nd coxae; posterior tibiae with very short spine near base and long spine before middle; tegmina a little more than twice as long as broad. *Genitalia* : Male plate (Fig. 303a) robust, simple; style (Fig. 303b) robust, elliptical, abruptly narrowed and twisted near apex; aedeagus (Fig. 303c) cylindrate, with two pairs of sharp slender terminal processes, shorter ones curved, directed anteriorly, longer one straight, directed posteriorly.



Figs. 303. *Cosmoscarta thoracica* Distant : a. male plate; b. style; c. aedeagus.

Alternative hosts : Coffee, Jack.

Length : 18-19 mm. (expanded)

Distribution : India : Kerala, Tamil Nadu, West Bengal.

Elsewhere : Oriental, Malayan and Eastern Palaearctic Regions.

Management : When severe, spraying with either carbaryl or malathion @ 0.05% early in June will be effective.

Remarks : This insect is a seasonal pest on cardamom leaves. The nymphs and adults pierce and suck the sap from the veins causing chlorosis. They are abundantly seen from June to October. Often the adults are seen at the top of banana leaves exposed to evening sun. Adults are medium-sized, brown black with three orange coloured cross bands on fore wings. Head and thorax black and the latter bordered with a thick organge line.

Genus 4. ***Eoscarta*** Bredd.

1902. *Eoscarta* Bredd., *Soc. Ent.*, xvii : 58.

Type species : *Eoscarta eos* Bredd.

Diagnosis : Body elongately oval; head forwardly reclined; face strongly laterally compressed; pronotum not laterally dilated, with basal margin truncate or a little sinuate; wings without triangular costal appendage; hind tibiae with one spine; face longitudinally sulcate.

6. ***Eoscarta nilgiriensis*** (Distant)
Brown spittle Bug
(Fig. 304)

1900. *Cosmoscarta nilgiriensis* Distant, *Tr. E.S.* : 681

1908. *Eoscarta nilgiriensis* (Distant) : Distant, *Fauna Brit. India,* **4** : 117.

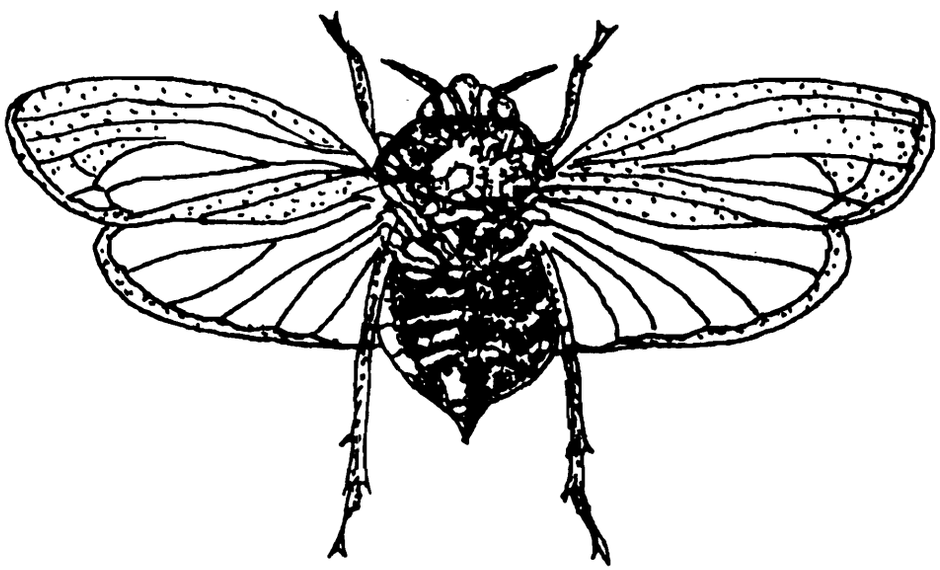
Diagnosis : Body elongate; head, pronotum, scutellum and tegmina finely densely pilose; pronotum foveate on each side behind anterior margin, its lateral margins somewhat laminate, surface finely punctate; face anteriorly sulcate, its lateral areas with strong transverse striations; presence of single strong spine in the posterior tibiae apically; legs dull reddish; tegmina castaneous; wings fuliginous.

Length : 24 mm (tegmen expanded)

Distribution : India : Southern part.

Elsewhere : Malaya.

Remarks : The species is a seasonal pest on cardamom and various shade plants. The adults are medium-sized, wedge-shaped, shiny brown and active hoppers. The damage is caused by both nymphs and adults. They suck the sap from leaves causing chlorosis. The adults congregate in abudance mostly on lower surface on the young leaves from June to September. They disappear from October onwards.



Figs. 304. *Eoscarta nilgiriensis* (Distant)

Genus 5. ***Phymatostetha*** Stal

1870. *Phymatostetha* Stal, *Ofv. Vet.-Ax. Forh* : 721.

Type species : *Phymatostetha perspicillaris* White

Diagnosis : Pronotum with the posterior margin before the scutellum slightly sinuated, posterior lateral margins straight or sinuated; two conical tubercles present on mesonotum posteriorly; posterior tibiae armed with one or two prominent spines, basal one well developed.

7. ***Phymatostetha deschamsi*** Lethiery
(Fig. 305)

1892. *Phymatostetha deschampsi* Lethiery, *Bull. Soc. Zool. Fr.* : 208.

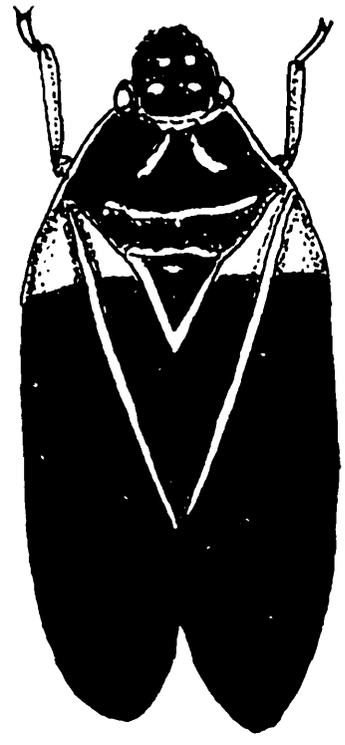
1908. *Phymatostetha deschampsi* : Distant, *Fauna Brit. India,* **4** : 128.

Diagnosis : Body somewhat elongately oval; shining black head transversely impressed in front of eyes; pronotum black, the posterior area usually sanguineous, body beneath and legs pale sanguineous; a subquadrate spot on lateral margins of prosternum behind eyes, and the apex of abdomen, black; tegmina black, the basal area sanguineous; wings pale fuliginous, base pale sanguineous; pronotum very finely punctate, foveately impressed on each side near anterior margin; lateral margins slightly reflexed; scutellum discally foveate; face globose, finely laterally transversely striate; posterior tibiae with a very short spine near base and a somewhat long spine beyond middle; tegmina little more than twice as long as broad.

Length : 18 mm (Tegmina expand)

Distribution : Oriental and Malayan Regions; India : Southern part.

Remarks : This is a brightly coloured black and blue species occurring on *Musa* spp. (Musaceae) in South India.



Figs. 305. *Phymatostetha deschamsi* Lethiery

Family III. MACHAEROTIDAE

Key to the genera of Machaerotidae

1. Scutellum distinct, obliquely raised and with a long apical spine .... ***Machaerota***

— Scutellum indistinctly raised, centrally ovately foveate, apical spine not as above but with moderate length ..... ***Machaeropsis***

Genus 6. *Machaerota* Burmeister 1835

1835. *Machaerota* Burmeister, *Handb. Ent.*, **1** : 128.

Type species : *Machaerota ensifera* Burmeister

Diagnosis : Head small, face tumid, confluent with the vertex, furrowed in the middle, elevated at the posterior margin, pronotum septangular, arcuate; scutellum larger, produced backward, with a median longitudinal groove being continued into a long, pointed, acute upwardly, curved downwardly, sabre-like process; tegmina hyaline, with seven cells at the apex and a large middle cell surrounded by a forked-vein.

Key to species of *Machaerota*

1. Scutellar spine about reaching apex of tegmina, being elevated and strongly curved downward; scutellum thickly punctate ..... *planitiae*

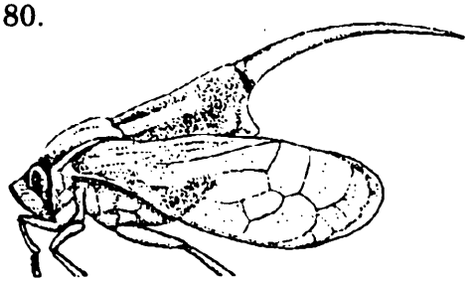
— Scutellar spine extends beyond the apex of tegmina, moderately curved downward; scutellum finely granulose ..... *ensifera*

8. *Machaerota ensifera* Burmeister
(Fig. 306, 437)

1835. *Machaerota ensifera* Burmeister, *Handb. Ent.*, ii, **1** : 128.

1908. *Machaerota ensifora* : Distant, *Fauna Brit. India*, **4** : 80.

Diagnosis : Body pale brownish, head small; scutellum with lateral margins greyish; hase of the posterior scutellar process blackish; pronotum and scutellum granulose; posterior process long, strongly arched, its apex passing the terminal portion of tegmina; abdominal segments above black.



Figs. 306. *Machaerota ensifera* Burmeister

Length : 6 mm (including tegmina)

Distribution : Oriental, Malayan and Australasian Regions; India : Northeast part.

Elsewhere : Philippines.

Remarks : The species is a minor pest of Fibre crops in India.

9. *Machaerota planitiae* Distant
(Tube making Cercopid)

1906. *Machaerota planitiae* Distant, *Fauna Brit. India*, **4** : 84.

1994. *Machaerota planitiae* Distant : Biswas *et al.*, Insecta : Hemiptera : Homoptera : Cercopidae. **In** : *Fauna of West Bengal, State Fauna Series,* **3**(Pt. 5) : 21. Zoological Survey of India.

Diagnosis : Body and pronotum brown; with a spot at the apex of the vertex and three longitudinal series of small dots on each side on the pronotum; a central carination and the posterior lateral margins of pronotum ochraceous; scutellum ochraceous, its apical area and posterior spine castaneous, the latter with an elongated ochraceous spot at base; scutellar spine about reaching apex of tegmina, elevated, passing the apex of tegmina and strongly curved downward; posterior tibiae stramineous.

Length : 7 mm (excluding tegmen)

Distribution : India : Bihar, Punjab, Tamil Nadu and West Bengal.

Remarks : The species is usually found on *Zizyphus* spp., cotton and other plants.

Genus 7 ***Machaeropsis*** Melichar

1903. *Machaeropsis* Melichar, *Hom. Faun. Ceylon* : 137.

Type species : *Machaeropsis valida* Melichar.

Diagnosis : Body stout; head broad and short; face globose, transversely striate; pronotum convex, anterior leteral margins short and slightly projecting; scutellum not prominently raised, ovately foveate, with a moderate spine; tegmina tale-like; wings hyaline, anal area broad with a central vein; posterior tibiae with a central spine.

10. ***Machaeropsis valida*** Melichar
(Fig. 307)

1903. *Machaeropsis valida* Melichar, *Hom. Faun. Ceylon* : 138.

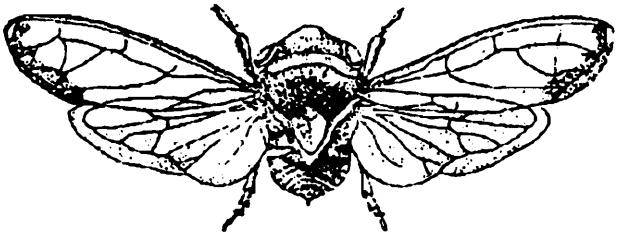
1908. *Machaeropsis valida* : Distant, *Fauna. Brit. India,* **4** : 84.

Diagnosis : Body robust, elongately oval; head transversely wrinkled; face with the striations and the posterior central area blackish; tegmina tale-like, semihyaline, the veins and costal area spotted with black; wings pale hyaline, the venation fuscous; pronotum transversely striate; scutellum brown-ochraceous, foveate area of the scutellum faintly transversely striate; body beneath and legs a little paler than above.

Length : 18 mm (tegmen expanded).

Distribution : India.

Elsewhere : Sri Lanka.



Figs. 307. *Machaeropsis valida* Melichar

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INSECTA : HOMOPTERA : CICADELLIDAE

The Cicadellids or leafhoppers (Figs. 308, 432) are members of the Auchenorrhynchus Homoptera constituting the largest family (Cicadellidae) in the order Hemiptera. Leafhoppers feed on leaves, shoots, stems of a variety of vegetation, a few feed on roots. Several species are oligophagous or polyphagous. Adults often feed on plants different from those preferred for oviposition (De Long, 1971). Some of the leafhoppers are attended by ants. The Cicadellids have been considered insects of economic importance and are common seasonal insects of rice growing areas. In the recent years these insects gained considerable importance as pests of economically important plants. These often cause direct damage to plants by disapping and thereby reduce their vigour. A few of them are also known to inject toxins causing local destruction of tissues. They act as vectors of several plant pathogens. They damage the rice plants by sucking the sap from the vascular tissues and transmitting virus diseases besides reducing the vitality, vigour and fruit bearing capacity, also forming malformations. Nielson (1979) listed 128 species of Cicadellidae as vectors of plants pathogens in the world. A knowldege of their distribution and their correct identity is of paramount important since each plant virus or mycoplasma-like organism is often transmitted by a specific vector. Hamilton (1984) estimated that 15,000 species of Cicadellids were described so far from all over the world. Studies on Oriental leafhoppers specially of Indian subcontinent are very much limited. The Indian leafhoppers are known through the works of Atkinson (1885), Distant (1908, 1918), Pruthi (1930-40), Ghauri (1963, 1967, 1974), Singh (1969), Bindra *et al.* (1973), Sohi (1972), Ramakrishna & Menon (1971-1974), Rao (1967, 1969, 1974, 1990), Malhotra & Sharma (1974, 1977), Datta (1972, 1973), Ghosh (1974), Datta & Dhar (1984), Sohi & Dworakoska (1984) and Viraktamath (1976a, 1976b, 1979a, 1979b, 1980, 1980b, 1981, 1982, 1983).

ECONOMIC IMPORTANCE

Many of the leafhoppers attack and suck sap from crops, trees and foliage while some species transmit phyto pathogenic agents and viral diseases. It has been estimated by Harris (1983) that 130 known leafhopper vector species and subspecies covering 10 subfamilies and 58 genera transmit about 71 disease agents (about 33 viruses, 31 mycoplasma-like organisms (MLO), 3 spiro plasmas and 4 rickettsia-like organisms. Harris (*op.cit*) also lists 20 genera and 34 species of leafhoppers as responsible for transmitting 33 viruses.

Oman (1949) listed leafhopper vectors and the viruses carried by them. Bindra *et al.* (1973) listed cicadellid vectors of plant pathogens from India. Sohi (1977) reported on pests of different plants in North-Western India. Viraktamath (1983) provided key

to all the economically important species of Cicadellidae in India. These include 25 species belonging to 75 genera.

A list is given below to know the important leafhoppers which are involved in damage to the plants (after Rao 1990) :

PESTS OF ECONOMIC IMPORTANCE

Vectors	Phytopathogens transmitted
Amritodus atkinsoni (Lethierry)	
Amritodus brevistylus Viraktamath	
Idioscopus clypealis (Lethierry)	
Idioscopus nagpurensis (Pruthi)	Mango
Idioscopus niveosparsus (Lethierry)	
Amrasca splendens Ghauri	
Empoascanara indica (Datta)	
Empoascanara maculifrons (de Motschulsky)	On seedling of rice, wheat and ragi
Cicadulina bipunctella (Matsumura)	Rice
Cicadulina chinai Ghauri	
Cofana spectra (Distant)	
Cofana unimaculata (Signoret)	Rice
Empoascanara alami (Ahmed)	
Empoascanara truncata (Ahmed)	
Thaia subrufa Motschulsky	
Thaia oryzivora Ghauri	Seedling of rice
Thai assamensis (Mahmood)	
Amrasca biguttula biguttula (Ishida)	Cotton, bhendi, sunflower, castor
Empoasca motti Pruthi	Pulses
Empoasca kerri Pruthi	
Empoasca terminalis Dist.	Groundnut
Empoasca signata Haupt	Castor
Yamotettix sexnotatus (Izzard)	Sugarcane
Zygina manaliensis Sawai Singh	Maize and Wheat
Hishimonus phycitis (Distant)	MLO's causing of little leaf brinjal
Orosius albicinctus Distant	MLO's causing Phyllody of seasame Phyllody of gram Potato purple top

Nephotettix virescens (Distant)	Rice tungro virus Rice yellow dwarf MLO
Nephotettix nigropictus (Stal)	Rice tungro virus Rice yellow drarf MLO
Recilia dorsalis (de Motschulsky)	Rice stunt, MLO and virus Orange leaf disease of Rice
Cicadulina chinai Ghauri	Ragi strak virus and ragi mottle streak virus
Cicadulina bipunctella (matsumura)	
Calodia kirkaldyi Neilson	Sandal spike MLO
Moonia albimaculate Distant	Sandal spike MLO (Suspected)
Alebroides nigroscutellatus (Distant)	Purple top roll of potato, witchz's broom of potato

SYSTEMATIC ACCOUNT

Family CICADELLIDAE

Subfamily I CICADELLINAE

Genus 1 ***Cicadella*** Latereille

1. *Cicadella spectra* (Distant)

Genus 2 ***Cofana*** Melichar

2. *Cofana mimica* (Distant)

Subfamily II HECALINAE

Genus 3 ***Parabolocratus*** Fieber

3. *Parabolocratus albomaculatus* (Distant)

Subfamily III DELTOCEPHALINAE

Genus 4 ***Eutettix*** Distant

4. *Eutettix physitis* Distant

Genus 5 ***Exitianus*** Ball

5. *Exitianus indicus* (Distant)

Genus 6 ***Nephotettix*** Matsumura

6. *Nephotettix nigropictus* (Stal)
7. *N. virescence* (Fabricius)

Genus 7 ***Recilia*** Edwards

8. *Recilia dorsalis* (de Mots.)

Subfamily IV IASSINAE

Genus 8 ***Iassus*** Fabricius

9. *Iassus indicus* (Lethiery)

Subfamily V IDIOCERINAE

Genus 9 ***Idioscopus*** Baker

10. *Idioscopus clypealis* (Lethierry)

Subfamily VI. TYPHLOCYBINAE

Genus 10 ***Zygina*** Fieber

11. *Zygina maculifrons* (de Mots.)

Genus 11 ***Amrasca*** Ghauri

12. *Amrasca biguttula biguttula* (Ishida)

Key to subfamilies of CICADELLIDAE

1(2). Veins at base of tegmina indistinct, not forked on corium ..... TYPHLOCYBINAE

2(1) Veins at base of tegmina distinct on corium more or less branched and connected by transverse veins 3

3(4) Face tumid; ocelli situated on vertex ..... CICADELLINAE

4(3) Face not tumid; ocelli may or may not be on vertex 5

5(6) Large insects, rather dorsoventrally flattened, ocelli at anterior margin of head ..... IASSINAE

6(5) Smaller insects, usually not dorsoventrally flattened 7

7(8) Ocelli on face; frontal sutures continued up to the ocelli ..... IDIOCERINAE

8(7) Ocelli on anterior margin of head or on vertex; face convex in profile; not depressed 9

9(10) Body distinctly dorsoventrally flattened; pronotum with lateral margins carinate; vertex, pronotum and scutellum without any longitudinal median impressed black-like ..... HECALINAE

10(9) Body not as above, rather robust, broad and compressed ..... DELTOCEPHALINAE

Key to genera of subfamily CICADELLINAE

Head little wider than pronotum and its margin almost evenly rounded ..... ***Cicadella***

– Head rather narrower than pronotum and its margin almost sinuate ..... ***Cofana***

MORPHOLOGICAL CHARACTERS

(Figs. 308, 309)

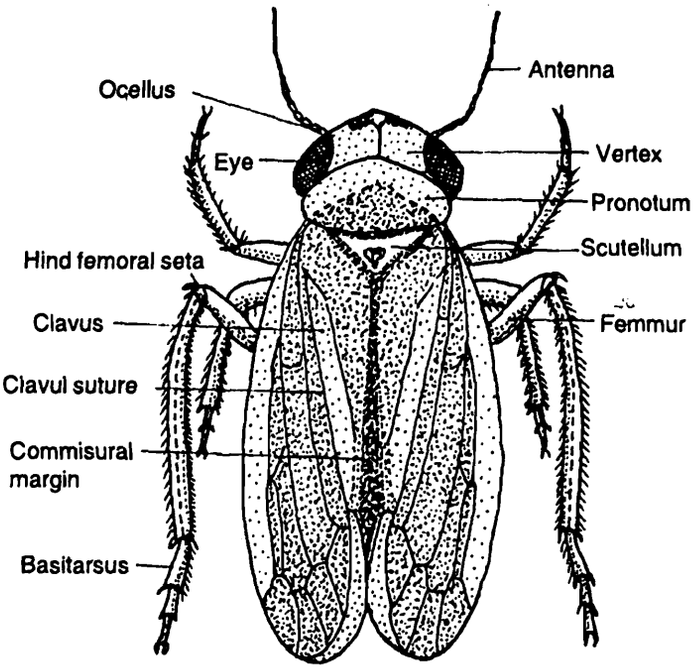
The principal morphology of a typical leafhopper is as follows :

Head : It is variable in size and shape. The length and width of head and its relative size compared to that of pronotum are diagnostic characters of some importance.

Face : (Fig. 309B) : It is divided into fronto-clypeus and clypellus (Clp). The lora (L) may or may not extend upto clypellus.

Ocelli : Ocelli (Fig. 309B, f) occupy different positions on the head and serve as useful characters for subfamily classification.

Pronotum : (Fig. 309A, a) : Lateral margins of pronotum, whether keeled or rounded and the nature of the surface of pronotum are useful charactes. The pre-episternum may be concealed or exposed.



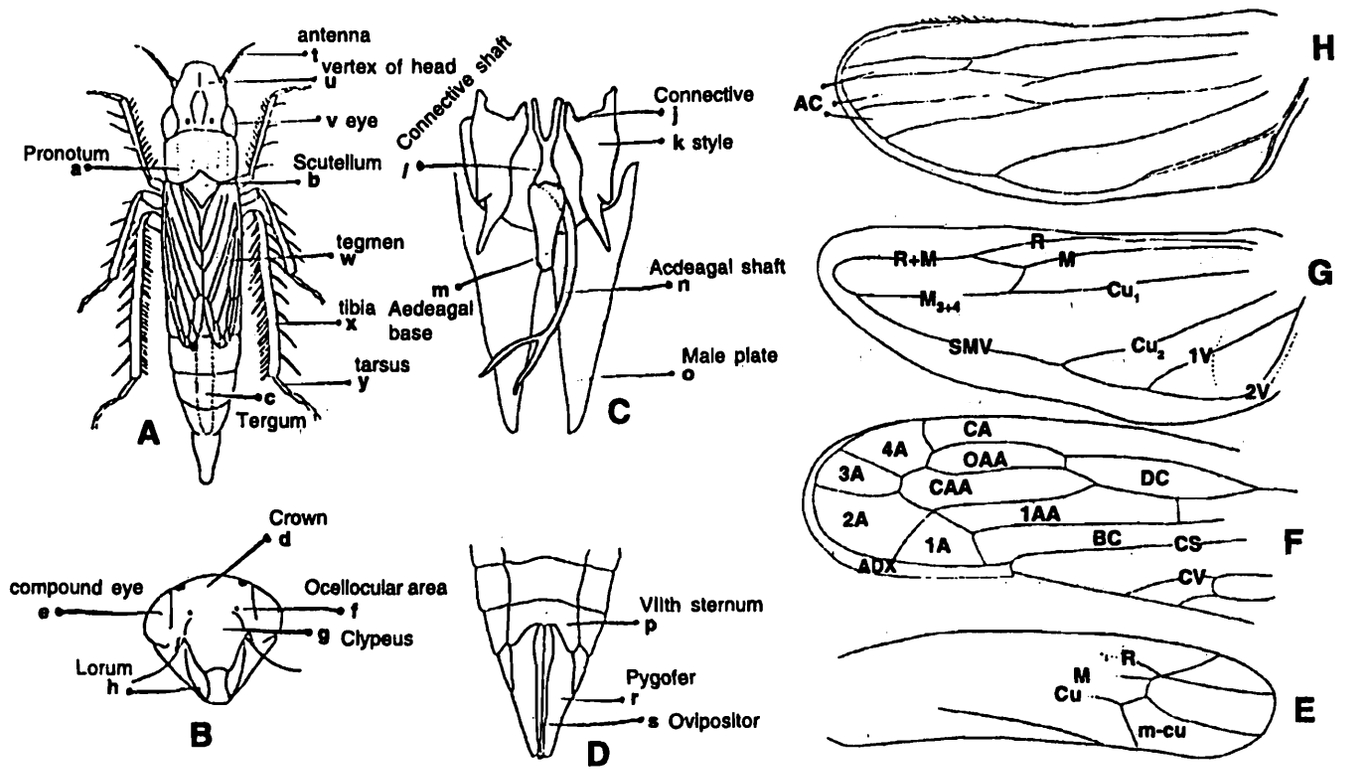
Figs. 308. A Generalised Cicadellid

Wings : (Fig. 310) : Leafhoppers may be macropterous, brachypterous or sub-brachypterous as seen in Deltocephalinae. Two principal sectors of veins are met with, the first sector corresponding to the R of Barnett before it branches. The veins are usually distinct. In the hind wings the number of apical cells (AC) the submarginal vein (Sv) provide useful diagnostic charactes.

Legs : The hind legs of leafhoppers provide a number of useful charactes.

Male genitalia : (Fig. 309C, D) : The ninth abdominal segment is usually deeply incised dorsally and appears to consist of two lateral lobes called pygofers (Fig. 309D,r). Each pygofer may have appendages of virous kinds. The pygofer may have a caudodorsal process, having apical serrated margins or it may have articulated membranous caudal lobe or its caudal as ventral processes may be hook-like. Ventral aspect of genital capsule is of value and a pair of subgenital plates articulate with it caudally. Ventrally the genital capsule is differentiated into valve and plates. Male plate (Fig. 309C,o) for instance, may have a process, or they may have narrow serrations or they may be frequently short, exceeded by styles.

The inner parts of male genitalia are the aedeagus, the connective and the paired styles (Fig. 309C,k). Styles articulate measally with the connective which in turn articulates with the aedeagus.



Figs. 309-310. Structural features of a generalised adult Leafhopper. A : a, Pronotum; b, Scutellum; t, antenna; u, vertex of head; v, eye; w, tegmen; x, tibia; y, tarsus. B : d, Crown; e, compound eye; f, Ocellocular area; g, Clypeus; h, Lorum. C : e, Clypellus; j. Connective; k, style; l, Connective shaft; m, Aedeagal base; n, Aedeagal shaft; o, Male plate. D : p, VIIth sternum; q, VIIth sternum; r, Pygofer; s, Ovipositor. E-H : AC, Apical cells; SMV, Submarginal Vein; 1A-4A : 1st-4th apical cells; ADX, Appendix; BC, Brachial cell; CAA Central anteapical; CA, Costal area; DC, Discal cell; OAA, Outer anteapical; CS, Claval suture; IAA, Inner anteapical; CV, Claval vein.

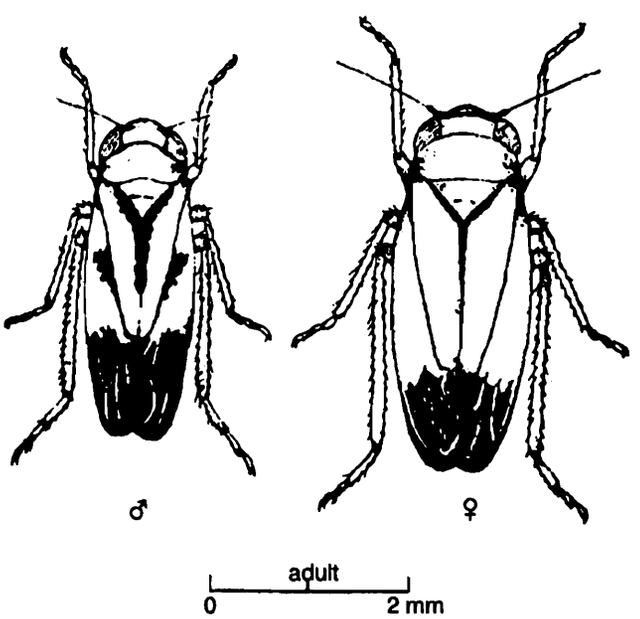


Fig. 311. Generalised Leaf hopper [*Nephotettix nigropictus* (Stal)]

Connective (Fig. 309Cj) : It is variously shaped and useful in the diagnosis of taxa of different subfamilies. Aedeagus and connective may be either freely articulated or fused.

Aedeagus (Fig. 309Cmn) : It usually articulates by its subterminal portion with the connective, but articulation may be terminal, dorsal or much more basal. The shaft is usually straight but may be curved. Aedeagus usually is with one gonopore but sometimes is provided with two gonopores.

Accessory genital structures, paraphyses occurring between the apex of connective and base of aedeagus are also important from the taxonomic view point.

Female genitalia : The shape of the female 7th sternum and the ovipositor (Fig. 309Ds) extending beyond pygofer do not provide useful charactes.

Subfamily CICADELLINAE

Genus 1. ***Cicadella*** Latereille

1817. *Cecadella* Latreille, *Contenant crustaces Arachnides insects,* **3** : 406.

Type, by subsequent designation, *Cicadella viridis* Van, Duzec.

1916. *Cicadella viridis* Van Duzee, Checklist of the Hemiptera of America, North Mexico, 1919 : 66.

Diagnosis : Anterior margin of head rounded, no carina or angle at Transition from crown to face; ocelli in line with anterior eye angles; clypeus convex, muscle impression distinct, clypellus with short pubescence; pronotal disk transversely rugulose; forewing with 3 closed anteapical cells, with 4 apical cells.

1. ***Cicadella spectra*** Distant
White Rice Leaf hopper
(Fig. 312)

1853. *Tettigonia albida* Signoret, *Ann. Soc. Ent. Fr.*, **21** : 663.

1908. *Tettigoniella spectra* Distant, *Fauna Brit. India,* **4** : 211.

1988. *Cicadella spectra* (Distant) : Datta, *Rec. zool. Surv. India, Occ. Paper* No. **90** : 26.

1998. *Cicadella spectra* (Distant); Ghosh, M. and Ghosh, L. K., *Fauna of Meghalaya, State Fauna Series,* 4(pt. 4) : 7.

2000. *Cicadella spectra* (Distant) : Ghosh, M., Biswas, B. and Ghosh, L. K. *Fauna of Tripura, State Fauna Series,* 7(Part-2) : 324.

Diagnosis : Vertex with 4 black spots, scutellum yellowish, tegmina greenish with fuseous and rather pale veins; pronotum greenish with transverse striations, abdomen greenish yellow; legs pale ochraceons. Male plate (Fig. 312A) triangulate, lateral margin convex, mesal margin almost linear, gradually tapered from base to apex, discal setae stout, much longer than those on apical and densely spinulated. Pygofer (Fig. 312B) densely spinulated, with macro setae on posterior past, lateral margin

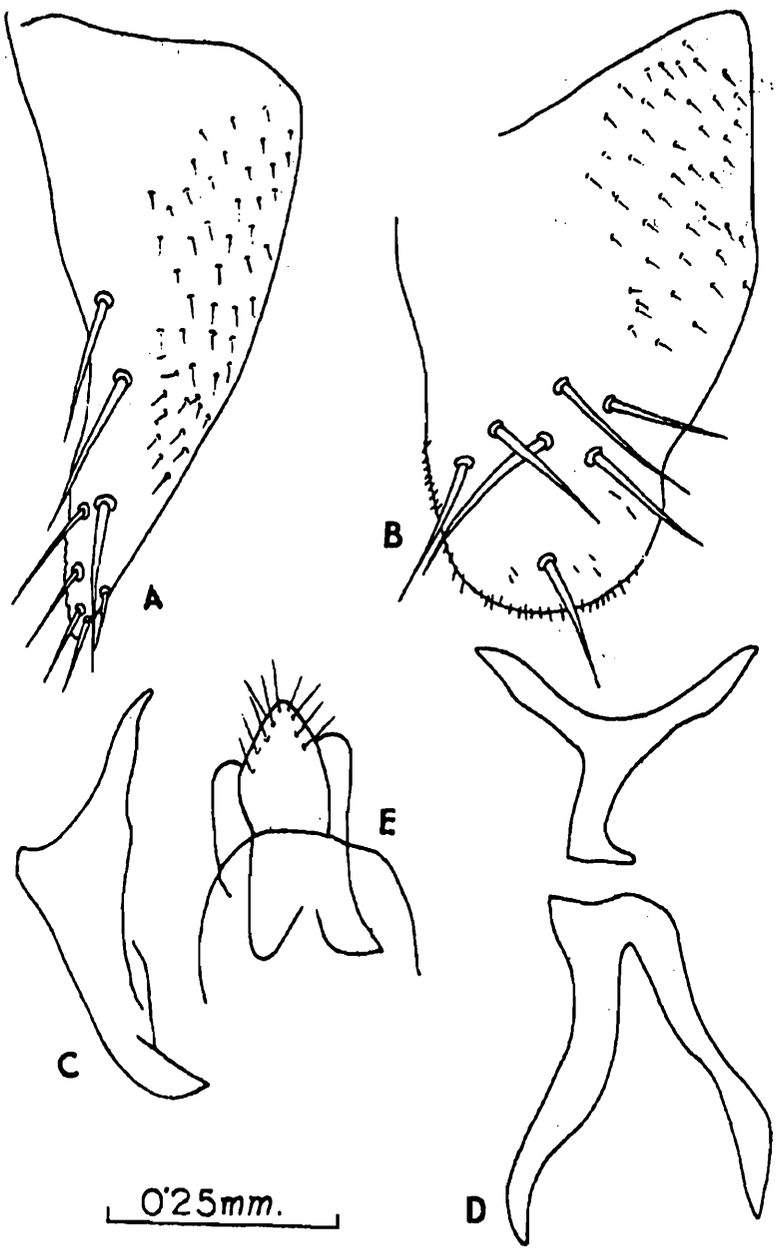


Fig. 312. A-E, *Cicadella spectra* (Distant) : A. Male plate; B, Pygofer; C, Style; D, Aedeagus; E, Anal tube.

unfolded. Style (Fig. 312C) beak-like, gradually tapering to pointed apex, subapically strongly concavous. Aedeagus (Fig. 312D) subapically, curvate, strunt developed, shaft slender. Anal tube as figured (Fig. 312E) Connective T-shaped.

Length : Female 10 mm, Male 8 mm.

Symptoms and Damage : The cell sap of plant is sucked by both nymphs and adults causing discoloration of the leaves. The leaves turn brown in case of heavy infestation. As a result, the plants fail to produce ears.

Bionomics : This insect group is active throughout the year. The adults, on emergence, take about 2-6 days before mating. The females lay greenish eggs in

masses. The female deposits a total of 17 masses in entire life time (30-35 days). The eggs hatch in 6-7 days and the nymphs, on emergence, first feed inside the leaf sheath. Afterwards they move on to the leaf blade. The life cycle involves 5 nymphal instars which are completed in 18 days.

Distribution : India : Assam, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Meghalaya, Orissa, West Bengal.

Elsewhere : Australia, Bangladesh, Nepal, Sri Lanka.

Remarks : The species abundantly occurs in the paddy field along with other paddy pests like *Nephotettix virescens, N. nigropicta, Recillia dorsalis* etc. during winter period. Sometimes the species feeds on wild grasses. There is apparently no record of transmitting any viral disease in rice by the species although it enjoys both tropical and subtropical distribution.

Genus 2. ***Cofana*** Melichar

1926. *Cofana* Melichar, *Ann. Mus. Nat. Hist.*, **23** : 345. Type species by subsequent designation of China, *Tettigonia eburnea* Walker.

1938. *Tettigonia eburnea* Walker, *China Ann. Mag. Nat. Hist.*, **2**(11) : 85.

Diagnosis : Head strongly produced, anterior margin narrow to broadly rounded; ocelli each closer to anterior eye angle; clypellus without pubescence; Lateral clypeal sutures extending upto crown; impression of cibarial muscles distinct.

2. ***Cofana mimica*** Distant
(Fig. 313)

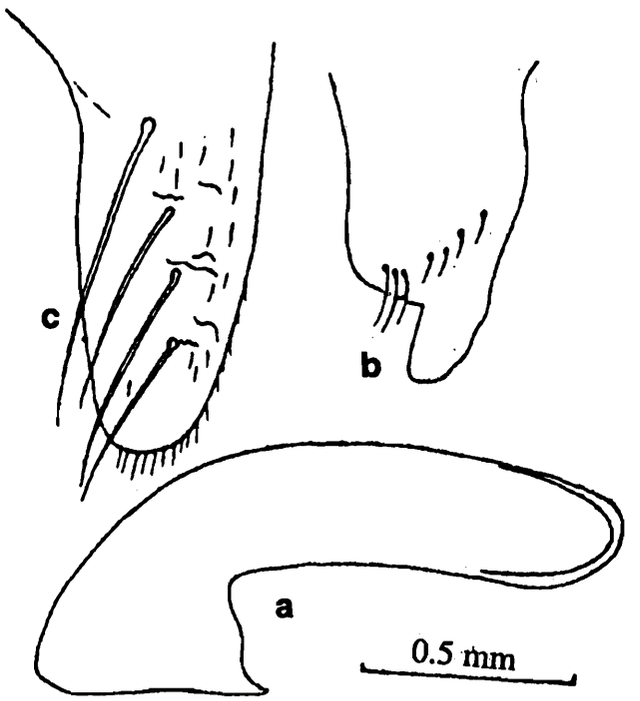
1908. *Kolla mimica* Distant, *Fauna Brit. India*, **4** : 225.

1998. *Cofana mimica* (Distant) : Ghosh, M. and Ghosh, L.K. Hemiptera : Cicadellidae, *Fauna of Meghalaya, State Fauna Series,* **4** : 8.

1999. *Cofana mimica* (Distant) : Ghosh, M., Biswas, B and Ghosh, L. K. *Fauna of Tripura, State Fauna Series*, **7**(pt. 2) : 325. Zoological Survey of India, Calcutta.

Diagnosis : Head ochraceons brown, triangulate, vertex with single central black spot, two identical spots close to ocelli, extreme lateral margin also with similar spot; face with central white streak, laterally striate; pronotum with fine transverse impressions; abdomen green, legs yellowish, tegmina greenish white. Aedeagus (Fig. 313a) with well developed basal strut, strongly geniculate at base, directed caudad; connective Y-shaped. Style (Fig. 313b) dorsoventrally compressed, mesal apical extension short, apex truncate obliquely, directed laterocaudad; male plate (Fig. 313c) robust, lateral margin uniseriate; pygofer simple.

Length : Female 6 mm, Male 5 mm.



Figs. 313. *Cofana mimica* (Distant). a. Aedeagus; b. Style; c. Male plate.

Distribution : India : Assam, Bihar, Maharashtra, Meghalaya, Tripura, Uttar Pradesh, West Bengal.

Remarks : The species is common on paddy crop during winter season. But its viruliferous nature in the field is yet to be ascertained. It is abundant with viruliferous cicadellids namely, *Nephotettix virescens, N. nigropicta, Recillia dorsalis* and Fulgorid species, *Nilaparvata lugens.*

Subfamily HECALINAE

Genus 3. ***Parabolocratus*** Fieber

1866. *Parabolocratus* Fieber, *Zoo.-bot. Gesella Wien. Verhandl.,* **16** : 502. Type by Monotype *Parabolocratus sulcatus* (Fieber)

1866. *Hecalus sulcatus* Fieber, *Zool. Bot. Geswell, Wien Verhandl.,* **16** : 502.

Diagnosis : Colour black, head sometimes with a fuscous line submerginally; clypeus swollen; genal margin notched below eyes; pronotal surface slightly rugulose; laterally carinate; tegmina broad, appendix small, outer anteapical cell shorter than central anteapical cell, base acuminate, apex truncate, apical cells very short.

3. ***Parabolocratus albomaculatus*** (Distant)
(Fig. 314)

1908. *Thomsoniella albomaculatus* Distant, *Fauna Brit. India.* **IV** : 280.

1917. *Parabolocratus albomaculatus* : Distant, *Fauna Brit. India,* **VII** : 32.

1988. *Parabolocratus albomaculatus* (Distant) : Datta, *Rec. zool. Surv. India, Occ. Paper* No. 90 : 82.

1989. *Parabolocratus albomaculatus* Distant : Ghosh *et al.*, Hemiptera. *In Fauna of Orissa* (Part 2) : 196. Zoological Survey of India, Calcutta.

1998. *Parabolocratus albomaculatus* (Direct) : Ghosh, M. and Ghosh, L. K., Homoptera : Cicadellidae, *Fauna of Meghalaya, State Fauna Series,* **4** : 15.

1999. *Parabolocratus albomaculatus* (Distant) : Ghosh, M. Biswas, B and Ghosh, L. K., *Fauna of Tripura, State Fauna Series,* **7**(pt. 2) : 326. Zoological Survey of India, Calcutta.

Diagnosis : Vertex dark brown, appearing laminate, margin somewhat strongly reflexed; body ochraceous, apical areas of tegmina brownish with white spots; pronotum fasciate. Scutellum with an angulate line before the apical area, occasionally a darker spot on each basal angle. Abdomen dorsally black and laterally brown, posterior

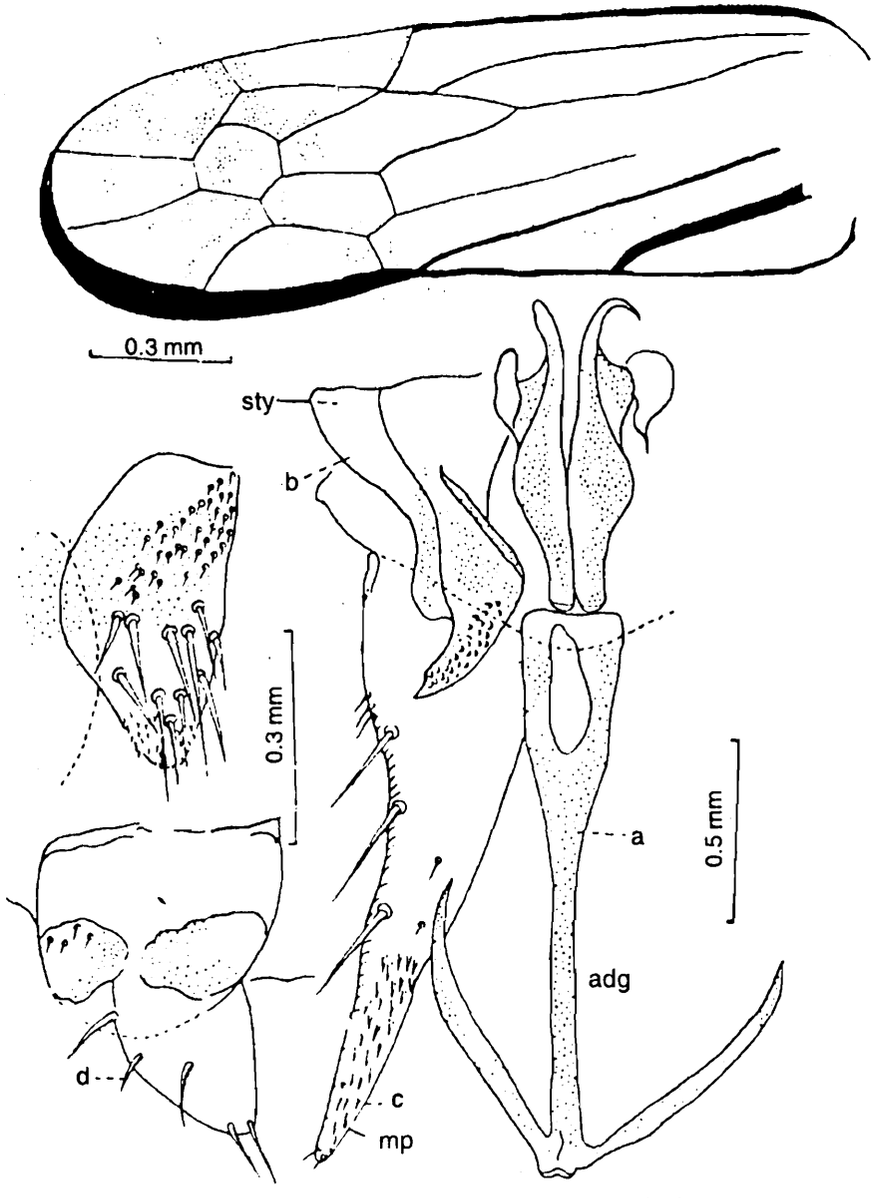


Fig. 314. *Parabolocratus albomaculatus* (Distant). a-Aedeagus; b-Style; c-Male plate; d-Pygofer.

portion of tegmina with brownish black colour. Genitalia : Male plate (Fig. 314c) broadened at base, gradually tapered towards apex, outer margin to some extent concave with a row of macrosetae at middle half, disc spinulate. Pygofer (Fig. 314d) somewhat conical apicad, with somewhat spinulate margin, long setae towards apical half, margin rather smooth. Style (Fig. 314b) broadened at base, beak-like towards apex, mesal apical extension sharply pointed, directed laterocauded. Aedeagus as figured (Fig. 314a), aedeagal shaft braodened basad; apical processes elongate, slender, acute rather plough-like.

Length : Female 5 mm, Male 4.5 mm.

Distribution : India : Meghalaya, Orissa, Tamil Nadu, Tripura, West Bengal.

Elsewhere : Congo; Luzon; Philippine Is., Sri Lanka; Sumbawa.

Remarks : The species closely resembles other paddy pests like *Nephotexttix virescens* (Fabr.), *N. apicalis* de Mots., *Kolla mimica* Distant and *Cicadella spectra* (Distant) but can be easily distinguished by the structure of aedeagal shaft with terminal process.

Subfamily DELTOCEPHALINAE

Key to genera

1(a). Fore wing with zigzag brown stripe ..... ***Recilia***

2(b) Fore wing not as above 3

3(4) Body robust, somewhat oval, tegmina usually punctate, with numerous white spots on basal area ..... ***Eutettix***

4(3) Body moderately elongated, slender, tegmina usually not punctate 5

5(6) Pronotum with the anterior margin bears more or less distinct brownish or piceous dots; aedeagal shaft without any spine ..... ***Exitianus***

6(5) Pronotum without any spot on anterior margin; aedeagal shaft with a few spines at its dorsal aspect at about middle ..... ***Nephotettix***

Genus 4. ***Eutettix*** Van Duzee

1892. *Eutettix* Van Duzee, *psyche*, **6** : 307.

Type species : *Thamnotettix luridus* Van Duzee

Diagnosis : Body robust, flattened; head with anterior margin subangular; ocelli large; vertex short; apex blunt, dorsally longitudinally striate; pronotum broader, longitudinally faintly striate, rugulose; tegmina with small appendix, velvety at apex, with a transverse nervure between 1st and 2nd sectors.

4. ***Eutettix physitis*** Distant
(Fig. 315).

1908. *Eutettix phycitis* Distant, *Fauna Brit. India,* **4** : 363.

1988. *Eutettix phycitis* Distant : Datta, *Rec. zool. Surv. India, Occ. Paper* No. **90** : 130.

1998. *Extettix phycitis* Distant : Ghosh, M. and Ghosh, L. K. *Fauna of Meghalaya, State Fauna Series,* **4** : 17.

1989. *Eutettix phycitis* Distant : Ghosh, L. K. and Ghosh, M. *Fauna of West Bengal, State Fauna Series,* **3** : 40.

Diagnosis : Robust insect, vertex rounded anteriorly; clypeus dark yellow, pronotum broader, longitudinally faintly striate, rugulose; dark yellow with blackish tinge; terminal surfaces finely ornamented with reddish brown patches and spots; abodmen dark yellow. Aedeagus (Fig. 315a) with a pair of tube-like shafts, spots, outer margin sinuate, apex sharp, hook-shaped, basal apodeme short triangulate, connective Y-shaped, arm short, broad; style (Fig. 315b) attenuate, inner margin of apical half serrate, pygofer setose, obliquely slanting; VIIth sternite in female with a tooth-like projection. Male plate as figured (Fig. 315c).

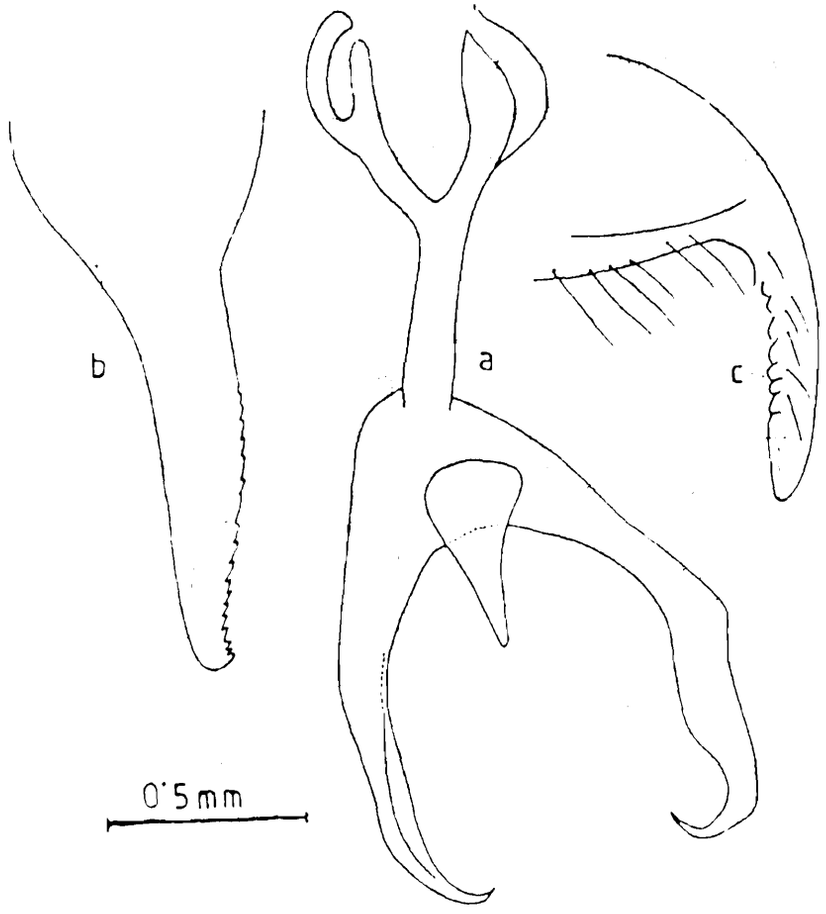


Fig. 315. *Eutettix phycitis* Distant : a-Aedeagus; b-Style, c-Male plate

Length : ♀ 4 mm; ♂ 3.5 mm.

Distribution : India : West Bengal.

Elsewhere : Australia, Sri Lanka.

Remarks : The species acts as a vector of little leaf virus of *Solanum melongena* Linn. Datura, *Lycopersicum* and *Tabacum nicotianum* (Thomas and Krishnaswami 1939). According to Pruthi (1934) the species is a suspect vector of spike disease of sandal in India.

Genus 5. ***Exitianus*** Ball

1929. *Eutettix* Ball, *Trans. Amir. Ent. Soc.*, **55** : 5.

Type species : *Exitianus obscurinervis* (Stål)

1859. *Jassus (Thamnotettix) obscurinervis* (Stål), *Svenska Vet. Akad. Zool.*, **4** : 293.

Diagnosis : Vertex rounded anteriorly; ocelli large; disc convex; tegmina hyaline, appendix large, expanded, anteapical cells closed, two in number.

5. ***Exitianus indicus*** (Distant)
(Fig. 316)

1908. *Athysanus indicus* Distant, *Fauna Brit. India.* **4** : 344.

1989. *Exitianus indicus* (Distant) : Ghosh, L. K., Biswas, Chakraborty and Sen, *Fauna of Orissa, State Fauna Series*, **1**(pt. 2) : 195.

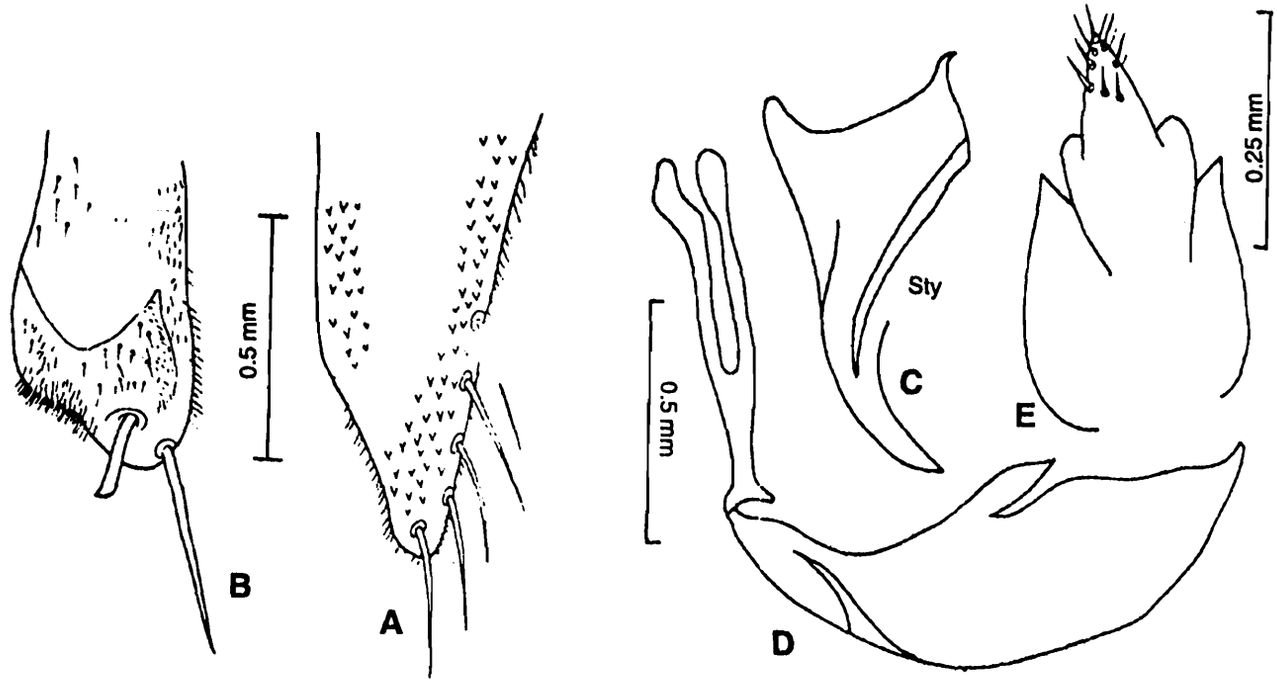


Fig. 316. *Exitianus indicus* (Distant) : A. Male plate; B. Pygofer; C. Style; D. Aedeagus; E. Anal tube.

1998. *Exitianus indicus* (Distant) : Ghosh, M. and Ghosh, L. K., Homoptera : Cicadellidae, *Fauna of Meghalaya, State Fauna Series*, **4** : 18.

2000. *Extitianus indicus* (Distant) : Ghosh, M., Biswas, B. and Ghosh, L.K., *Fauna of Tripura, State Fauna Series*, **7**(pt. 2) : 327.

Diagnosis : Vertex subangularly rounded anteriorly, brownish yellow in colour, a transverse black fascia between the eyes; between the black fascia a distinct central longitudinal line at base; ocelli large; face centrally flattened and indistinctly finely granulated, with transverse brown stidae on each lateral area. Pronotum brownish yellow, on disk dark greyish, a bow-like impressed line near anterior margin and with more or less distinct brownish dots; scutellum granulated, basal area transversely impressed; tegmina greyish subhyaline; its vein brownish; legs brownish yellow; femora with longitudinal brownish streaks; abdomen inscous. Aedeagus (Fig. 316D) laterally compressed, beak-shaped, apex sharp; style (Fig. 316C) with apex sharply pointed. Male plate (Fig. 315A) posteriorly converging to angulate apex; pygofer (Fig. 316B) densely spinulate, with a pair of distinct apical spur.

Genus 6. ***Nephotettix*** Matsumura, 1902
(Fig. 432)

1902. *Nephotettix* Matsumura, *Termeszetr. Fuz.*, **25** : 378. Type-species : *Selenocephalus cincticeps* Uhler; Distant, 1908, *Fauna Brit. India, Rhynchota*, **4** : 317; 1918 Ibid., 7 : 60 : Merine, 1936, *Philip. J. Sci.*, **61** : 373; Evans, 1947, *Trans R. ent. Soc., Lond.*, **198** : 236; Ishihara, 1953, *Matsilyama, agric Coll. Sct. Rep.*, **11** : 39; 1964. *Trans Shikoku ent Soc.*, **8** : 39-44; 1983, *Proc 1st International Symp. Leafhoppers and Plant hoppers of economic importance, London, C.I.E.* 459; Mathur, 1953, *Indian Forest Leaflet* **121**(3) : 158; Linnavouri, 1960, *Insects Micronesia*, **6** : 231; Nielson, 1968, *Tech. Bull. U.S. Dep. Agric.*, 1382 : 269; Ishihara & Kawase, 1968, *Appl. Ent. Zool.*, **3** : 119; Ghauri, 1971, *Bull. Ent. Res.*, **60** : 481.

Diagnosis : The genus *Nephotettix* includes leafhoppers having always green colour with black markings on head, face, pronotum, forewing and other parts of the body and showing variable degree of sexual dimorphism. Female with reduced black markins. Ghauri (1971) subsequently provided an excellent redescription based on the type material who provided common and differential characters for the genera *Nephotettix* and *Exitianus*.

Owing to its economic importance, the genus has attracted the attention of many entomologists and in recent times many significant contributions have been made on the biotaxonomy of the genus.

Nielson (1979) listed six viral and mycoplasma diseases transmitted by *Nephotettix virescens* (Distant) and *N. nigropictus* (Stal) from all over the world, two of these diseases being known from India *viz.*, the Rice Tungro and the Yellow Dwarf. The former is a viral and the latter a mycoplasma disease. Sivaramakrishnan and Sen Sharma (1978) demonstrated the transmission of sandal-spike disease by *Nephotettix virescens* in the laboratory but field studies in this regard are wanting.

Key to the species of *Nephotettix Matsumura*

1(2). Crown with submarginal black band; discal black patches of tegmen touching claval suture in male (arms of connective not close to each other); paraphysis of aedeagal shaft rudimentary; pygofer without any long spur; aedeagus with 8 pairs of spines ..... *nigropictus*

2(1) Crown without submarginal band; discal black patches either absent or present, if present, not touching claval suture in male (arms of connective close to each other); paraphysis of aedeagal shaft short or not projecting obliquely; pygofer with a long sharp spur besides three smaller spurs; aedeagus with 4-5 pairs of spines ..... *virescens*

6. *Nephotettix nigropictus* (Stal)
Green Leafhopper
(Fig. 317)

1870. *Thamnotettix nigropicta* Stal, *Ofv.-vet. Ax. Forh.*, 7 : 74.

1906. *Nephotettix nigropicta* Kirkaldy, *Rep. Exp. Sta. Haw. Plant Assoc.* pt. IX : 333.

1907. *Nephotettix apicalis* Distant, *Fauna Brit. India*, **11** : 360.

1971. *Nephotettix nigropictus* Ghauri, *Bull. Ent. Res.*, 60 : 491 (= *Thampotettix nigropictus* Stal. = *Nephotettix apicalis* sensu Distant and sensu Ishihara); Rao 1980, *Rec. Zool. Surv. India*, 76 : 193 : 1981, *Ibid.*, 78 : Hongsaprug, 1983, *Proc. Ist. International Symp. Leafhoppers and plant hoppers of economic importance London*, C.I.E., 68; claridge, 1983 *Ibid*, 117; Wilson, 1983, *Ibid.*, 128; Siwi & Roechan, 1983, *Ibid.*, 262-275; Ramakrishnan, 1983, *Ibid.*, 128; Inouse, 1983, *Ibid*, 341-342; Ishihara, 1983, *Ibid.*, 459-460; Viraktamath, 1983, *Ibid.*, 490-491.

1998. *Nephotettix nigropicta*, Ghosh, M. and Ghosh, L. K. *In* : *Fauna of Meghalaya, State Fauna Series*, **4** : 20.

2000. *Nephotettix nigropicta* (Stal) : Ghosh, M. Biswas, B. and Ghosh, L. K. *In* : *Fauna of Tripura, State Fauna Series*, **7**(Part-2) : 328. Zoological Survey of India, Calcutta.

Diagnosis : Body greenish yellow, smooth and shinning; vertex with transverse line between eyes; tegmina with an oblique broad stripe extending medially to claval suture; apical 1/3 of tegmina and abdomen blackish. Anterior margin of pronotum black, anterior margin of scutellum black, and two small black spots on each side. Greater part of femera tibiae and tarsi black; spinules black spotted at base of the posterior tibiae; abdomen black. Aedeagus (Fig. 317a) with 3 pairs of lateral processes and well developed apodeme; stylar shaft with mesal apical extension gently notched posterolaterally (Fig. 317b); male plate (Fig. 317c) beyond to middle spinulate on both margins; pygofer (Fig. 317d) subrectangular, extension gently notched posterolaterally (Fig. 317).

Length : ♀ 5.5 mm; ♂ 4.5 mm.

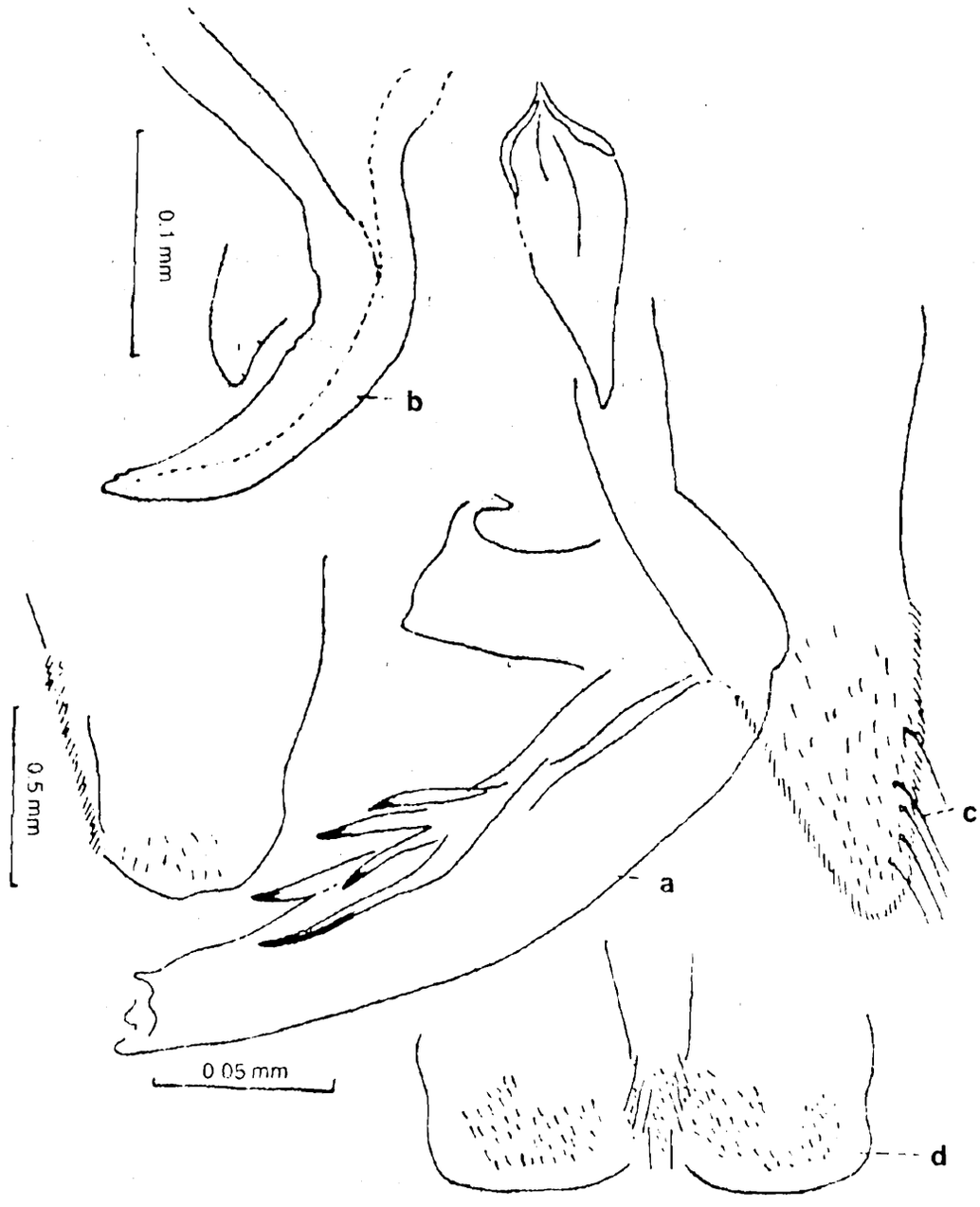


Fig. 317. *Nephotettix nigropictus* (Stal) : a–Aedeagus; b–Style; c–Male plate; d-Pygofer.

Symptom and Damage : The nymphs and the adults suck sap from the leaves of plants. As a result, the leaves turn brown. Due to the pest attack the plants become weak and turn yellow. It hardly allows the earheads to grow in full.

Bionomics : The female lays eggs on the inner surface of the leaf sheath in groups of 18. The eggs hatch in 3-5 days and the nymphal stage is completed in 12-21 days. The longevity of adults is 7-22 days in summer. There are about 6 overlapping generations from March to November. The species overwinters in adult stage. The maximum population of the insect is in July-August and minimum after a heavy rain.

Distribution : India : Bihar, Meghalaya, Orissa, Punjab, Tripura, West Bengal.

Elsewhere : East Africa, Philippines, Sri Lanka.

Remarks : This is a cosmopolitan species enjoying wide distribution in all rice growing areas of the world. The species is a common seasonal insect of rice fields in West Bengal. It is abundantly found during kharif season particularly during August-November. It occurs along with *N. virescens* (Fabricius) during winter in the eastern and western India. It acts as a vector of virus on paddy crops. The species is reported to transmit "dwrarf" disease in Japan and "Tungro" disease in India. *N. nigropictus* resembles closely the African species *N. modulatus* Melichar in the presence of these parallel black bands the marginal and submarginal on vertex and the anterior band on pronotum. It also bears a resemblance to another African species *viz., N. afer* Ghauri in having inner black margin of clavus and discal spot on corium touching claval suture. However, it can be distinguished from both these by the aedeagus having eight pairs of spines on the lateral side whereas the African species do not possess the aedeagal spines at all.

7. ***Nephotettix virescens*** (Fabricius)
(Fig. 318)

1803. *Cicada bipunctata* Fabricius, *Synt. Rhyng.*, 78, *nom. Praceocc.* by *Cicade bipunctata* Scopoli. 1763. *Methodo Linnaena* : 115.

1869. *Thamnotettix bipunctata* Stal, *Syenska Vetensk. Akad. Handl.*, **8** : 82.

1902. *Nephotettix bipunctata* Matsumura, *Termeszetra. Fuz.*, **25** : 397 (= *Thamnotettix bipunctatus* Fabricius).

1908. *Selenocephlus virescens* Distant, *Fauna Br. India, Rhynchota,* **4** : 291.

1908. *Nephotettix bipunctatus* : Distant, *Fauna Dr. India,* **4** : 259 (= *Cicada bipunctata* Fabricius, = *Thamnotettix bipunctatus* (Stal); Misra, 1920, *Indian Dep. Agric. Mem. Ent. Ser.,* **5** : 207-239.

1971, *Nephotettix virescens* : Ghauri, *Bull. Ent. Res.,* **60** : 484; Rao, 1981, *Rec. zool. Surv. India,* **78** : 3 : Hongsaprag, 1983. *Proc 1st. International Symp. Lethoppers and Plant hoppers of economic importance* London C.I.E., 88 : Claridge, 1983, *Ibid.,* 117; Wilson, 1983, *Ibid.,* 128; Siwi & Roodchan, 1983, *Ibid.,* 263-275; Ramakrishnan, 1983, *Ibid.,* 328; Inoue, 1983, *Ibid.,* 341-342; Ishihara, 1983, *Ibid.,* 460-461; Viraktamath, 1983, *Ibid.,* 490-491.

1998. *Nephotettix virescens* (Fabricius) : Ghosh, M. and Ghosh L. K., *In* : *Fauna of Meghalaya, State Fauna Series,* **4** : 20. Zoological Survey of India, Calcutta.

Diagnosis : Body yellowish green, shinning, smooth, bear as broad as pronotum; fine black line to anterior margin of vertex; face greenish yellow; in male, face with lateral transverse dark black lines, in female without dark black lines; tegmina in male with a discal black spot before middle; in female without discal black spot; lateral sternum black, abdomen also black. Aedeagus (Fig. 318a) with well developed apodeme, with 3 pairs of lateral processes, stylar shaft (Fig. 318b) with mesal apical

extension gently notched posterolaterally, saw-like; male plate (Fig. 318c) beyond middle spinulate on both margins; pygofer (Fig. 318d) posteriorly with a long sharp spur besides three smaller spurs.

Length : ♀ 4.45-4.50 and ♂ 3.95-4.50 mm.

Distribution : India : Bihar, Meghalaya, Orissa, Tripura, West Bengal.

Elsewhere : Ethiopian region, Indonesia, Japan, Korea, Malayasia, Micronesia, Natal, Palestine, Philippines, Singapore, Sumbawa, Taiwan, Thailand.

Remarks : The species transmits viruses consisting of transitory yellowing (Taiwan), Rice Tungro virus (RTV) (India and Philippines), rice dwarf virus (Japan) and Ponyanit morah (Tungro) (Malayasia), Rice tungro virus (RTV) occasionally occurs as epidermis

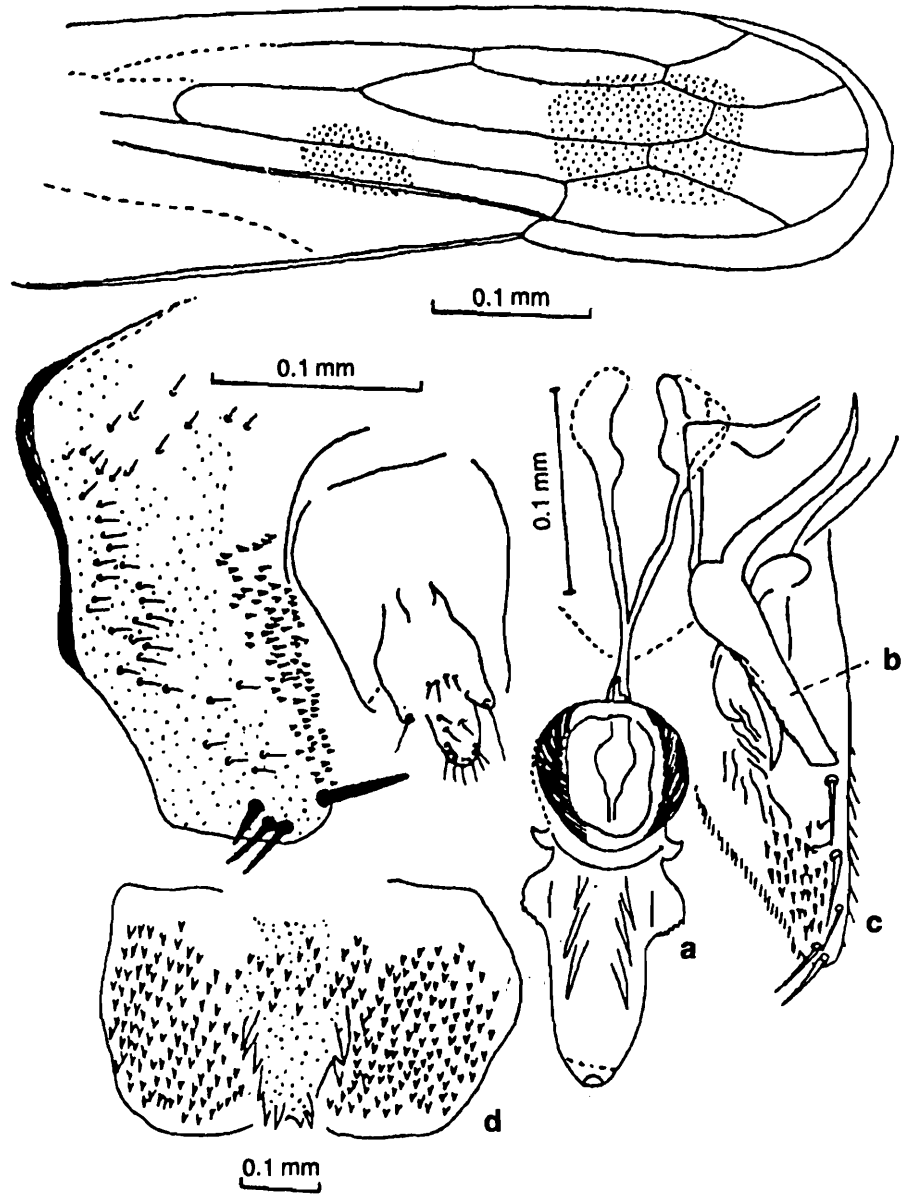


Fig. 318. *Nephotettix virescens* Fabricius. a–Aedeagus; b–Style; c–Male plate; d–Pygofer.

in several states of India including West Bengal. The spread of these diseases usually takes place during the months of September-October when the pupulation of the species also remains high.

This is one the most common species found in rice fields. Males resemble *Nephotettix nigropictus* and *N. cincticeps* in general colour and can be separated from them by the rounded dorsal and ventral corners of pygofers and in having fewer spines on dorsal carinae of aedeagus. Females can be distinguished from other species by the immaculate head, pronotum and clavus. Some females, however, may have apical third of tegmen black.

Genus 7. ***Recilia*** Edwards, 1866

1922. *Recilia* Edwards, *Entomologist's mon. Mag.*, **58** : 204; Type-species : *Jassus coronifer* Marshall.

1953. *Inazuma* Ishihara, *Matsuyama agric. Coll. Sci., Rep.*, **11** : 15 & 48. Type species : *Deltocephalus dorsalis* de Motschulsky.

1962. *Recilia* Kramer, *Proc. Biol. Soc., Wash.*, **75** : 259; Nielson, 1968, *Tech. Bull. U.S. Dep. Agric.* 1332 : 315 : Ghauri, 1980, *Reichenbachia*, **18**(25) : 166.

Diagnosis : Vertex obtuse, ocelli on anterolateral margin. Scutellum triangular broader than long fore wing longer in males of some species, male plate triangular with stout setae on lateral side; connective Y- or U-shaped and arms approximated. Aedeagus and connective fused, shaft long and pointed at tip, gonopore dorsal.

The genus is well distributed in the Palaearctic, Ethiopian and Oriental Regions. The genus *Recilia* differs from *Deltoceohalus* in the gonopore being dorsal and ill-defined, whereas in the latter the gonopore is well-defined and apical in position. The arms of the connective in *Recilia* are approximated while they are divergent anteriorly in *Deltocephalus*.

In India, *Recilia* is so far represented by six species *viz.*, *R. maculata* (Pruthi), *R. intemedia* (Mel.), *R. dorsalis* (de Motschuslky), *R. indica* Rao, *R. probha* (Pruthi) and *R. veinatus* (Pruthi).

Recilia dorsalis (de Motschulsky) is the only species of the genus so far known as a vector of virus disease of paddy (Nielson, 1979).

8. ***Recilia dorsalis*** (de Motschulsky)
Zigzag Leafhopper
(Fig. 319)

1859. *Deltocephalus dorsalis* de Motschulsky, *Etude. Ent.*, **8** : 114.

1902. *Deltocephalus fulguralis* Matsumura, *Termeszetr. Fuz.*, **2** : 391.

1908. *Deltocephalus dorsalis* : Distant, *Fauna Br. India, Rhyncheta*, **4** : 380. (= *Deltocephalus fulguralis* Matsumura) : Pruthi, 1934, *Indian Forest Rec. Ent. Ser.*, **19**(4) : 1-30.

1953. *Inazuma dorsalis* Ishihara, *Matsuyyama agric. Coll. Sci. Rep.*, **11** : 48 (= *Deltocephalus dorsalis* de Motschulsky).

1968. *Recilia dorsalis* : Nielson, *Tech. Bull. U.S. Dept. Agric.* 1382 : 315 (= *Inazuma dorsalis* Ishihara) : Viraktamath, 1983, *Proc. 1st International Symp.* Leafhoppers and planthoppers of economic importance, London, C.I.E., 497.

1994. *Recilia dorsalis* (de Mots.) : Ghosh, M. and Ghosh, L. K., *In* : *Fauna of Meghalaya State Fauna Series*, **4**(Pt. 4) : 21.

Diagnosis : Vertex ochraceous with a short pale brownish fascia and two short submarginal fasciae; two pale obscure brown spots (Fig. 319a) between eyes; (sometimes) vertex either with two longitudinal short pale brownish streaks at apex

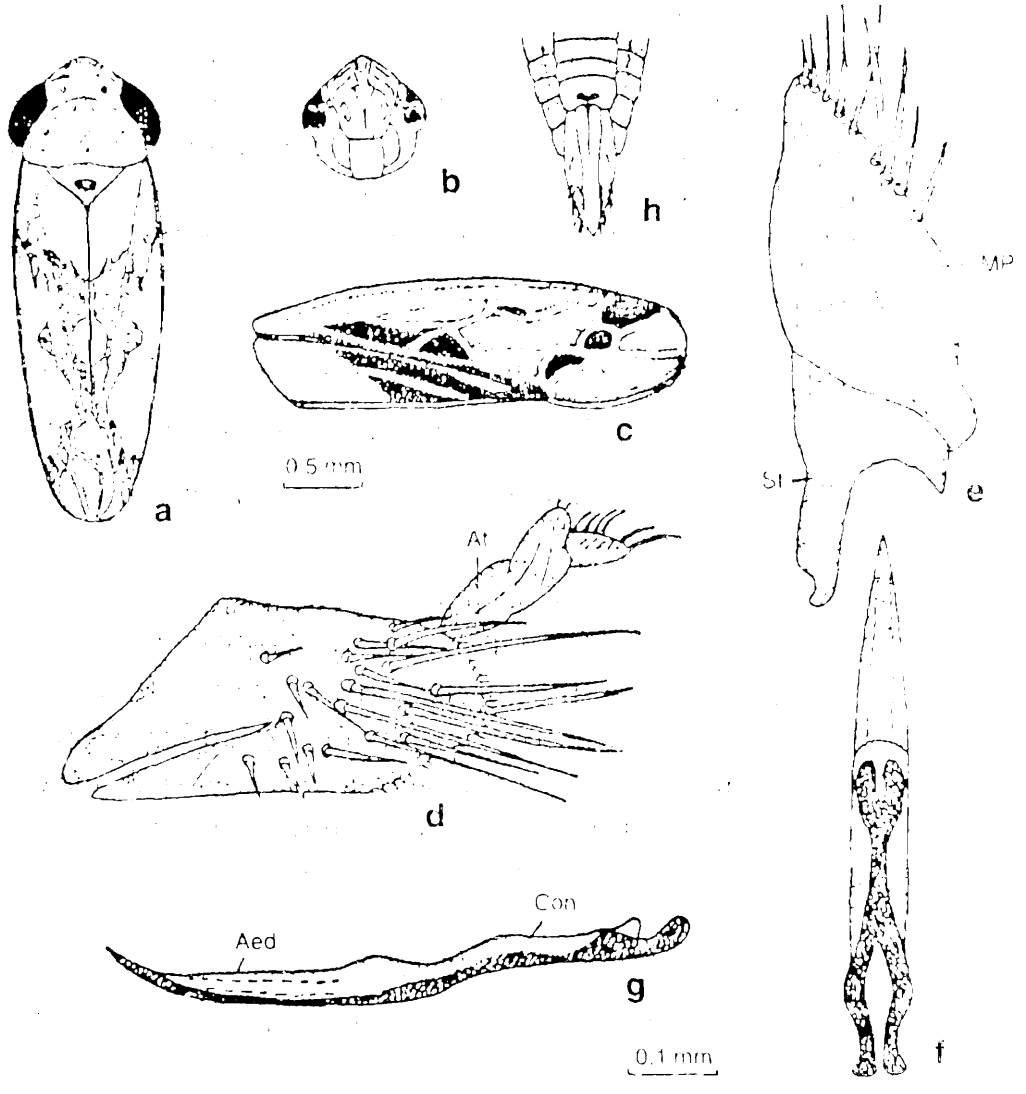


Fig. 319. *Recilia dorsalis* (de Motschulsky) a–dorsal view; b Face—ventral view; c–Forewing—dorsal view; d–Pygofer—lateral view; e–Male plate and Style—ventral view; f–Aedeagus and Connective—dorsal view; g–Aedeagus and Connective—lateral view; h–Female genitalia—ventral view.

or two semicircular pale spots and two brownish spots between eyes. Ocelli placed on lateral margins, nearer to eyes than to apex. Face (Fig. 319b) broader than long ochraceous; lora short, convex, not reaching apex of clypeus; frontoclypeus marked with or without lateral brownish striations. Pronotum ochraceous with irregular markings. Scutellum small, as long as vertex with obscure pale patches at basal angles and a small brown streak on each lateral margin. Forewing (Fig. 319c) with zigzag markings, a brownish longitudinal band arising from antero-lateral part traversing claval suture upto clavus and then diagonally crossing to costal margin from the apex of clavus, a central pale spot enclosed on claval sutures where forweings, meet. Pygofer (Fig. 319d) large, caudal margin minutely dentate, large setae arising from mid-dorsal region, caudoventral region oblique. Male plates large, norrowed to the apical end with large stout setae at lateral margins (Fig. 319e). Connective Y-shaped (Fig. 319f), arms fused, Style large, the inner limb (mesal) with a small curve at apex turned mesiad, pre-apical lobe small, apophysis long, narrow at apex. Aedeagus (Fig. 319g) long, fused with the connective, shaft long, dagger-like. Seventh sternum short, posterior margin truncate, pygofer long, narrow, with stout setae at posterior margins; ovipositor (Fig. 319h) long, reaching posterior extremity of abdomen.

Length : ♀ 3.35-3.52 mm; ♂ 3.0-3.3 mm.

Distribution : India, Meghalaya, Tamil Nadu, Tripura, West Bengal.

Elsewhere : Burma, Sri Lanka, Southest and Fareast Asian Countries.

Remarks : It can be easily distinguished from other species of the genus by the zigzag brown stripes on the fore wing.

Ling *et al.* (1983) listed four viruses of plant diseases transmitted by this vector, viz., Dwarf, Gall Dwarf. Orange leaf and Tungo virus, Harris (1983) also reported on the transmission of Tungo virus by this species. Viraktamath (1983) included this in the illustrated key, fork separating the economically important leafhoppers. The species is considered to be disseminating the viral diseases and Dwarf disease (restricted to Japan), Orange leaf virus (southest Asian countries) and Tungro in Thailand. However, there is no such record of viruliferous trait of the species in India.

Genus 8. ***Iassus*** Fabricius

1803. *Iassus* Fabricius, *Systema Rhyncotorum* : 85 : Type designation *Cirda iania* Fallen, 1826.

Diagnosis : Body brown to fuscous red, robust; vertex blunt at apex, rounded; ocelli placed remotely from each other; antennal base short, thick, apical one with a short bristle; pronotum posterolaterally oblique, anterior angles feebly rounded; tegmina narrowing towards apex, apical cells short; inner anteapical cells acute at tip; posterior tibiae densely spined.

9. *Iassus indicus* Lethiery
(Fig. 320)

1892. *Macropsis indica* Lethierry, *Bull Zool. Soc. France* : 209.

1988. *Iassus indicus* (Lethierry) : Datta, *Roc zool. Surv. India, Occ. Paper No.* **90** : 218.

1994. *Iassus indicus* (Lathierry) : Ghosh, L. K. and Ghosh, M., Insecta : Homoptera : Cicadellidae, *Fauna of West Bengal, State Fauna Series*, 3(Part 5) : 48.

1998. *Iassus indicus* (Lethierry) : Ghosh, M. and Ghosh, L. K. Homoptera : Cicadellidae, *In* : *Fauna of Meghalaya, State Fauna Series*, 4(Part 4) : 23. Zoological Survey of India.

Diagnosis : Body robust, vertex blunt at apex, rounded, ocelli placed far apart from each other, frons raised above cheeks, pronotum finely striate; scutellum depressed at base narrowing towards tip, brownish yellow, coarsely punctate, posterior tibiae

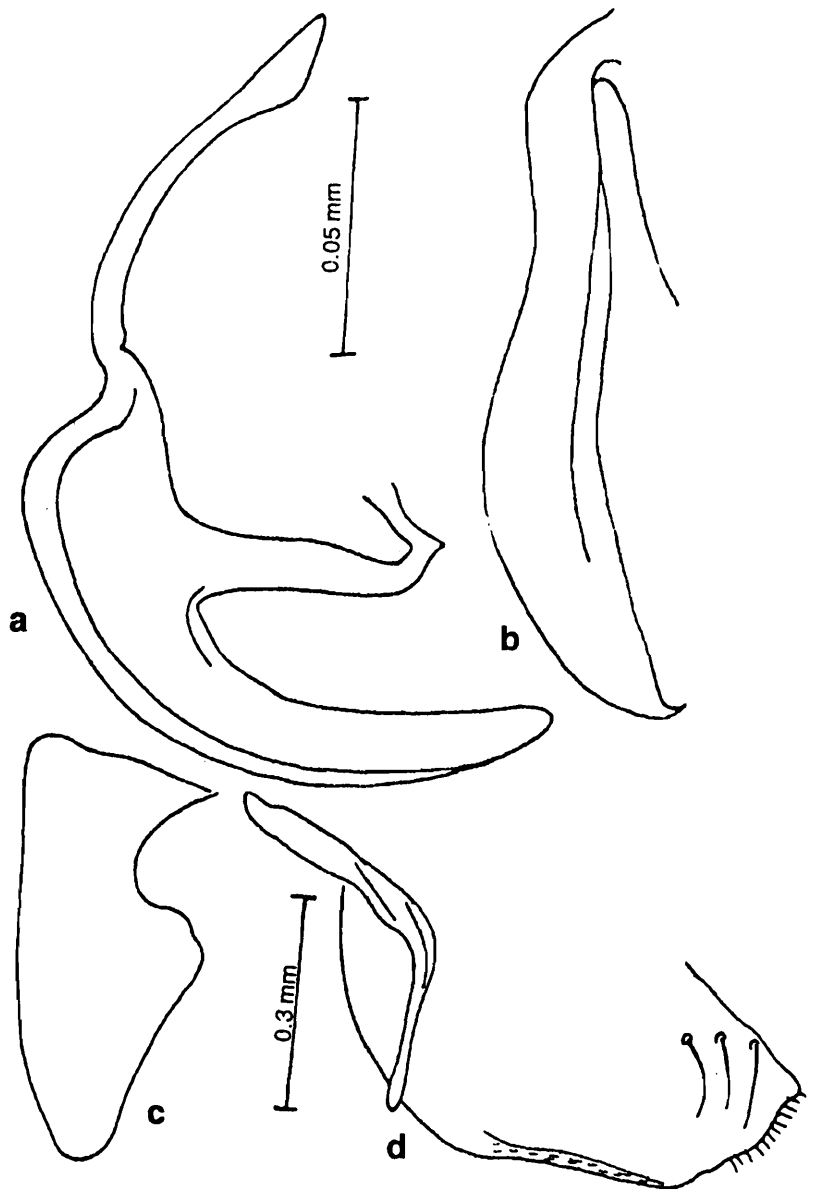


Fig. 320. *Iassus indicus* (Walker). a–Aedeagus; b–Style; c–Male plate; d–Pygofer.

densely spined; 8th tergite with a deep circular notch medially. Aedeagal shaft (Fig. 320a) semitransparent, dorsoventrally flattened, deeply notched at base, a stout lateral process arising medially, margin at apex serrate; stylar shaft (Fig. 320b) at tip beak-shaped; Pygofer (Fig. 320d) with a sharply geniculate hook; male plate ligulate with minute setae (Fig. 320c).

Length : ♀ 7.5 mm; ♂ 1.7 mm.

Distribution : India : Andaman Is., Karnataka, Tamil Nadu, West Bengal.

Elsewhere : Africa, Burma, Buru, Flores, Formosa, Fukeen, Java, Krakataus, Lomboj, Luzon, Murquesas Is., Mindano Is., Philippines, Samoa, Seychelles Is., Silhouette, Sri Lanka, Sumbawa; Upolu.

Remarks : Pruthi (1934) and Mathur (1958) recorded the species as a suspect vector of spike disease of Sandal wood.

Subfamily IDIOCERINAE

Genus 9. ***Idioscopus*** Baker

1915. *Idioscopus* Baker, *Philippine J. Sci.*, **10** (6) : 338. Type of original designation : *Indiocerus clypealis* Lath. 1889.

1889. *Indiocerus clypealis* Leth. *J. Asiat. Soc Bengl.*, **58** : 252.

Diagnosis : Body small (about 5 mm); vertex 0.3 times as long as pronotum, finely rugose transversely, anterior margin convex, posterior margin parallel; eyes on posterior margin of head; ocelli on face, closer to eyes; clypeus, and clypellus well developed; pronotum anteriorly convex; scutellum short, triangulate, narrower than long; hind tibiae with spines; tegmina longer than abdomen in both sexes.

10. ***Idioscopus clypealis*** (Lethierry) **(Mango hopper)**

(Fig. 321)

1889. *Idiocerus clypealis* Lethierry, *J. Asiat. Soc. Beng.*, **8** : 252.

1989. *Idioscopus clypealis* (Leth.) : Ghosh *et al.*, Hemiptera, *In* : *Fauna of Orissa, State Fauna Series*, **1**(Part 2) : 197.

1991. *Idioscopus clypealis* (Leth.) Ghosh, L. K. and Ghosh, M. Insecta : Homoptera : Cicadellidae, *Fauna of Orissa, State Fauna Series*, **1**(Pts. 1-3) : 194. Zoological Survey of India, Calcutta.

Diagnosis : Vertex a little longer in the middle than at the eyes. Head as broad as pronotum, a transversely impressed line below anterior margin across eyes. Pronotum greenish with a band on anterior margin. Scutellar margin boardered by dark brown longitudinal stripes extending along commissure of clavus. Tegmina with a black stripe extending from middle to claval sutures. Abdomen black, posterior

tibiae at bases of the spinules spotted with black. Genitalia : Male plate (Fig. 321A) cleviform, with a row of fine setae along lateral margin. Pygofer as figured (Fig 321B); Pygofer hook lying along lateral margin. Style (Fig. 321C) long, slender, curvate dorsolaterally, somewhat serrated towards apex. Aedeagus (Fig. 321D) with four distinct subapical processes directed basad, strut well developed. Connective 'U'-shaped.

Length : ♀♀ 3.0-3.5 mm; ♂♂ 3.5-6 mm.

Symptom and Damage : The pest is most destructive in case of fruit trees. Injury to the inflorescence and young shoots is caused by egg-laying and feeding. The voracious feeding nymphs are particularly harmful. They cause the inflorescence to wither and ultimately turn brown. As a result, development and fruit-setting are arrested even

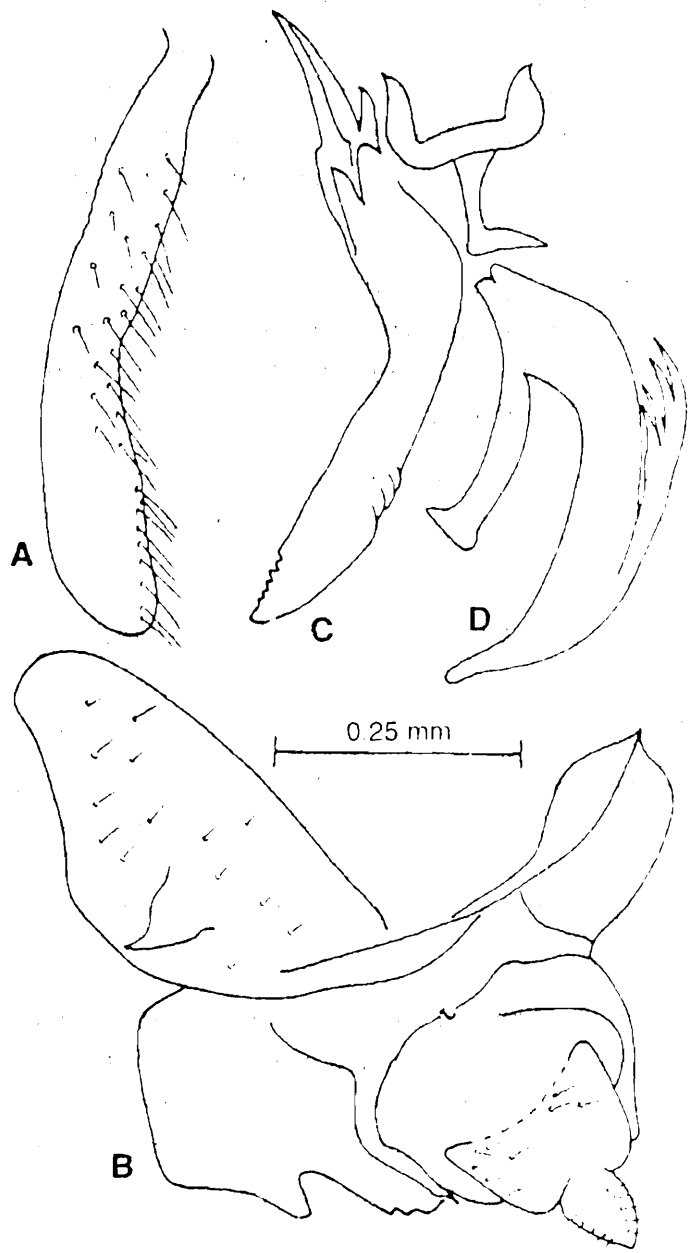


Fig. 321. *Idioscopus clypealis* (Lethierry) : A. Male plate; B. Pygofer; C. Style; D. Aedeagus

if the flowers are fertilized. In the humid atmosphere, a sooty mould develops on patches of honeydew exuded by the nymphs. With the blowing of winds young fruits and dried inflorescence break off at the axil and fall to the ground. The young trees grow slow and the older trees do not bear much fruits. The mango hoppers cause damage upto 60%.

Bionomics : The adults are found sitting in large numbers on the bark of trunks, twings etc. during hot months of May-June and the cold months of October-January. The adults surviving winter emerge in February from underneath the bark of trees. They cluster on the floral buds and start sucking the cell-sap. On the appearance of inflorescence, they start laying eggs on them in the 2nd or 3rd week of February and continue to do so far some weeks. The eggs are deposited singly. A female deposits, on an average 200 eggs, within 4-7 days, the eggs hatch and the newly emerged nymphs are first seen at the end of February or at the beginning of March. They start feeding on the inflorescence, quickly suck the cell sap and exerete honeydew which ultimately forms sooty mould (Chaetothyrium magniferae). As a result, a dull blackish look appears in the mango tree. The smoky-black appearance persists for many months untill the fruits are mature.

By the time the majority of nymphs are mature, the fruit has set. The nymphs afterwards imigrate to the stems and the young leaves, and become full grown in three stages (8-13 days). The full fed nymphs then moult and give rise to winged adults. The life cycle covers 15-19 days.

The adults congregate on the undersurface of twigs and trunks. During May-June the insects do not feed and lay eggs but remain very agile. They jump at the slight disturbance.

Natural enemy complex : *Epipyrops fuliginosa* Tams (Epipyropidae) and *Pipunculus annulifemur* Bruvelli.

Note : Mango is grown in a area of 750.000 hectares throughout the Indian subcontinent. India produces about 80% of world's mango production. Also, the mango fruit is a rich source of vitamin A and also vitamin C. A number of insect pests are involved with this fruit and over 175 species of insects are reported to damage mango tree but the most destructive at the flowering stage are the mango hoppers of which *I. clypealis* is most important.

The species poses a serious problem to Mango cultivation because it is recorded as virulent pest on mango inflorescence. It occurs along with *Idioscopus atkinsoni* (Pruthi), Dover and Appana (1934) reported it as a suspector vector. The species is parasitised by *Halictophagus* sp. (Strepsitera) [Bohart 1934]. It can be distinguished by its lighter colour, with two sports on the scutellum and dark spots on vertex.

Distribution : India : Bihar, Jammu & Kashmir, Karnataka, Orissa, Punjab, Rajasthan, Tamil Nadu, West Bengal.

Elsewhere : Burma, China, Formosa, Indonesia, Japan, Java, Malayasia; Philippines, Sri Lanka.

Remarks : This is the most destructive pest of all the varieties of mango. Injury is caused by nymphs (dust yellow or dull yellow) and adults, sucking cell sap from the inflorescence and tender shoots. Adults are greyish.

Subfamiluy TYPHLOCYBINAE

Genus 10. *Zygina* Fieber

1866. *Zygina* Fieber, *Zool. bot. Ges. Wien,* **16** : 509. Type : *Typhlocyba nivea* Mulsant & Rey.

1855. *Typhlocyba nivea* Mulsant and Rey, *Ann. Linn. Soc. Lond.,* **2**(2) : 246.

Diagnosis : Varied color marking, body broad and robust narrow and delicate insects; hind wing with submarginal veins confluent with cell apically, posterior branch or RI with M vein, Cu2 confluent with submarginal vein at basal half of wings; tegmina with inner apical cell having base oblique to angulate.

11. *Zygina maculifrons* (de Mots.)

1863. *Typhlocyba maculifrons* de Motschulsky, *Soc. Nat. Moscow Bull.,* **36** : 103.

1909. *Zygina maculifrons* Matsumura, *Stschr. E. Wiss. Insektenbiol.,* **6** : 104.

1968. *Zygina maculifrons* : Metcalf, *Genl. Catagoque of Homoptera* : 1394. Ghosh, M., Biswas, B. and Ghosh, L. K., *Fauna of Tripura, State Fauna Series,* **7**(Part 2) : 331. Zool. Surv. India.

Diagnosis : Body yellow in colour, anterior margin of head rounded, at apex large black spots; vertex not produced; face yellow, long with indistinct transverse brownish stripes; clypeus black at apex; pronotum longer than vertex, rounded in front, or the above of pronotum yellow with greyish colouring on the disk; scutellum long and triangular, a transverse depressed line on its middle, tegmina yellowish green in colour, with delicate vein; membrane slightly clouded with smoky brown; wing hyaline; legs yellow, abdomen blackish.

Length : ♀ 2.5 mm; ♂ 1.9 mm.

Symptom and Damage : Both the morphs, nymphs and adults suck cell sap from the leaves which, in the early stages of attack, exhibit whitish, waxy lines. As the damage progresses, the leaves show symptoms of withering. If the pest is not controlled, the plants die.

Bionomics : The pest is found practically throughout the year. The females deposit eggs in batches of 2.3 or 4. A female lives for 45-50 days and during the period, they lay an average of 48 eggs. The eggs hatch in 6-12 days and the young nymphs, on emergence, start feeding inside the leaf sheath. The nymphs moult five times and become mature in 11-20 days and the entire life cycle is completed in 19-32 days.

Distribution : India : Tripura, West Bengal.

Elsewhere : China, Formosa Japan, Java, Kwantung Honshu, Malay Peninsula, Singapore.

Remarks : This insect, popularly known as "Blue Jassid", is primarily a pest of rice nurseries throughout India and adjoining areas. Besides feeding on paddy, it also feeds on Sorghum, Maize, Sugarcane and wild grasses. The pest is characterised in small bluish body having a yellowish vertex with a black patch and a black spot in the middle of the pronotum. It lays eggs on the midrib of leaf, resulting in yellowing of leaf (Nath *et al.* 1986).

Genus 11 ***Amrasca*** Ghauri

1967. *Amrasca* Ghauri, *Proc. R. Ent. Soc. Lond.*, (B)., **36**(11-12) : 159. Type by original designation, *Amrasca splendens* Ghauri.

1967. *Amrasca splendens* Ghauri, *Proc. R. Ent. Lond.*, (B).

Diagnosis : Delicate leafhoppers head with eyes wider than pronotum, vertex narrowed, anterior and posterior margins not parallel; ocelli placed on margin between vertex and frons close to eyes, tegmina translucent, with first and second apical veins from cell 'M', third apical vein from redial cell; hindwing with marginal vein extending around apex of wing to Cu_1 and Cu_2 and anal veins; connective short, aedeagal shaft short, elongate, densely setose.

12. ***Amrasca biguttula biguttula*** (Ishida)
Cotton Jassid
(Fig. 322)

1912. *Amrasca biguttula* (Shiraki), *Spec. Rept. Formosa Agr. Sta.*, **5** : 96.

1988. *Amrasca biguttula biguttula* (Ishida) : Datta, *Rec. zool. Surv. India, Occ. Paper* No. **90** : 239.

Diagnosis : Vertex with a pair of dark spots on anterior margin; pronotum, scutellum brownish yellow and spotted. Tegmina with greenish tinge, a black spot near claval region; abdomon pale. Aedeagal shaft (Fig. 322a) linear, apical third abruptly narrowed to rounded apex; stylar shaft (Fig. 322b) linear, posterior third serrate, concave laterally; male plate (Fig. 322c) connivent, disk with stout spurs; pygofer hook elongate, apex sharp, lateral margin arcuate along axis, 8th sternite (Fig. 322e) as figured. The male pygofer (Fig. 322d) with spine-like process maintains its separate identity although genital armature bears close resemblance to *Empoasca papyae* Oman.

Length : 2 mm (♂)

Biological notes : The species breeds on hollyhook, castor plants, brinjal, tomato, bhindi, ground nuts etc.

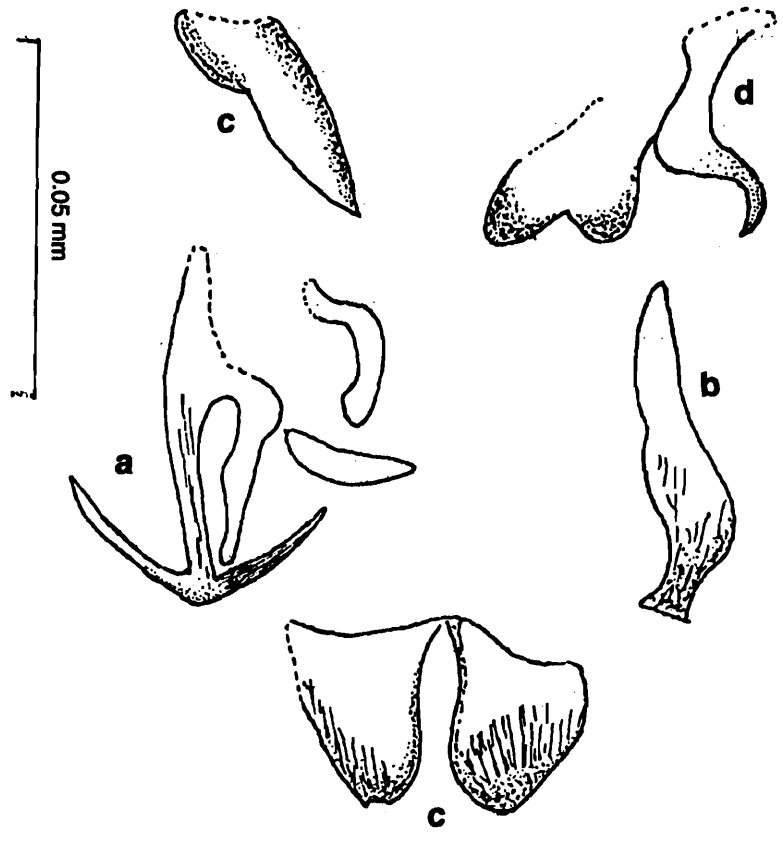


Fig. 322. *Amrasca biguttula biguttula* : a. Aedeagus, b. Style; c. Male plate; d. Pygofer; e. Abdominal apodeme

Symptom and Damage : Plant injury is due to the loss of sap and probably also due to the injection of toxins. The attacked leaves turn pale and then rust-red. With change in appearance, the leaves also turn downwards, dry up and fall to the ground. Owing to the loss of plant vitality the cotton bolls also drop off, causing upto 35% reduction in yield.

Bionomics : The pest breeds practically throughout the year but during winter months, only adults are found on plants such as potato, brinjal, tomato etc. In spring they migrate to Okra and start breeding. The females lay about 15 yellowish eggs on the underside of the leaves, embedding them into leaf-veins. The eggs hatch in 4-11 days and give rise to nymphs which are wedge-shaped and are very active. They suck sap from the underside of the leaves and pass through six stages of growth in 7-21 days. On transformation into winged adults, they live for 5-7 weeks, feeding constantly on plant sap. The pest completes 7 generations in a year.

Natural enemy complex : The insect *Chrysoperia* sp. (Fam. Chrysopidae) and Spiders *(Distina albidat)* feed on nymphs and adults. No other parasitoids are known for this insect.

Distribution : The pest is abundantly found in the cotton growing areas in India.

Elsewhere : Burma, Pakistan, Sind and Sudan.

Remarks : The species is a major pest on cotton due to its occurrence in serious proportions almost every year. It is widely distributed in India and is the most destructive pest not only in India but also in America. Besides cotton, it also feeds on okra, potato, brinjal and some wild plants like hollyhock. It is recorded as vector of little leaf brinjal. The capability of disseminating viral disease is confirmed on cotton plants. It is also recorded as vector of big bud of tomato which bears relation to yellow of kodsaghyz and yellow aster. It plays role also in Mosaic disease of egg plant (Datta 1988). It is known that the pest has capability to spread the disease to various crops of economic importance.

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INSECTA : HOMOPTERA : COCCOIDEA

Coccides are small phytophagous insects belonging to the order Homoptera. They (scale insects/Mealy bugs) look like lifeless, small protuberances or sometimes a white powdery covering on the leaves and tender shoot of plants. They are mostly soft-bodied and covered with copious secretion of white wax. These are economically important insects because many species are severe sucking pests on many plants including vegetables and fruit trees. The females are sedentary. Males pass through 3 pupal stages and emarge with one pair of wings. Characterized by single-segmented tarsi with a single claw. Females are apterous and are devoid of legs. Males are dipterous with atrophied mouth parts. They are well known as pests of fruits, crops, shrubs and ornamentals. The coccids cause tremendous damage to the host plants. They are remarkable or prolific breeders and create havoc on the plants. Some coccids are monophagous while mostly are polyphagous [e.g. *Ferrisia virgata* (Cockerell– known as white-tailed mealy bug). Although they are minute insects, a moderately prolific species may have several generations per season. The coccids are structurally and biologically unique (Kosztarab, 1987). These notorious insects also cause and transmit many a plant viral diseases.

Their role in spike disease of sandal was investigated by Chatterjee & Ayyar (1936). According to Ayyar (1939) the surai disease of paddy is caused by the coccid ***Brevennia rehi***. Anjaneyulu *et al.* (1980) investigated the viral diseases of paddy caused by coccids. Transmission of sugarcane spike disease by coccids was studied by Sharma & Jha (1957) and Ali (1963). Tukra disease of the mulberry by ***Maconellicoccus hirsutus*** was reported by Misra (1919), Raichoudhury (1958) and Sriharan *et al.* (1980).

Coccid pests of economic importance have been listed by Green (1910) and Ayyar (1919, 30) from South India, and Ghose (1961) from West Bengal.

About 624 species of coccids under 208 genera in 15 families are known from India and adjacent countries including Burma, Sri Lanka, Myanmar, Indonesia etc. region as against world fauna of nearly 6000 species. Significant contributions made on the Indian coccid insects are chiefly : Green (1896-1922), Lefroy (1909), Fletcher (1919, 1921), Ayyar (1921, 1930), Ramachandran & Ayyar (1934), N. Dutt & Co-workers (1948-1964), G. M. Das & Co-workers (1948-1962), Banerjee (1956-1965), Banerjee & Basu (1956), Ghose (1961), Ali (1969-1974), Varshney & Maharana (1987), Agarwala & Varshney (1988), Varshney (1985, 1992, 1998, 2000, 2002) etc.

SYSTEMATIC ACCOUNT

Family I MONOPHLEBIDAE

Subfamily MONOPHLEBINAE

Tribe DROSICHINI

Genus 1 ***Drosicha*** Walker, 1858

1. *Drosicha mangiferae* (Green)

Tribe ICERYNI

Genus 2 ***Icerya*** Signoret, 1875

2. *Icerya purchasi* Maskell

Family II PSEUDOCOCCIDAE

Subfamily PSEUDOCOCCINEA

Tribe PHENACOCCINI

Genus 3 ***Brevennia*** Goux, 1940

3. *Brevennia rehi* (Lindinger)

Genus 4 ***Nipaecoccus*** Sulc, 1945

4. *Nipaecoccus viridis* (Newstead)

Tribe PSEUDOCOCCINI

Genus 5 ***Dysmicoccus*** Ferris, 1950

5. *Dysmicoccus brevipes* (Cockerell)

Genus 6 ***Ferrisia*** Fullaway, 1923

6. *Ferrisia virgata* (Cockrell)

Genus 7 ***Maconellicoccus*** Ezzat, 1958

7. *Maconellicoccus hirsutus* (Green)

Genus 8. ***Saccharicoccus*** Ferris, 1950

8. *Saccharicoccus sacchari* (Cockerell)

Family III COCCIDAE

Subfamily COCCINAE

Tribe COCCINI

Genus 9 ***Coccus*** Linnaeus, 1758

9. *Coccus viridis* (Green)

Genus 10 ***Saissetia*** Deplanche, 1859

10. *Saissetia cofeeae* (Walker)

11. *Saissetia nigra* (Nietner)

Family IV DIASPIDIDAE

Subfamily ASPIDIOTINAE

Genus 11. ***Aonidiella*** Berlese & Leonardi, 1895

12. *Aonidiella aurantii* (Maskell)

Genus 12 ***Aspidiotus*** Bouche, 1833

13. *Aspidiotus destructor* Signoret

Genus 13 ***Quadraspidiotus*** Mac Gillivray, 1921

14. *Quadraspidiotus perniciosus* (Comstock)

GENERAL MORPHOLOGY

The female coccid is covered with a scale or gill-like test, or some waxy, resinous or powdered mealy coating (hence the name scale insect or mealy bug). The body is membranous, highly degenerated, apterous with little or no segmentation, and often with reduced antennae, legs and genital structures.

Adult coccids are small to minute bodies, with exceptional giant mealy bugs which exceed 1 cm. size. All are as a rule draped with a covering, secreted by insect itself. This covering may be either a waxy coating, hard armoured scale or a resinous cell (also called a test or puparium), or a white mealy powder (fine wax filaments) which covers wholly or partially the body.

A female coccid body is highly modified structure. It is round or oval mass, often flat or convex, in which head and thorax are fused into one, merging even with abdomen. All females are apterous. Antennae 1-13 segmented. Legs, when present, have 1-2 segmented tarsi, bearing a single claw. The body generally leads a stationary life fixed to the plant surface. However, monophlebid and pseudococcid females are able to move slowly. All possess a long thread-like proboscis as mouth parts.

A male has head, thorax and abdomen, 3 pairs of legs, one pair of antennae, simple eyes, but with or without only one pair of wings. However, the male is not having functional mouth parts. They are generally not available for study and so not used for identification purpose.

Key to families

1. Abdominal spiracles present; body covered with white powdery wax; setigerous anal ring absent. ..... MONOPHLEBIDAE

– Abdominal spiracles absent 2

2. Abdominal segments fused to form distinct pygidium; body covered with flat hard shield-like scale having a few exuviae ..... DIASPIDAE

– Abdominal segments not fused to form pygidium as above, scale of body without exuviae 3

3. Anal cleft present on posterior end of abdomen; openings of wax glands not geminate; and opening covered usually with 2 plates; body usually covex..... ..... COCCIDAE

– Anal cleft absent; wax gland opening geminate when present; dorsal gland organs and 3-celled glands present; anal ring with 4 or more setae..... ..... PSEUDOCOCCIDAE

Family I MONOPHLEBIDAE

Female : Body distinctly segmented, often covered with waxy secretion or woolly covering; antennae and legs well developed; simple eyes often present; abdominal spiracels present; and ring distinct or reduced, eyes with or without stalk; anal ring nonsetigerous. These coccids are referred as "ground pearls" and some taxa with fossorial forelegs. These are often large-sized specimens, hence referred as "giant"

Key to genera of MONOPHLEBIDAE

Female small in size about 0.02 mm; dorsal hairs usually minute, slender or moderately shout. ..... ***Drosicha***

– Female large in size, 4-5 mm; white, convex egg-sac, brown to reddish brown soft-bodied; dorsal hairs rather stout and of verious sizes..... ***Icerya***

Genus 1 ***Drosicha*** Walker

1908. *Drosicha* Walker, List of specimens of Homopterous insects in the collection of British museum-supplement, London : 304

Types species : *Drosicha confratiens* Walker, 1858

1. ***Drosicha mangiferae*** (Green)
Mango mealy bug
(Fig. 323)

1908. *Monophlebus stebbingi* Green, *Mem. Dept. Agr. India* (Ent.), **2**(2) : 16

1928. *Drosicha mangiferae* : Morrison, *Tech. Bull. U.S Dept. Agr.*, **52** : 169.

1992. *Drosicha magniferae* (Green) : Varshney, *Rec. zool. Surv. India, Occ. Paper No.* **139** : 18. Zoological Survey of India, Calcutta.

Diagnosis : Female about .02 mm, atrium or outer chamber of the abdominal spiracles without multiocular pores; dorsal setae minute or long and slender to moderately stout in different species. Male with wing expanse of 12 mm. Four pairs of abdominal tussels.

Host plants : Mango, citrus and over 60 other plants *viz. Acacia modesta, Acer pictum, Alstonia* sp., *Artocarpus integrifolia, Dalbergia sissoo, Ficus bengalensis, F.*

carica, F. glomerata, F. infectoria, F. religiosa, Grewia subinaequalis, Helianthus annuus, Litsea polyantha, Jackfruit, Guava, Jamun, Papaya, Peach, Plum, Citrus etc.

Symptom and Damage : With the setting in of spring, when shoots grow luxuriant with cell sap, the attack of the pest becomes severe. Nymphs and adults (wingless female) squeeze the sap from the soft twigs, foliage and fruits. A thicky "honey dew" is secreted by them which is conductive to the growth of sooty mould and aslo affects photosynthesis activity. Older fruits do not develop properly.

Biology : Soon after emergence the winged male mates with the apterous females. The mated female descends the tree and reaches the soil for oviposition. The eggs are laid inside cottony white ovisacs during April to beginning of June at a depth & 50–175 mm in lose soil near or away be laid in the cracks of the soil and bark. The nymphs hatch out from the eggs during September. The incubation period varies from 98-185 days depending on the soil temperature and humidity. The nymphs start to ascend the trees from October–November. They come in the axils of twigs and cracks of the bark in clusters of 17–283. There are four nymphal stages in females and three in males. In female, the total developmental period from egg to adult on *Citrus* varies from 160 to 304 days and in male it is 165–290 days. The prepupal periods of the male ranges from 2–5 and 6–13 days respectively.

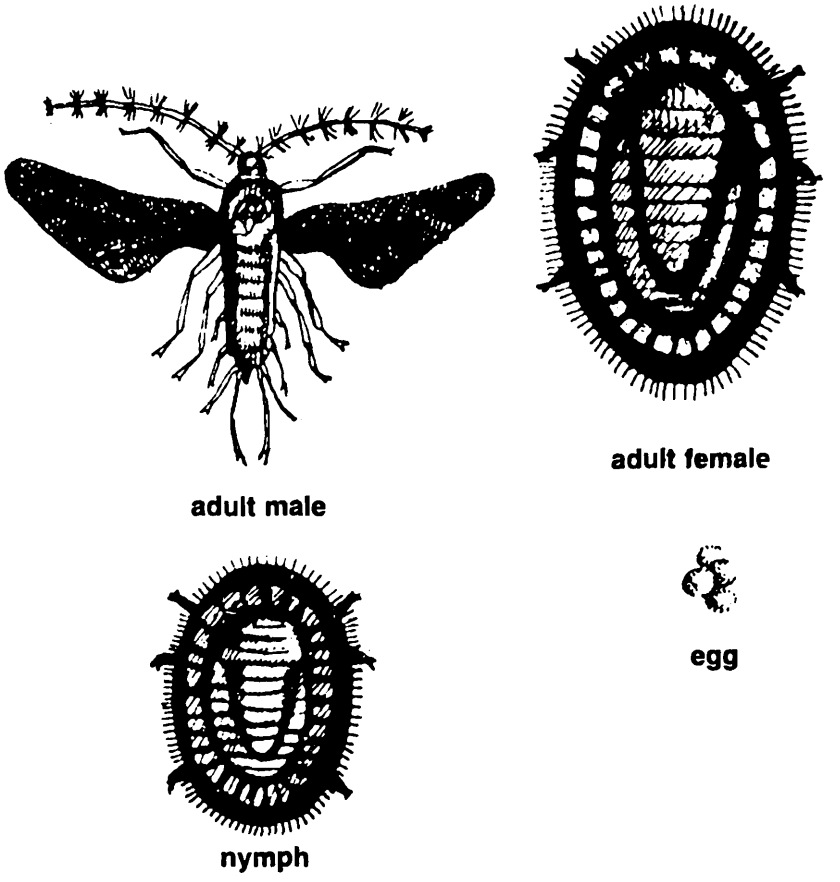


Fig. 323. *Drosicha mangiferae* (Green)

Natrual enemy complex : Parasites : *Phygadeuon* sp. (Hymenoptera : Ichneumonidae), *Getonides perspicax* Knal, *Brinckochrysa scelestes* (Banks) [Chrysopidae]. An entomogenous fungus *Aspergillus parasiticus*is parasite on it. The mite *Bochartia* sp. is an ectoparasite on the adults and nymphs.

Predators : *Coccinella septempunctata, C. undecimpunctata, Cheilomenes sexmaculata Aulis vestita.* Grabs of *Rodolia fumida* (Mulsant) [Coleoplera : Coccinellidae] Apart from these, there are predatory birds also, which feed on this harmful insect pest.

Distribution : India : Assam, Bihar, Punjab, Uttar Pradesh, Indo-Gangetic Plains and foothills

Elsewhere : Pakistan.

Remarks : This species is known as serious pest of mango crop. The mango mealy-bug is widely distributed in the Indo-Gangetic plains from Punjab to Assam. Besides mango, it also attacks about 62 other plants, including such trees as the jack-fruit (*Artocarpus heterophyllus)*, the banyan (*Ficus bengalenis),* guava (*Psidium guajava),* Papaya (*Carica papaya), Citrus* spp. etc.

Management : These pest can, to some extent, be kept under control by some natural insect enemies as well. These enemies are cocccinella species, *Rodolla fumida* etc. Apart from these, there are predatory birds also, which feed on this harmful insect pest.

As the eggs are laid on the soil at the root of infested trees, they can be destroyed by removing the soil under the infested trees.

It is also of great use to apply Aldrin 5 per cent dust around the base of trees and spray malathion 0.005 per cent or diazinon 0.03 per cent in view of controlling early instar nymph.

Genus 2. *Icerya* Signoret

1875. *Icerya* Signoret, *Ann. Soc. Ent. de France,* 5(5) : 350

Type species : *Dorthesia seychellarum* Westwood

Diagnosis : Large-sized soft-bodied scale, (4-5 mm long), body covered with setae of verious sizes. Presence of convex egg-sac secreted by the female; ovisac with a series of more or less prominent humps being accenuated by the presence of dense dufts of stout setae; antennae 11-segmented; limbs well developed, black; claw strongly fulcate.

2. *Icerya purchasi* Maskell
Cottony Cushion Scale or Fluted Scale
(Fig. 324)

1878. *Icerya purchasi* Maskell, *Trans New Zeal. Inst.,* **11** : 221.

1987. *Icerya purchasi* Maskell : Varshney and Moharana, Insecta : Homoptera : Coccoidea, In : *Fauna of Orissa, State Fauna Series*, **1** : 163. Zoological Survey of India, Calcutta.

1994. *Icerya purchasi* Maskell : Varshney : Insecta : Homoptera : Coccoidea. *In* : *Fauna of West Bengal, State Fauna Series*, **3** : 326. Zoological Survey of India, Calcutta.

Diagnosis : The adult female body (4-5 mm) is covered with setae of various sizes. The most important character of the female is the large, white, fluted, convex egg-sac which is secreted by the female being flat oval (4.5 × 3.5) brown to reddish-brown soft-bodied scale. The ovisac is with a series of more or less prominent humps which are accentuated by the presence of dense tufts of stout blackish setae each arising from a prominent tubercular base. Antennae 11-segmented, each segment cylindrical, 3rd usually constricted near at the middle, 4th-10th narrowed at base and extended distally, 11th very irregularly ovate. Limbs black, well developed; tibia as long as femur, tarsus half as long as tibia, strongly bowed; claw strongly fulcate. Abdominal spiracles 3 on each side, one pair on each of the 3 terminal segments. The full grown larva is broadly oval, 3.0 × 1.5 mm, reddish brown to brick-red in colour.

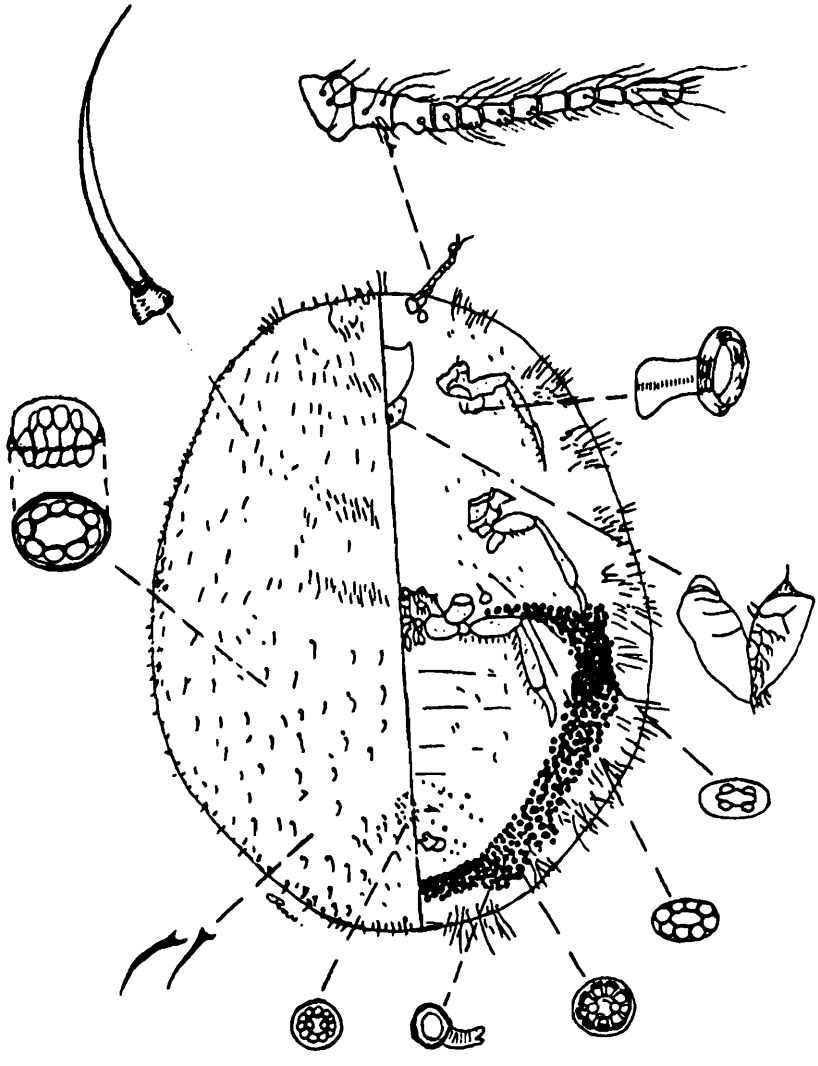


Fig. 324. *Icerya purchasi* Maskell

Host plants : On many species of *Acacia, Anaphalis, Artemisia, Acanthospermum, Barberis, Bidens, Bupleurum, Buxus, Bursaria, Casuarina, Citrus, Camellia, Callistris, Carissa, Conyza, Cytisus, Cassia, Clausena, Desmodium, Dodonaea, Eupatorium, Ficus, Gaultheria, Glochidion, Justicia, Leucas, Loranthus, Malas, Osyris, Prunus, Pyrus, Phyllanthus, Plumbago, Rhamnus, Rhodomyrtus, Rosa, Solanum, Sophora, Sopubia, Ulex* etc.

Symptom and Damage : Due to infestation the leaves and twigs firstly turn pale and then all prematurely. Sometimes, the heavily infested young shoots and small nursery plants are also severely affected.

Biology : During the dry-hot months, its multiplication is the maximum. The scale generally reproduces asexually. The female lays up to 700 eggs in the ovisac held behind the body. The young nymphs emerge from the eggs within 24 hours during the hot season, but may take several weeks when the weather is cold. The newly hatched nymphs move some distance before fixing themselves on leaves and twigs for feeding. They moult thrice before attaining adulthood. The life-cycle is completed in 46-240 days.

Natural enemies : Predator : *Rodalia cardinalis* (Mulsant) (Family Coccinellidae)

Distribution : Widely distributed in India, particularly from Maharashtra, Karnataka, Kerala, Orissa, Tamil Nadu.

Elsewhere : Sri Lanka, Bangladesh.

Remarks : It is a serious pest of citrus plants in certain tropical and subtropical regions of the world. It is a native of Australia where it lives mostly on *Acacia* spp. In India, the pest is present in southern States, mostly on wild plants such as wattle, casurina and grose. It has also been recorded damaging apple, almond, walnut, peach, apricot, fig, grapevine, guava, pomegranate etc.

The pest species, first discovered in New Zealand, was described by Maskell in 1878. Since then it has been reported from many countries all over the world. It was known to be a serious pest of *citrus* in California and its control was possible only by the introduction of its natural enemy *Rodalia cardinalis*. The insect was first seen in our country during spring of 1928. *R. cardinalis* plays important role in controlling the pest effectively in many parts of India.

The speices is highly polyphagous. Rao and Cherian (1994) and Rao (1951) have listed host plants in south India.

Management : Spray 1.70 Litres of dimethoate 30 EC or 1.25 Litres of malathion 50 EC or 500 ml of fenitrothion 50 EC in 1250 Litres of water per ha.

Family II PSEUDOCOCCIDAE (Mealy-bug)

Diagnosis : The body is oval, antennae and legs are well developed, long marginal setae are found on certain segments and anal lobes. Various type of pores (trilocular, multilocular etc.), cerarii and ducts are present, though minute.

The most distinctive feature of the family is the presence of dorsal ostioles. It is now known, however, that in a few species these structures are lacking in the adult female although present in the first stage and that in a few more species, which are similar to those others in general structure, they seem to be lacking in all stages. The females are usually with elongate-oval body with distinct segmentation; generally covered with a white powdery mealy or filamentous waxy secretion; legs and antennae well developed; ventral circuli and marginal cerarii often present. These insects are well known as mealy-bugs.

Key to genera of the family PSEUDOCOCIDAE

1. Body oval with cerarii reduced to normally one ..... ***Ferrisia***
– Body with at least one pair of Cerarri 2
2. Mealy bugs with only 1 pair of Cerarri ..... ***Brevinnia***
– Mealy bugs usually with more than 1 pair of Cerarri 3
3. Cerarri usually 2 pairs ..... ***Maconellicoccus***
– Cerarri more than 2 pairs 4
4. Dorsum of body with 17 pairs of Cerarri ..... ***Dysmicoccus***
– Dorsum of body less than 17 pairs of Cerarri 5
5. Margins of segments 6-9 with very long setae; irregular pores present near the attachment of the hind coxa ..... ***Saccharicoccus***
– Margins not as above, rather with waxy filaments pores near the attachment of hind coxa usually absent ..... ***Nipaecoccus***

Genus 3 ***Brevennia*** Goux

1940. *Brevennia* Goux, *Bull. Soc. d' Hist. Nat. E' 'Afrique du Nord,* **31** : 58.

Type species : *Ripersia (Brevennia) tetrapora* Goux

Diagnosis : Body elongate, with at least one pair of cerarri; oral-collar tubular ducts at least twice longer than wide; tarsal digitules with acute apices; dorsal and ventral quinquelocular pores more numerous than other pores; swirled trilocular pores present in small numbers at least in anal lobe cerarri or near spiracles; claw usually without donticle; antennae usualy 6 or 7-jointed.

3. ***Brevennia rehi*** (Lindinger)
Rice Mealy Bug
(Fig. 325)

1908. *Ripersia sacchari* : Green, *Mem. Dept. Agr. India (Ent.),* **2**(2) : 25.

1917. *Ripersia sacchari oryzae* Fletcher, *Rept. Proc. 2nd. Ent. Mtg. Pusa* : 177

1943. *Ripersia rehi* Lindinger, *Arb. Morph. Taxon Ent.*, **10** : 152

1964. *Ripersia oryzae* : Ganguli & Ghosh, *Indian J. Ent.*, **26** : 359.

1992. *Brevennia rehi;* Varshney, *Rec. zool. Surv. India, Occ. Paper No.*, **139** : 39.

2000. *Brevennia rehi* : Varshney, *In* : *Fauna of Tripura, State Fauna Series*, **7**(pt 2) : 387 [Other synonyms : *Ripersia sacchari* Green; *Heterococcus rehi* (Lindinger); *Heterococcus tuttlei Miller & McKenzie Tychea rehi* (Lindinger)]

Diagnosis : The nymphs and the adult females being wingless, look alike. They are plump oblong, reddish white, soft-bodied and have a distinct powdery coating on their body.

Diagnosis : Female 1.2-2.7mm long with 0.5-1.3mm as maximum width. Dorsum with 1-4 pairs of cerarii all restricted to posterior abdominal segments; anal lobe cerarii with somewhat robust, bristle-shaped setae (13-25μ long). Antennae usually 6-segmented, 183-208μ long; Discoidal pores abundant over surface. Quinquelocular pores of one size scattered over surface. Multilocular disk pores present in medial areas on posterior margin of abdominal segments VIII-VII or VI, absent on anterior margins; ostioles present on abdomen only dorsal setae bristle-shaped; anal ring dorsal in complete anteriorly, with setae slightly longer than greatest diameter of ring; *venter* with multilocular disk pores present medially on posterior margins of abdominal segments IX-VII, VI or V, normally absent on anterior margins; oral-collar tubular ducts of two sizes; posterior seta 108-155μ long. circulus absent; multilocular disk pores larger than quinqueloculars legs robust, femur on hind leg rather larger than femora on remaining legs; hind coxae without pores; hind femora dorsally with about 50 translucent pores; hind tibiae dorsally with about 18 pores; claws without denticle.

Host Plants : On leaves or leaf-sheath of paddy *(Oryza sativa), Sorghum vulgare, Leptochloa polystachya, Eragrotis interrupta, Panicum colonum, p. javanicum, p. repens, Fimbristylis miliacea, F. argentea, Eriochloa polystachya, Impereta arundinacea, Andropogon annulatus, Apludia varia, Cynodon dactylon Ischaemum ciliare, Eleusine coracana, Cyperus pygmaeus, C. rotundus, Echinochloa colona, Paspalum scrobiculatum, Saccharum spondaneum, Sefaria glauca, Digitaria sanguinalis, Cymbopogan caesius.* (Source : Varshney, 1992).

Distribution : India : West Bengal, Tripura, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Madhya Pradesh, Maharashtra.

Elsewhere : Australia; Southern USA; Burma; Bangladesh; Myanmar; Nepal; Pakistan; Papua New Guinea; Puerto Rica; Thailand.

Symptom and Damage : Handreds of both the nymphs and adult females cause damage by sucking plant sap from the rice stem in colonies. This results in stunted

plant growth and yellowish curled leaves. When the attack is severe the ear heads become suppresed and are unable to grow out of their sheaths. An infested field shows isolated patches of the stunted and sickly looking plants. When the outer sheath of an infested stem is drawn apart numerous bugs of all stages are soon attached to the stem. Under severe infestation at growth stage of the crop, when there is no panicle emergence causes 50–60% yield loss. However, since the infestation is generally in patchy form it was found to cause 15–20% yield loss especially under drought prone areas (Mammen, 1976). Alam and Karim (1981) reported a severe outbreak of the mealy bug causing 100% yield loss, when there was a long and sereve drought in Bangladesh.

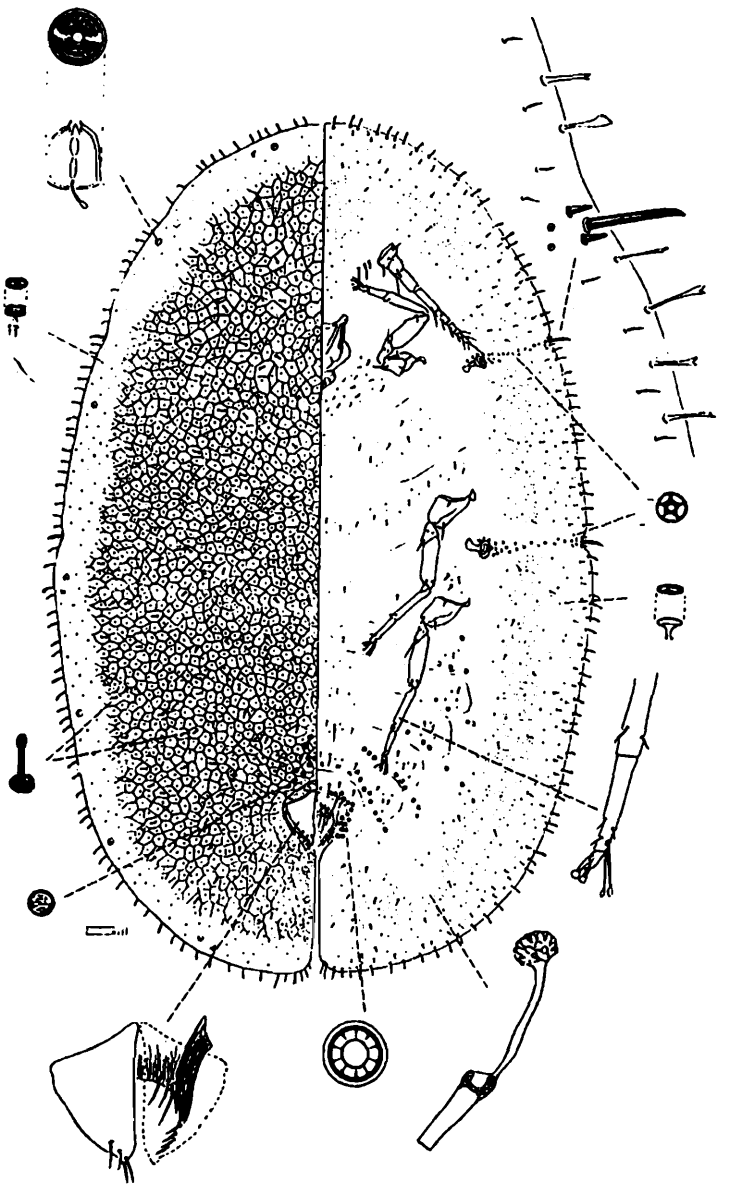


Fig. 325. *Brevennia rehi* (Lindinger), Adult ♀

Factors responsible for losses : Severe drought, bad drainage and poor soil increase the mealy bug infestation. Primarily the pest is reported to cause heavy damage in upland rice due to dry atmosphere. Temperature around 40°C with moderate humidity are congenial for the population build up of the mealy bug. III maintained, weakly fertilised crops under low moisture conditions are susceptible to the mealy bugs.

Biology : The species reproduces parthenogenetically and the females either lay eggs or simply deposit nymphs in the outer leaf sheath. The females have been reported to lay 126-319 eggs or nymphs. The mature females have a life span of about 5 days. The eggs and the young nymphs are whitish in colour and measure 0.3 and 0.4 mm in length respectively. The duration of the egg stage may range from a few minutes to 24 hours. The nymphs instinctively stay within the egg sac or under the body of the mother for about 2 days. Then, they move away and establish themselves between the leaf sheath and the stem. There, they feed and complete the nymphal period in 15-34 days. After the last moulting, the female nymphs become sessile and start depositing eggs or nymphs at the same spot. The numphs which are destined to become males, transform into winged adults which fly off without feeding and some also mate with females. Thus, the asexual and sexual cycles are completed side by side. By the activity of the nymphs within the leaf sheath white waxy fluff shows out from the sheath. Adult mealy bug is oblong, 3-4 mm long, reddish white, soft bodied, wingless insect covered with white filamentous materials. Mealy bugs are usually found in colonies attached to the stem and leaf-sheath of the plant. The nymphs and adults being wingless look alike. Males are slender, pale yellow in colour, having single pair of wings and a style like process at the end of the abdomen but lack mouth parts and smaller in size than the females. Males are seldom found in the colonies and migrate freely from plant to plant. There are about 10–12 generations in a year.

Remarks : *Brevennia rehi* is an important pest of paddy. The pest ocasionally causes heavy damage to the rice crop in many countries including India, Bangladesh and Thailand. In tropical and subtropical regions, the pest is found throughout the year in one development stage or the other. The coccids attacking paddy have been studied by Ayyar 1939, Mani (1939), Banerjee (1956) and Ali (1974). A detailed account of the mealy bugs attacking paddy all over the world was given by Williams (1970).

Management : Mealy bugs are generally parasitised by *Adelencurtus; Doliphoceros* sp.; *Gyranusa* sp.; *Parasyrphophagus* sp. and *Xanthoencurtus* sp. predated upon by *Gitonides perspicax* Knab, *Leycopis luteicornis* Malloch, *Scymnus* sp.; *Pullus* sp.; *Anatrichus pygmaeus* Lamb and *Mepachymerus ensifer* (Nair, 1986). Since many poaceus and cyperaceous plants are its alternate hosts, such weeds growing in the fields or bunds should be destroyed. Sometimes simply by irrigating the crop infestation of the mealy bugs can be isolated intested patches in the field with any of the synthetic insecticides like phosphamidon or monocrotophos @ 0.5 kg a.i./h. (Prakash and Rao 1999).

Genus 4 ***Nipaecoccus*** Sulc

1945. *Nipaecoccus* Sulc, *Acta Soc. Sci. Nat. Norav.* **17**(3) : 1.

Type species : *Dactylopius nipae* Maskell.

Diagnosis : Mealy bugs with dorsal ostioles; body flatened, margins with waxy filaments; adult female wingless, adult male winged, midge-like, without mouth parts.

4. ***Nipaecoccus viridis*** (Newstead) (Black Citrus Mealy-bug)

1894. *Dactylopius viridis* Newstead, *Indian Mus. Notes,* **3**(5) : 25.

1895. *Dactylopius vastator* Maskell, *Trans. Proc. New Zealand Inst.,* **27**(1894) : 65

1919. *Pseudococcus nipae* : Fletcher, *Rept. Proc. 3rd Ent. Mfg. Pusa,* (1) : 289.

1992. *Nipaecoccus viridis* : Varshney, *Rec. zool. Surv. India, Occ. Paper No.,* **139** : 43.

2000. *Nipaeccoccus viridis* : Varshney, *In* : *Fauna of Tripura, State Fauna Series,* **7**(Part 2) : 386. Zool. Surv. India.

Diagnosis : The adult female is wingless, with a flatened body (4.0–4.5 mm long) and short, waxy filaments along the margins. It has piercing and sucking mouthparts. The male is winged, midge-like, with long antennae and no mouth parts; consequently, it does not feed. The nymphs are amber with a whitish waxy coating and filaments.

Host plants : *Artocarpus, Casuarina, Cotton, Cucumis, Luffa, Psidium, Vitis, Ziziphus, Euphorbia, Thea, Dalbergia, Solanum etc.*

Symptom and Damage : Damage is caused by nymphs and females. The pest feeds on cell-sap and the plants become pale, wilted and the affected parts eventually die. The insects also excrete honeydew on which a black mould grows and thus, interferes with photosynthesis. Black ants are attracted to the honeydew and they become a nuisance. In severe cases of infestation, the citrus flowers do not yied any fruit.

Biology : Eggs are laid in clusters on citrus plants. The eggs (about 300) are found in protective cotton-like masses. The eggs hatch in 10-20 days and the nymphs crawl out and start feeding by inserting their mouthparts in the lower surface of the leaves. A waxy white covering is soon formed on their bodies. A female nymph is full-grown in 6-8 weeks. The male nymphs spin cotton-like cocoons before transforming themselves into winged adults. These are usually found on the underside of the leaves in clusters.

Distribution : India : Andhra Pradesh, Bihar, Delhi, Gujarat, Goa, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Tamil Nadu, Tripura, U.P. W. Bengal, N.E. States and Orissa.

Elsewhere : Bangladesh, Pakistan and Sri Lanka.

Remarks : The mealy bug resembles other allied species, namely *Pseudococcus citriculus* Green found in China and USA; *P. calceolariae* (Maskell) in California and

Planococcus citri (Risso) found in Malaysia and Indonesia. The species is more common in southern India than in the north. The mealy-bugs are known to feed on a number of plants. In the gardens, they are seen on *Cactus* spp., ferns., begonia, gardenia, poinsettia and other flowers.

Management : Spray 750 ml of monocrotophos 40 WSC or 625 ml of methyl parathion 50 EC or 1.5 litres of diazinon 20 EC in 625 litres of water per ha.

Genus 5. ***Dysmicoccus*** Ferris

1950. *Dysmicoccus* Ferris, *Atlas of the scale insects of N. Amercia* **5** : 22, 53.

Type species : *Dactylopius brevipes* Cockrell.

Diagnosis : Dorsum with 17 pairs of cerarri. Anal lobe cerarius with 2 setae and several slender auxiliary setae. Dorsum beset with triocular pores. Anal ring of normal form and size; each of its 6 setae about twice as long greatest diameter of ring; venter with multiocular disk pores.

5. ***Dysmicoccus brevipes*** (Cockrell)
Pineapple Mealybug
(Fig. 326)

1893. *Dactylopius brevipes* Cockrell, *Entomologist,* **36** : 267.

1930. *Pseudococcus bromeliae* (Bouche); Ayyar, *Bull. Dept. Agr. Res. Inst. Pusa,* **197**(1929) : 60.

1934. *Pseudococcus cannae* Green, *Stylops,* **3** : 162.

1967. *Dysmicoccus brevipes* : McKenzie, *Mealy bugs of California* : 160.

1970. *Dsysmicoccus brevipes;* Ali, *Indian Mus. Bull.* **5**(2) : 105

1992. *Dysmicoccus brevipes;* Varshney, *Rec. zool. Surv. India, Occ. Paper No.,* **139** : 50.

2000. *Dysmicoccus brevipes* : *In* : Varshney, *Fauna of Tripura, State Fauna Series,* **7**(Part 2) : 385. Zoological Survey of India.

Diagnosis : Female round spherical, 2-3 mm long with 1.8–2.00 mm as maximum width. Dorsum with 17 pairs of cerarii. Antennae 8-segmented, anal lobe with 2 conical setae, with several auxiliary setae, slight cluster of triocular spores and with slight selerotisation of surrounding area. Dorsum evenly beset with trilocular pores. Tubular ducts lacking Dorsal body setae rather numerous of various lengths. Anal ring of normal form and size, each of its 6 setae about twice as long as greatest diameter of ring. Triocular pores evenly distributed. Discoidal pores similar to those on dorsum, generally scattered over entire venter. Oral-collar tubular ducts abundant in mid region of abdominal sgements 8–5. Body setae relatively long, those on 9th segment shorter than corresponding ones on dorsum. Circulus comparatively large, divided intersegmental line across which it lies. Legs well developed, translucent porescent on femur, claws without denticle.

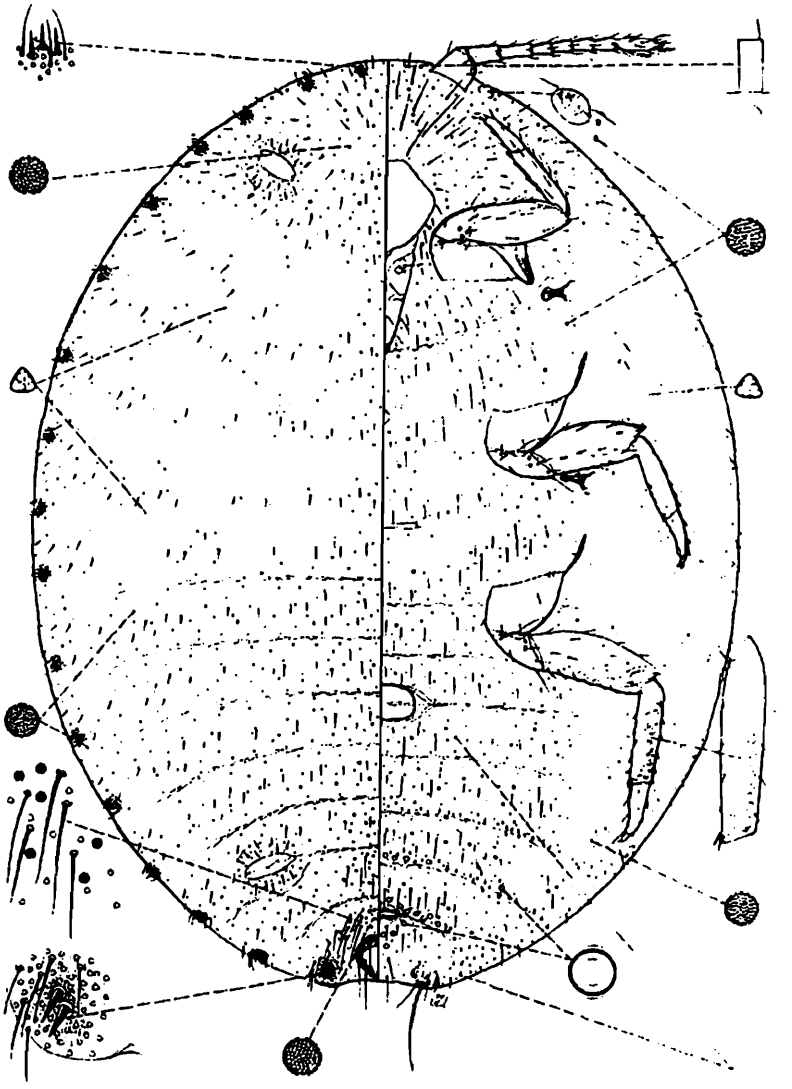


Fig. 326. *Dysmicoccus brevipes* (Cockerell)

Host plants : Pineapple *(Ananas comosus).* Also on *Canna, Arachis, Vitis, Area, Impatiens, Magnifera* etc. Occurs often on roots and rhizomes.

Distribution : India : Andhra Pradesh, Karnataka, Kerala, Orissa, Tripura, West Bengal.

Elsewhere : Bangladesh, Malay Peninsula, Philippines, Sri Lanka, Taiwan and Thailand.

Remarks : This species attacks roots and foliage of pineapple, mango, mulberry, pegs and pods of groundnut, rhizomes of *Canora* sp. *Vitis vinifera, Oreodoxa regia, Areca catechu* and roots of *Impatiens* sp.

Management : 5% aldrin dusting around the base of plants and spraying of parathion 0.05% or malation 0.05% for controlling early instar nymphs will be effective.

Genus 6 ***Ferrisia*** Fullaway

[nec. *Ferrisia* Walker, 1903 (Mollusca)] = *Ferrisiana* Takahashi, 1929; *Ferrisia* (lapsus).

Type species : *Dactylopius virgatus* Cockerell, 1893.

Diagnosis : Body oval; two pairs of ostioles present; antennae normally 8-segments; number normally only 1 and lobe pairs present; dorsum with a few enlonged tubular ducts; venter with multilocular disk pores usually in small numbers about the vulva or completely absent. Circulus present or absent; if present, normally quite large, divided by segmental line. Legs well formed; claws without denticles.

6. ***Ferrisia virgata*** (Cockerell)
White-tailed or striped Mealy-bug

(Figs. 327, 328, 329)

1893. *Dactylopius virgatus* Cockerell, *Entom.*, **26** : 178.

1987. *Ferrisia virgata* (Cockerell) : Varshney and Moharana, Insecta : Hemiptera : Coccoidea. *In* : *Fauna of Orissa, State Fauna Series*, **1** : 166. Zoological Survey of India.

2000. *Ferrisia virgata* (Cockerell) : Varshney, *Fauna of Tripura, State Fauna Series*, **7**(Part 2) : 385. Zoological Survey of India.

Diagnosis : Female elongate oval, 1.95–4.75 mm long with 1.1–2.1 mm width. Antennae 8-segmented, slender. Dorsum with reduced cerarii. Anal lobe cerarius a little sclerotised, with 2 quite large conical setae 2-3 slender auxiliary setae. Dorsum of trilocular pores quite numerous. Scattered minute circular pores present. Presence of large dorsal tubular ducts. Dorsal body setae relatively few and slender. Anal ring relatively large, relatively large, situated so close to posterior apex of abdomen that ring frequently seems to extend somewhat to ventral side. Venter with variable number of multilocular disk pores about vulva. Trilocular pores quite numerous, bare areas evident in thoracic region. Minute circular pores scattered. Presence of a very few small slender tubular ducts of the oral colar. Circulus moderately large, capable of folding along intersegmental line. Legs well developed; coxa with translucent pores at base; tibia with similar pores on distal half segment; claw without denticles.

The adults female is a distinctive mealy bug with a pair of conspicuous longtudinal submedian dark stipes and long glossy waxy threads and a long tail.

Host plants : Highly polyphagous. usually feeds on *Annona squamosa, Croton* sp. *Citrus* sp. *Casuarina equisetifolia, Citrus* sp., *Ficus* sp. *Gossypium* sp. *Ixora coccinea, Lantana camara, Mangifera indica, Mimosa pudica, Psidium guajava, Punica granatum, Tagetes indica,* More than 100 plants have been recorded as alternative host (Varshney, 1992).

Symptom and Damage : *Ferrisia virgata* sucks the sap from leaves, petioles, stems and pods–a severe infestation causes crust formation which ultimately results in

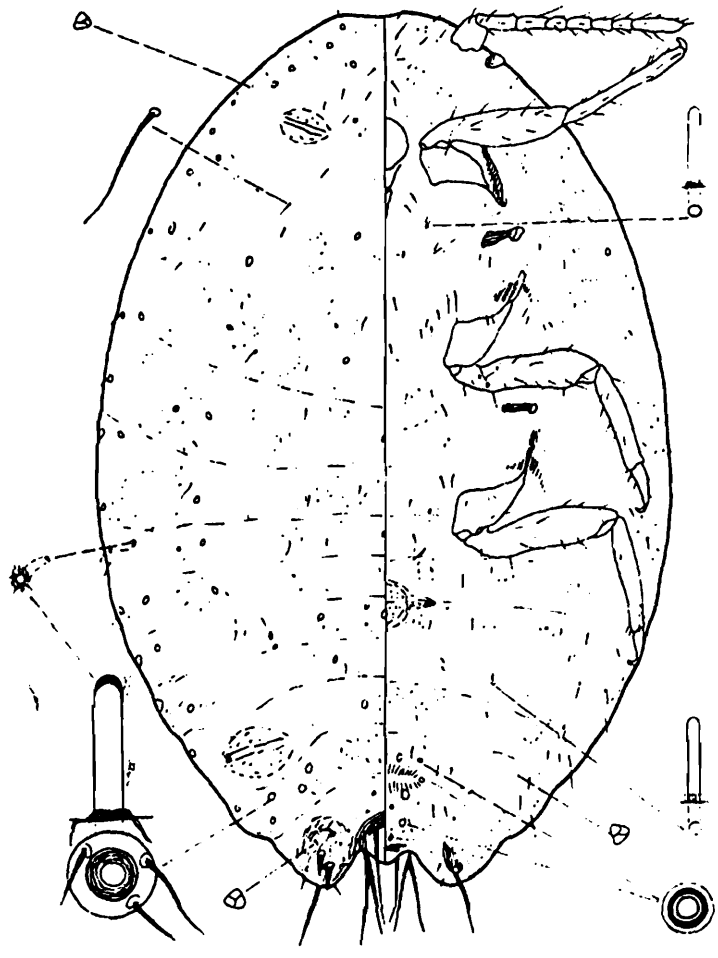


Fig. 327. Ferrisia virgata (Cockerell). (After Ferris)

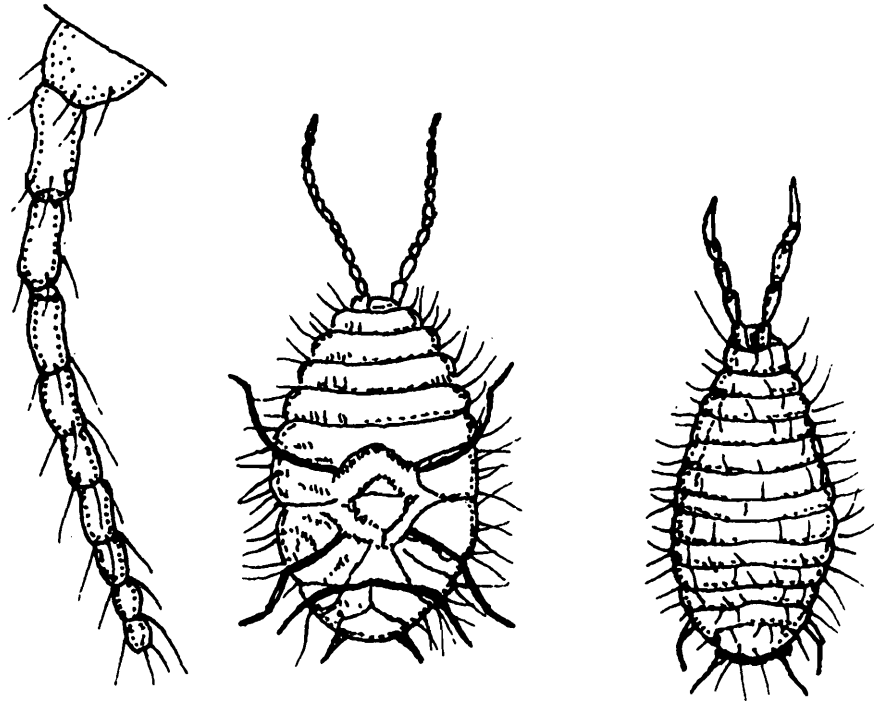


Fig. 328. *Ferrisia virgata* (Cockerell)



Fig. 329. The striped mealybug, *Ferrisia virgata* (Cockerell), infesting purple lantana. *Lantana* sp.

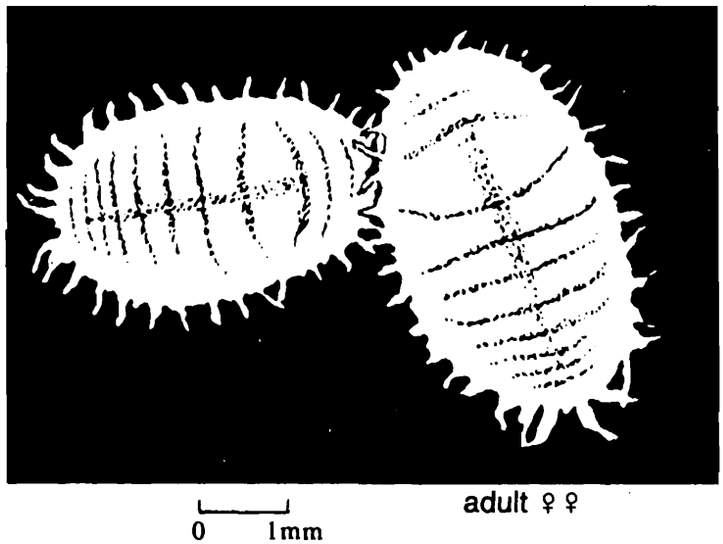


Fig. 330. *Dysmicocous brevipes* (Ckll.)

barky fibre. The pest generally appears in July-August on Jute. It remains clustering upon the terminal shoots, leaves and berries and sucks the sap resulting in yellowing, withering and drying of plants or shedding of berries etc. This pest occurs throughout the year but it prefers dry weather and heavy infestation often occurs following periods of prolonged drought. It has the usual habit of encircling itself by secreting thin glassy threads of wax specially when its population is less. The pest is reported to act as a vector of virus causing the swollen shoot disease of cocoa.

Biology : The female bug is apterous with two long prominent waxy filaments at the posterior end and a number of waxy hairs over the body. Covered with waxy powder. In the posterior end of the body the dorsum has a prominent blackish patch. Its size is 4.3 x 2.1 mm. and is very active and mobile throught their life. Reproduction takes place both sexually and asexually, the latter being more common. Mating takes place only once and lasts for about 12 to 20 minutes. The sessile female lays 100–200 eggs in groups which lie under the body. The oviposition period lasts for 20-29 days. The incubation period is about 3-4 hours. Female and male nymphs moult 3-4 times respectively and the development period respectively varied from 26-47 and 31-57 days. The nymphs feed by sucking cellsap. They become full-grown in six weeks and the life cycle is completed in about 40 days. The pest species multiplies in large numbers and becomes abundant during drought conditions. The longevity of female is 36-53 days and that of male only 1–3 days.

Natural enemy-complex : Parasites and Predator complex consisting of about 54 insect species are so far known from various parts of the world. 35 parasitoids comprise 30 encyrtids and 19 predators, 2 chrysopids, 10 coccinellids, a lygaeid, 3 lycanids, a noctuid and a syrphid are components of Natural enemies complex.

Distribution : India : Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Western Ghats, Goa, Maharashtra in Southern part of India, Northeast India (including West Bengal, Bihar, Orissa), Uttar Pradesh, Madhya Pradesh.

Elsewhere : Bangladesh, Sri Lanka, Maldive Is. Pakistan, Myanmar, Malayasia, the Philippines, Java, New Guinea.

Remarks : It is widely distributed species in tropical and subtropical countries, causing serious damage to a large number of host plants like Coffee, Cocoa, Citrus, Cotton, Jute, Groundnut, Beans, Casava, Sugarcane, Sweet Potato, Cashew, Guava, Tomato etc.

Management : It is recommended to spray 500ml of quinalphos 25 EC or fenitrothion 50 EC in 250 litres of water per ha.

Genus 7 ***Maconellicoccus*** Ezzat

Diagnosis : Reddish brown to orange-pink; number of lateral filaments absent, rarely 1 or 2; stripes absent; presence of clusters of multilocular pores on lateral areas of abdomen retricted to tail forming pore cluster and anterior 1 or 2 abdominal

segments. Presence of numerous fleshy setae on legs and antennae being 10-segmented. Anal scleratised lobe bar usually present; number of cerarii 1 or 2 pairs.

7. ***Maconellicoccus hirsutus*** (Green)
Pink Mealy-Bug
(Fig. 331)

1908. *Phenococcus hirsutus* Green, *Mem. Dept. Agric. India,* **2**(2) : 25

1987. *Maconellicoccus hirsutus* (Green) : Varshney and Moharana, Insecta : Homoptera : Coccoidea, In : *Fauna of Orissa, State Fauna Series*, I : 167. Zoological Survey of India.

1987. *Maconellicoccus hirsutus* (Green) : *Indian J. Syst. Ent.,* **4**(1) : 25.

2000. *Maconellicoccus hirsutus* (Green) : *In* : Varshney, *Fauna of Tripura, State Fauna Series,* **7**(Part 2) : 383. Zoological Survey of India.

Diagnosis : Female oval in shape, about 2.7 mm. Eyes well developed. Antennae 9-jointed, about 0.50 mm long. Rostrum dimerous. spiracles well developed. Circulus small. Legs normal; claw simple, digitules longer than claw and clubbed at apices. Dorsum with numerous slender setae of variable lengths; trilocular pores (Fig. 331I). sparsely distributed; tubular ducts of two types : oral rim type (Fig. 331C) numerous; ostioles well developed with slightly sclerotised inner edges of anterior and posterior lips, each with a few minute setae and trilocular pores. Body with 5 pairs of cerarii confined to posterior abdominal segments; anal lobe cerarii each with 2 conical spines. Anal ring with 6 setae being 1½ lines longer than the greatest diameter of ring. Venter with numerous slender setae of variable lengths; anal lobes with or without sclerotised bar extending from the base of anal lobe seta; trilocular pores (fig. 331I) as those on dorsum; multilocular pores (Fig. 331F) segmentally arranged posterior to circulus.

Host Plants : "On leaves, young stems and tips, roots, pods and pegs of *Ficus indicus, F. religiosa, Tectona grandis* (teak), *Morus* sp., *Psidium guajava, Acanthus ilicifolius, Hibiscus esculentus, H. cannabinus, H. sabdariffa, H. rosa-sinensis, Corchorus* spp. (jute), *Boehmeria nivea, Erythrina variegata, Annona squamosa,* groundnut, *Gossypium* sp., *Punica granatun, Abutilon indicum, Vitis vinifera, Spondias dulcis, Clitoria ternetea, Jasminum sambac, Mikania cordata, Thespesia lampas, Ziziphus mauritiana* and *Cordia obliqua.*" (Source : Varshney 1992).

Symptom and Damage : As a result of feeding of the nymphs on apical portion of plant, its growth becomes stunted. The petiole becomes shortened, the lamina crumples and the internodal length is reduced, resulting in fibre deterioration and yield reduction.

Biology : The females lay pink cylindrical eggs. The eggs are laid on plants inside the ovisacs and measure 0.3/0.2 mm. The incubation period varies from 7 to 14 days in different seasons. On completion of the incubation period, the emergence of the nymphs starts from the ovisacs in batches, corresponding with the sequence of egg-laying. The tiny nymphs crawl out on the host and select a suitable spot to settle

down. They are light pinkish and secrete both a white mealy powder and honey-dew. They develop distinctive sex characters after undergoing a few early moultings. The full-grown larva secretes fine white mealy fibres with which it forms a cocoon and then pupates in it. The females remain wingless, and on maturity, they develop ovisacs in which eggs are laid. The bugs sack sap from the stem and leaves. The female is a sack-like, light pink and measures about 3 mm in length. The males are slender and with a pair of wings.

Natural enemy-complex : *Scymnus pallidicollis* (Coccinellidae) is the most efficient predator and feeds vigorously on the eggs, nymphs and adult females.

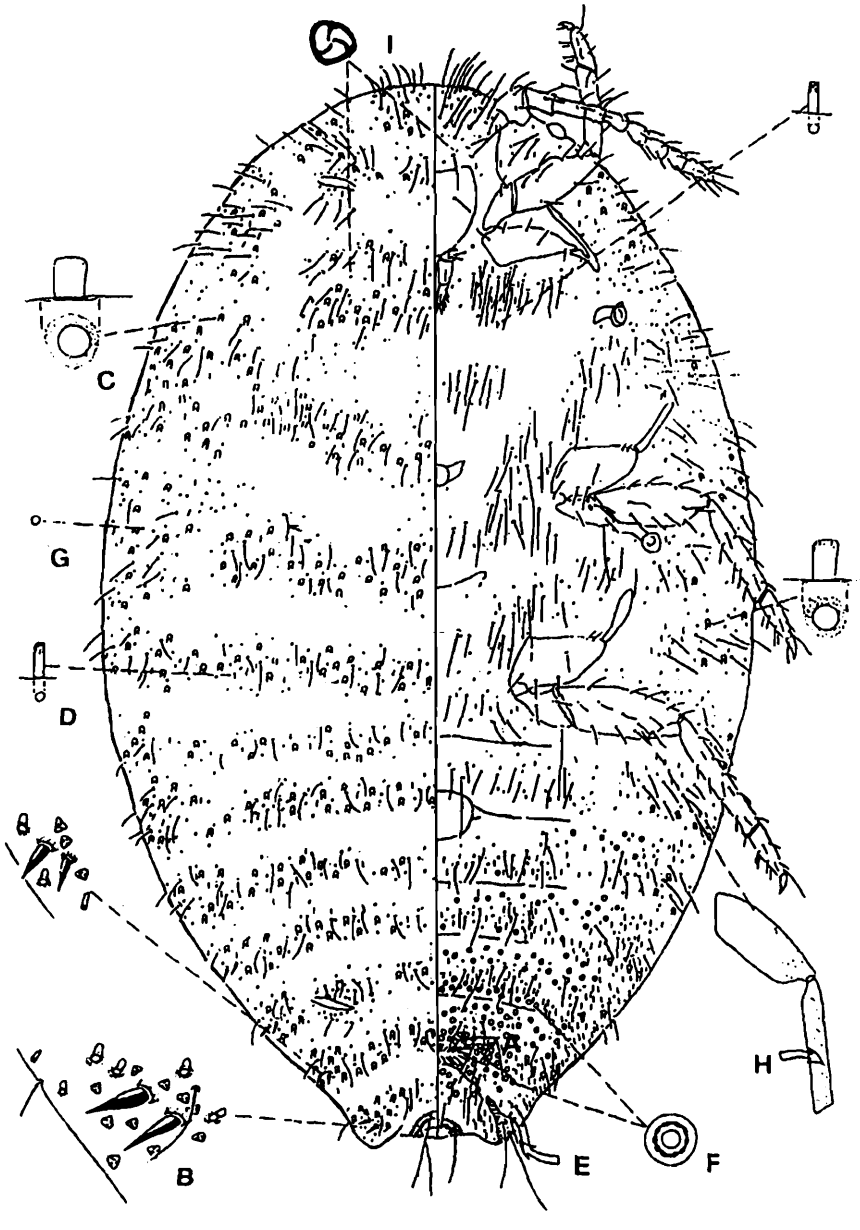


Fig. 331. General morphology of adult female of *M. hirsutus* (Green), pink hibiscus mealybug. A–Vulva; B–Cerarius; C–Oral rim; D–Oral collar; E–Anal bar; F–Multilocular pore; G–Discoidal pore; H–Translucent pore; I–Trilocular pore.

Distribution : India : Andaman Is., Andhra Pradesh, Bihar, Delhi, Karnataka, Kerala, Orissa, Punjab, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal.

Elsewhere : Bangladesh; Pakistan and Sri Lanka.

Remarks : It is a severe pest of mulberry, causing "tukra" disease in it; in Jute, it causes abnormalities in anterior portions; and of ramie causing stunted disease. Besides jute, this sap-sucking mealy-bug attacks the roselle fibre crop (*Hibiscus sabdariffa*), an important fibre allied to jute, and is responsible for an appreciable decrease in the yield of fibre. This pink mealy bug is a common "hard to kill pest" of horticulture crops all over the world. Mulberry being a perennial crop and forms a sole food of silkworm, *Bombyx mori* Linn. which is affected by several insects, among them *M. hirsutus* is severe one. Mulberry plants affected with this pest species show curling of leaves, thickening and flattening of stem at the growing point resulting in stunted growth of plants.

Management : As in *Ferrisia virgata* (Cockerell).

Genus 8 ***Saccharicoccus*** Ferris

1895. Saccharicoccus Ferris, *J. Trinidad* Field Nat club 2 : 195.

Type species : *Dectylopius sacchari* Cockerell, 1895

Diagnosis : Circulus large and medially constricted; margins of sements 6-9 with very long setae; presence of irregular pores near the atachment of the hind coxa; multilocular disc pores around the margins of both surfaces.

8. ***Saccharicoccus sacchari*** (Cockerell)
Sugarcane Mealy Bug
(Fig. 332, 333)

1895. *Dachylopius sacchari* Cockerell, *J. Trin. Nat. Club,* **2** : 195.

1987. *Saccharicoccus sacchari* (Cockerell) : Varshney and Maharana, Insecta : Homoptera : Coccoidea, *In* : *Fauna of Orissa, State Fauna Series*, **1** : 169. Zoological Survey of India.

Diagnosis : Female oval, about 4 mm long, more than 1½ times longer than wide; anal lobes moderately developed. Antennae rostrum small, dimerous, spiracles well developed. Eyes small. Circulus large, medially constricted; legs rather small; hind coxae with a few translucent pores; claw (Fig. 332) simple and digitules small and clubbed at apices. Anal lobes moderately developed. Dorsum with numerous hair-like setae; trilocular pores densely and uniformly distributed; multilocular pores numerous on anterior and posterior edges of most segments, a few submarginally on thoracic and abdominal regions. Ostioles well developed with inner portions of anterior and posterior lips membranous; cerarii confined to anal lobes each with a pair of small

conical spines, about 6-9 trilocular pores and without auxilliary setae. Anal ring with 6 setae being about 1½ longer than the greatest diameter of ring. Venter with hair-like setae of various lengths; anal lobe seta a little less than 3 x anal ring setae; abdominal segments 6-9 with very long setae marginally; trilocular pores numerous and evenly distributed; Oral-collar tubular ducts small, sparse submarginally on cephalic and thoracic regions; minute irregular pores numerous.

Host : Roots, leaf sheaths and nodes of sugarcane (*Saccharum officinarum)* other *Saccharum* spp. and *Sorghum* sp.

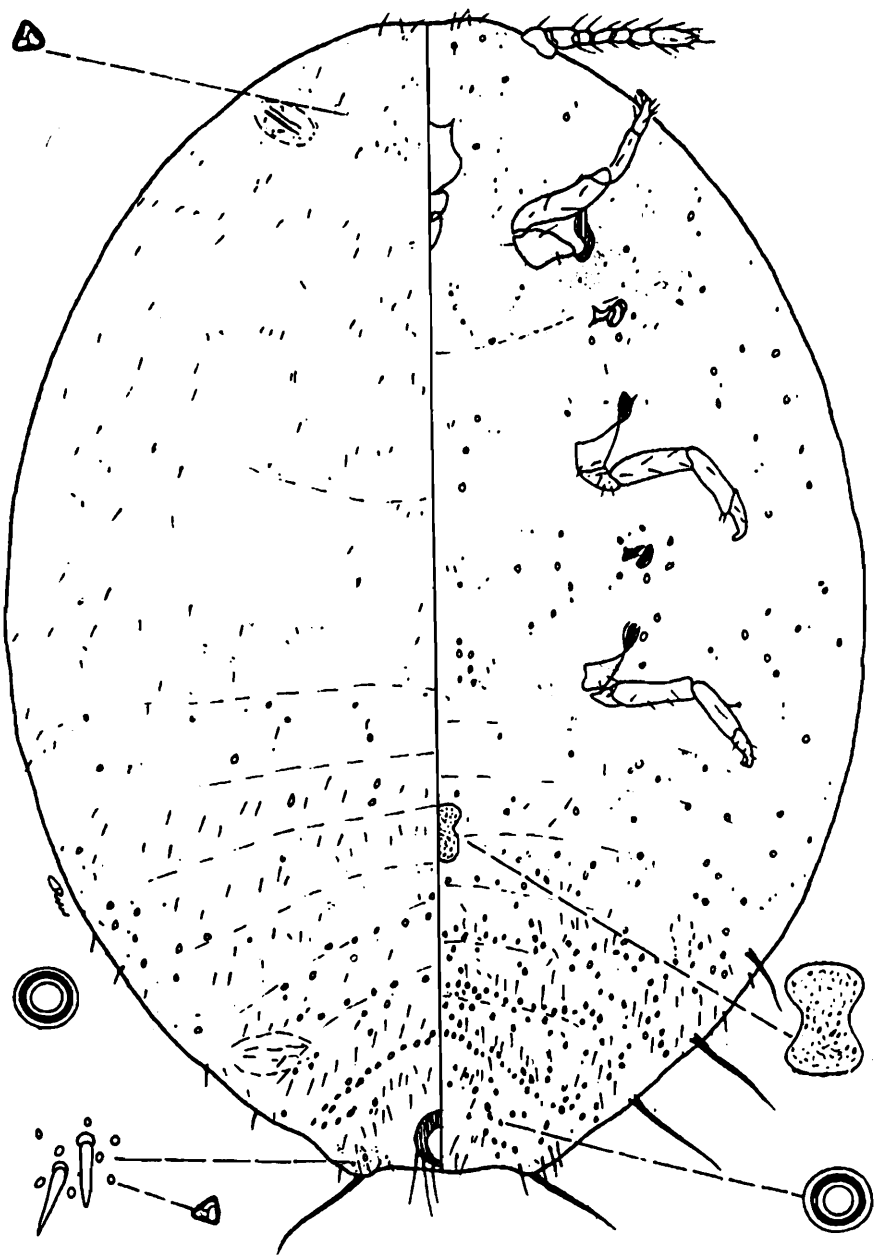


Fig. 332. *Sccharicoccus sacchari* (Cockerell) (After Ferris)

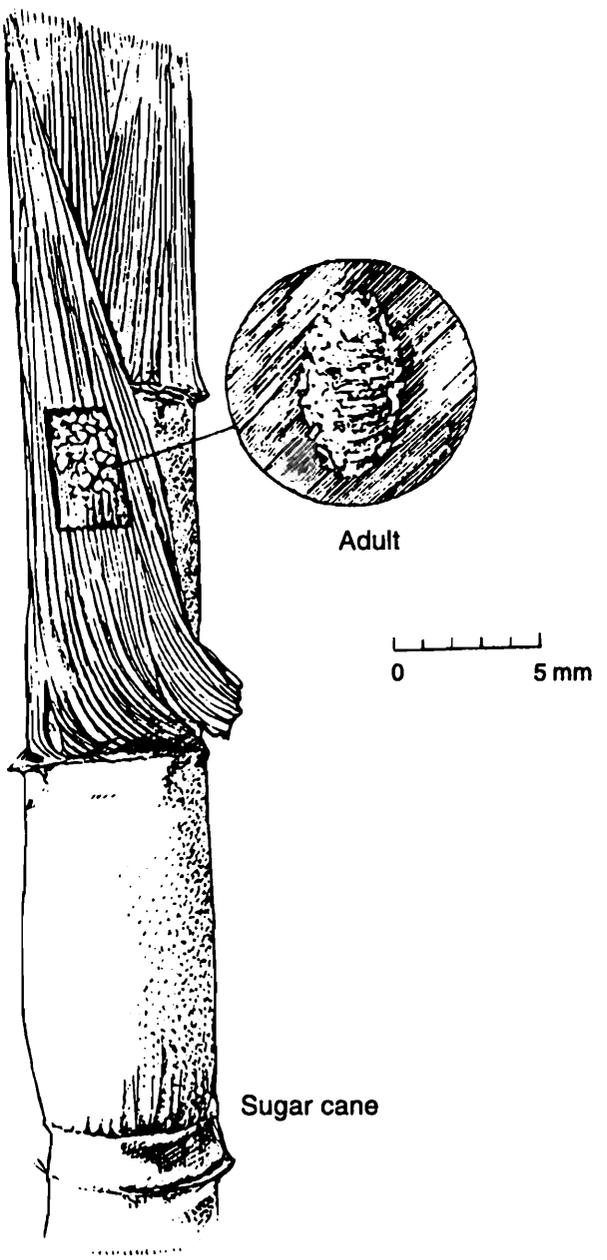


Fig. 333. *Saccharicoccus sacchari,* Pink Sugarcane Mealy Bug infesting sugarcane.

Symptom and Damage : The bugs drain away large quantites of sap from the sugarcanes and befoul them by their mealy secretions and honeydew. A sooty mould develops on these secretions giving a blackish appearance to the canes. It is also suspected that the mottling disease of sugarcane which is serious in certain parts of India, is transmitted by this insect.

Biology : The species breeds practically throughout the year. The females lay a large number of eggs at short intervals. The eggs 0.35/0.16 mm are yellowish, smooth, cylindrical and rounded at both ends. Within a few hours of egg laying, the eggs become soft and elongated, and the crawlers emerge. These are transparent, pink and very active. They move about for some time and spread all over the field or many

even be blown away by the wind to the adjoining fields of sugarcane. After finding a suitable host plant, they force themselves underneath the leaf sheaths near the basal nodes. As the sugarcanes grow taller, the older bugs remain at the lower end and the crawlers reach the higher nodes. The nymphs feed voraciously and pass through 6 stages before they are full-grown in 2-3 weeks. The life of a full-grown winged female varies from 3-5 days. The entire life-cycle is completed in about a month.

Natural enemy-complex : The natural enemy includes the following species (Coccinellidae) : (i) *Pharoscymnus grimeti* Mulsant, (ii) *Scymnus coccivora* Ramkrishna Ayyar, (iii) *S. andrewsi* Sie, (iv) *S. nulilis* Muls.

Distribution : India : Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Temil Nadu, West Bengal.

Remarks : This is a minor pest of sugarcane. It feeds on weeds and some of the grasses. Mealy bugs cluster at the basal nodes of canes and are exposed when a leaf sheath is removed. Nymphs and the wingless female adults cause damage by sucking the cell-sap. They are inert pink insects, having a rotund, sack-like, segmented body covered completely with a white mealy powder. A large female measures about 5 mm in length and 2.5 mm in width. The males, are sluggish having only one pair of wings and are short-lived. Their main function is to fertilize the females.

Management : Application of 1.25 litres of malathion 50 EC or 2 litres of diazinun 20 EC in 1250 litres of water per ha will be useful.

Family III COCCIDAE

Diagnosis : Coccids (sensu str.) are soft scale insects. It's female has a remarkable character of having an anal cleft along median line of hind part of body. Upon it lie a pair of triangular opercular plates. Antennae are developed. Legs developed in some, but degnerated in other genera. Various types of setae are found on the derm and at margin. Spiracular pore bands and spiracular setae present; abdominal spiracles, brachii and dorsal ostioles and circuli absent. Originally all scale insects and mealy bugs were included in the family coccidae, which is now equivalent to the superfamily Coccoidea. Coccidae (s. str.) is now restricted to soft scales and wax scales.

Key to genera of the family COCCIDAE

Adult female cicular; dorsal derm pattern reticulated 'H'-shaped; fimbrication of marginal setae variable; dorsal setae spine-like ..... ***Saissetia***

– Adult female oval or elongate; dorsal derm pattern not as above; marginal setae short, bifid and fimbriate apically; dorsal setae cylindrical, slightly swollen apically ..... ***Coccus***

Genus 9 *Coccus* Linnaeus

= *Calymmata* Costa, 1828; *Calypticus Costa,* 1835; *Lecanium* Burmeister, 1835.

Type-species : *Coccus hesperidium* Linn., 1758

Diagnosis : Antennae usually 7-segmented, spiracles normal; dorsal setae small cylindrical, with slight swelling apically; submarginal tubercles 9-11 in number; anal plates together quadrate, about as long as their combined with; anal fold with two pairs of fringe setae; marginal setae short, bifid and fimbriate apically, stigmatic cleft well developed, each with 3 spines; Quinquelocular pores few, arranged in a row between cleft and spiracles; multilocular pores present around genital opening; tubular ducts present in bands on mid thoracic regions; eyes absent; legs well developed, with tibio-tarsal articulatory sclerosis; claw simple.

9. *Coccus viridis* (Green)

Coffee Green Bug

(Fig. 334)

1886. *Lecanium viride* Green, *Eton* : 1

1903. *Coccus viridis* (Green) : Fernald, *Special Bull. Mass. Agr. College, Hatch Exp. Stn.* **88** : 174

1992. *Coccus viridis* (Green) : Varshney, *Rec. zool. Surv. India, Occ. Paper No.*, **139** : 87.

Diagnosis : Female oval to elongate oval, about 2.50 mm long Eyes absent. Antennae 7-segmented, about 0.20 mm long. Spiracles normal. Legs well developed, with tibio-tersal articulatory sclerosis; claw simple, digitules longer than claw and clubbed apically. Dorsal setae small, cylindrical, slightly swollen apically. Submarginal tubercles 9-11. Anal plates quadrate, about as long as their combined width; anal fold with 2 pairs of finge setae. Marginal setae short, bifild, 7-10 setae between anterior and posterior stigmatic clefts which are well developed and each bearing 3 spines; median spine about twice the length of lateral spines. Quinque locular pores few Multiocular pores present around genital opening and a few present on all abdominal segments. Tubular bands present in bands on midthoracic regions.

Host Plants : *Aegle* sp. *Carrissa* sp. *C. opaca, Psidium guajava, Plumiera acutifolia, Cichona sccirubra, Manihot ceara, M. para, M. utilissima, Gardenia* sp., *Ixora sp., Maesa indica, Antidesma bunius, Hiptage madoblata, Callicarpa lanata, Loranthus* sp., *Microcos paniculata, Magnifera indica.*

Symptom and Damage : The pest occurs on the under surface of leaves, crowding along the midribs and veins. Tender branches and developing fruits are also attacked. As a result of heavy feeding, the leaves and fruits become discoloured and malformed drop off. The plants become very weak and unproductive.

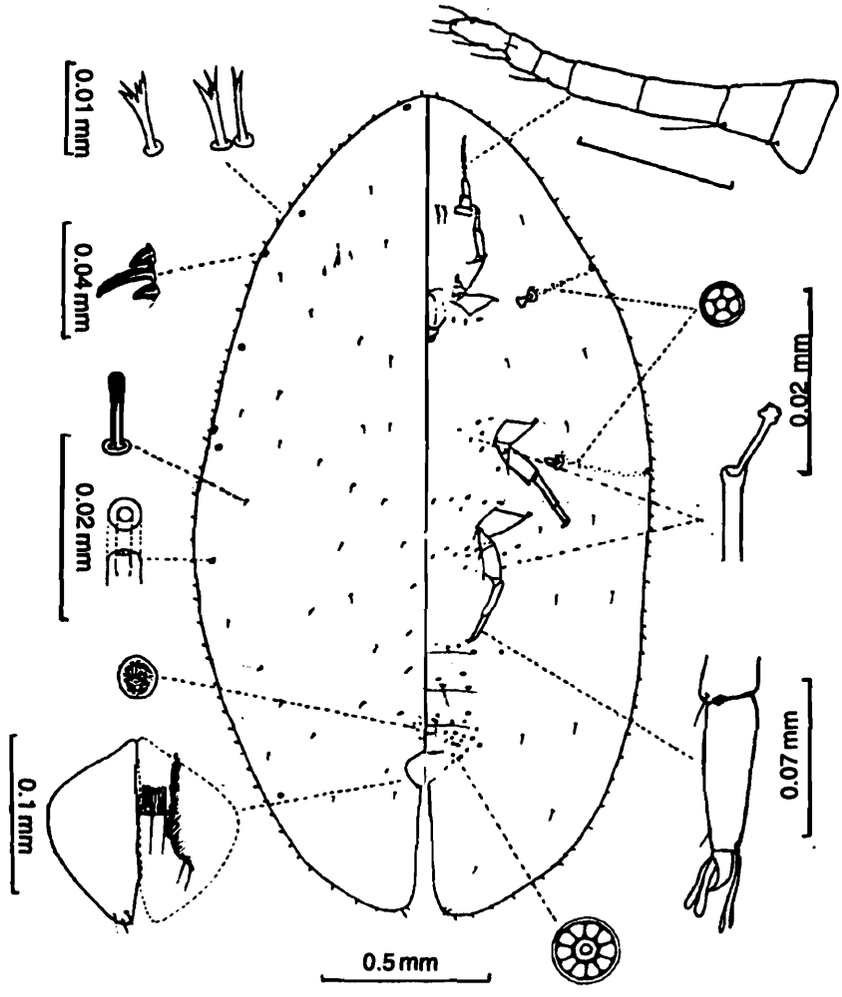


Fig. 334. *Coccus viridis* (Green)

Biology : The female lays 300-500 eggs in the life time of 2-5 months. The hatching of eggs occurs within a few hours but the young ones remain under the scale for a few days and then crawl out. They get fixed at some succulent spot for feeding. There are three nymphal instars and then they become adults. A generation is completed in 1-2 months and there are many generations in a year.

Natural enemy-complex : *Oecophylla smaragdina* (Fabricius), *Cremastogaster* sp. and *Camponotus* sp. (Formicidae). The entomophagus fungi, *Empusa lecanii* Zimmermann and *Cephalosporium lecanni* Zimm. infect the scale and thus play an effective role in the natural control of the pest.

Distribution : India : Assam, Tripura, Karnataka, Andhra Pradesh, Tamil Nadu, Kerala.

Elsewhere : Bangladesh; Burma; Pakistan; Myanmar; Sri Lanka; Thailand; Malaysia.

Remarks : It is a major pest of coffee in the southern states. In addition to coffee, this green coloured scale also feeds on citrus, guava, loquat, mango and other plants. The young ones are flat, ovate, slightly convex, pale-green to yellowish-green in colour. When mature, these are 2-3 mm long.

The leaf or green shoot is sucked by the pest species.

Management : The pest on effectively be cotrolled by spraying 750 ml of malathion 50 EC or 500 ml of dimethoate 30 EC or 375 ml of methyl parathion 50 EC or 200 ml of phosphamidon 85 WSC in 500 litres of water per ha (Atwal and Dhaliwal 1997).

Genus 10. ***Saissetia*** Deplanche, 1859
= *Bernardia* Ashmead, 1891; *Parasaissetia* Takahashi, 1955

Type species : *Lecanium coffeae* Walker 1852, (= *Saissetia coffeae* Deplanche, 1859)

Diagnosis : Dorsal derm pattern reticulated; "H"-shaped ridges absent; dorsal setae cylindrical; tibio-tarsal articulatory slerosis absent; amount of fimbrication of marginal setae variable; females usually elongate oval and flat to round and convex depending on type of host; dorsum smooth, often with a single series of white wax plates around the margin along with 5 longitudinal dorsal rows of smaller wax plates; presence of polygonal reticulations or cell-like oval clear spots on the dorsum.

10. ***Saissetia coffeae*** (Walker)
Helmet Scale

1852. *Lecanium coffeae* Walker, List of specimens of Homopterous insects in the collection of the British Museum, pt. 4, London; 1079 (1065–1091)

1859. *Saissetia coffeae* (Waker) : Deplanche, *Bull Soc. Linn. de Nor mandie* **4** : 203–207

1992. *Saissetia coffeae* (Walker) : Varshney, *Rec zool. Surv. India, Occ. Paper No.* **139** : 97.

Diagnosis : Adult female circular, moderate to strongly convex, about 5 mm, test dark brown to blackish, female (young) and nymphs yellowish in colour. Adult convex hemispherical in shape. Body with large discal setae on each operculum, spine-like dorsal setae with tubular bands on ventral submargin.

Host plants : Coffee plant and many others *viz. Citrus* spp., tea, fern, guava, brinjal, *Abelmoschus esculentus, Hibiscuss rosa-sinensis,,* loquat, crotons, *Thunbergia* sp., *Trichosanthes anguina, Manikara achras, Jacaranda mimosaefolia, Psidium* sp., *Duranta* sp., *Gardenia florida, Mikania scandens, Ixora coccinea, Tabernaemontana coronaria, Terminalia catappa, Cajanus cajan, Cephalandra indica, Ixora parviflora,* palms and orchids in greenhouses etc. (Varshney, 1992)

Symptom and Damage : The scales cluster on the shoots, leaves and green berries. Because of their feeding the chlorotic leaves and fruits begin to drop.

Biology : Upto about 600 eggs are laid by female beneath her helmet. The newly hatched crawlers are flat and oval in shape. They get fixed at suitable spots and may feed on leaves, berries, or the green shoots. The nymphs undergo three moultings and then they become adults. The immature females have an H-shaped yellow mark on

their body. The dark brown adult females are with strongly convex helmet-shaped carapace and are immobile. One generation is completed by the species in about six months' time.

Natural enemy-complex : Parasites : *Aneristus ceroplastae* Howard, *Coccophagus cowperi* Girault (Hymenoptera : Aphelinidae)

Remarks : The cosmopolitan pest species is widely distributed in the tropics and in some subtropical areas. It attacks both *arabica* and *robusta* coffee. It has a wide range of alternative hosts including tea, citrus, guava, mango and many other plants, both wild and cultivated. The scale is green in colour when young but becomes dark brown later on. Mature scales are about 2 mm long. It is a severe pest on *Citrus aurantium* and *C. rotundata* in Darjiling region (Dutt, 1984; Basu, *et al.* 1969; Nath 1972).

Management : Same as in *Coccus viridis* (Coffee Green Bug).

11. ***Saissetia nigra*** (Nietner)
Black Scale
(Fig. 335)

1861. *Lecanium nigrum* Nietner, *Ceylon Times,* 1861 : 9.

1902. *Saissetia nigrella* King, *Psyche,* **9** : 296.

1985. *Saissetia nigra* : Varshney, *Oriental Ins.* **19** : 27

1988. *Parasaissetia nigra* : Gill, Scale insects of California, Pt. I : 57.

2000. *Saissetia nigra* : *In* : Varshney, *Fauna of Tripura, State Fauna Series,* **7**(Part 2) : 389. Zoological Survey of India.

Diagnosis : Female usually elongate oval and flat to rounded and convex depending on type of host. Rounded individuals usually found on leaves and elongate ones on twigs. Colour of adults varies with type of host plant and location of host. Young adult females translucent yellow, occasionally with brown or red mottling, shiny and dark brown to purple black with age. Dorsum of older, darkended females smooth, polygonally reticulated, and often with a single series of staggered, squarish white wave plates around the margin along with 5 longitudinal dorsal rows of smaller wave plates.

Host Plants : *Annona, Abelmoschus, Begonia, Canna, Cucumis, Cynodon, Hibiscus, Lawsonia, Microcos paniculata, Morus, Thespesia, Ficus, Musa, Psidium.*

Symptom and Damage : It infests tender leaves, shoots and twigs of clove tree. When the attack is mild, rapid growth of sooty mould fungus is observed on leaves and stems which hinders the photosynthetic activity of the plant resulting in retarded growth. However, infestation in severe form causing dropping of the affected leaves.

Biology : The adult females are elliptical, flattened and shiny black. The white to red orange eggs are deposited under the shell-like dorsal wall of the female scale. The

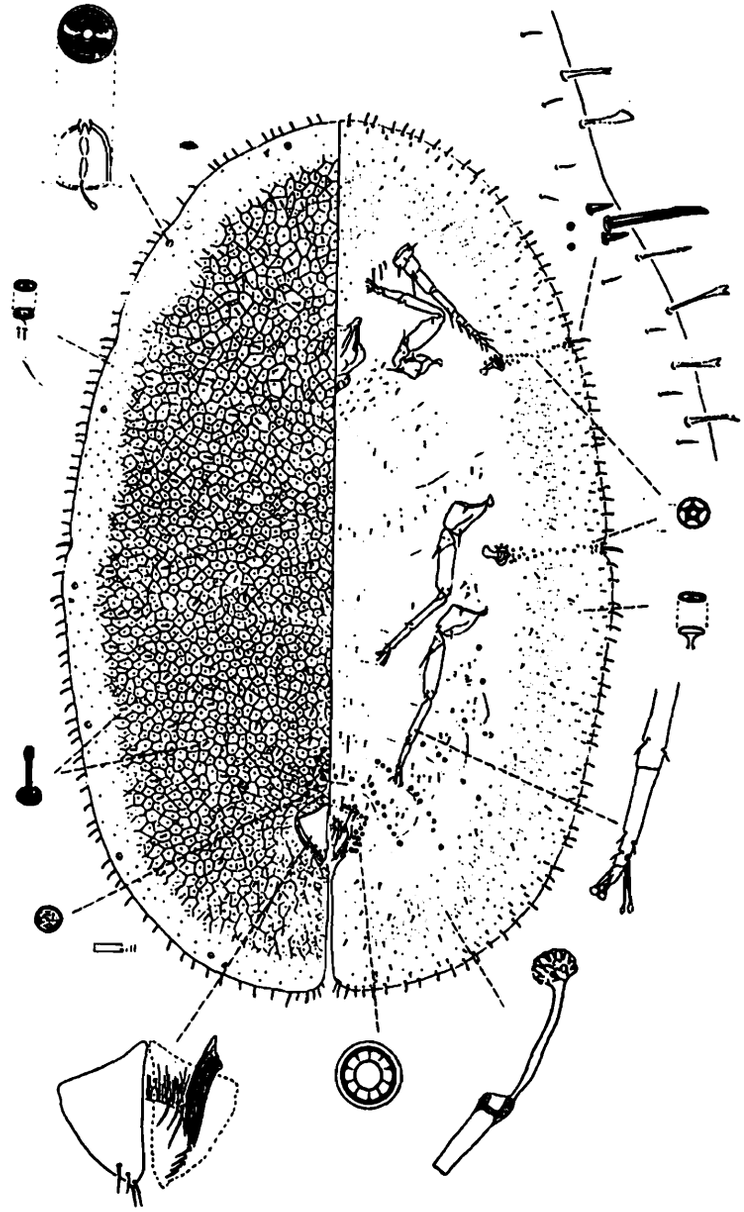


Fig. 335. *Saissetia nigra (Nietner)*

shrivelled remains of the undersurface of the female body, can be found inside, near the beak of the dorsal wall. By the way it follows up to protect its eggs. Hatching may occur in 16 days or be extended over a period of 6 weeks in cold winter. The young scales called crawlers migrate to the twigs and branches after the second moult. This is an important period for dissemination.

Alternative Hosts : It affects number of crop plants like cotton, castor, grapes, jute, bhendi, citrus, coffee, guava, litchi, rubber, tea and ornamental plants like ivy, holyhock and japanese aralia.

Natural enemy-complex : Parasites : *Marietta bopardina* Motschulsky, *Scuttellista cynea* Motschulsky, *Anicetus ceylonensis* Howard, *Encystus kctinski, Analysis saissetiae* (Ashmead), *Coccophagus longifasciatus* Howard, *Euccmys lecaniorum* Mayet and *Aneristus ceroplastae* Howard. Predator : *Eublemma scitula.*

Distribution : India : Assam, Bihar, Jammu & Kashmir, Karnakata, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal.

Elsewhere : Many countries including Burma, Sri Lanka and Pakistan.

Management : Same as in case of coffee green bug *(Coccus viridis).*

Family IV. DIASPIDIDAE

Diagnosis : The general morphology of a *diaspid female,* the largest family, is illustrated in Fig. 336 (after Ferris). The body is divided into prosoma and postsoma. While the former has head and pro-and mesothorax in it, the latter has metathorax and the abdomen. In prosoma, the minute antennae are in front. On ventral side, oral lobes and proboscis lie in the center, surrounded on each side by a reduced foreleg and a thoracic (anterior) spiracle. On the metathorax are middle and hind leg, another (posterior) spiracle and pores. Abdomen is 8–segmented. Its pygidium has anus and vulvar openings, pores and processes, supported by various types of setae, ducts and pore-cluster. The margin of postsoma has various lobes in living condition, a diaspid

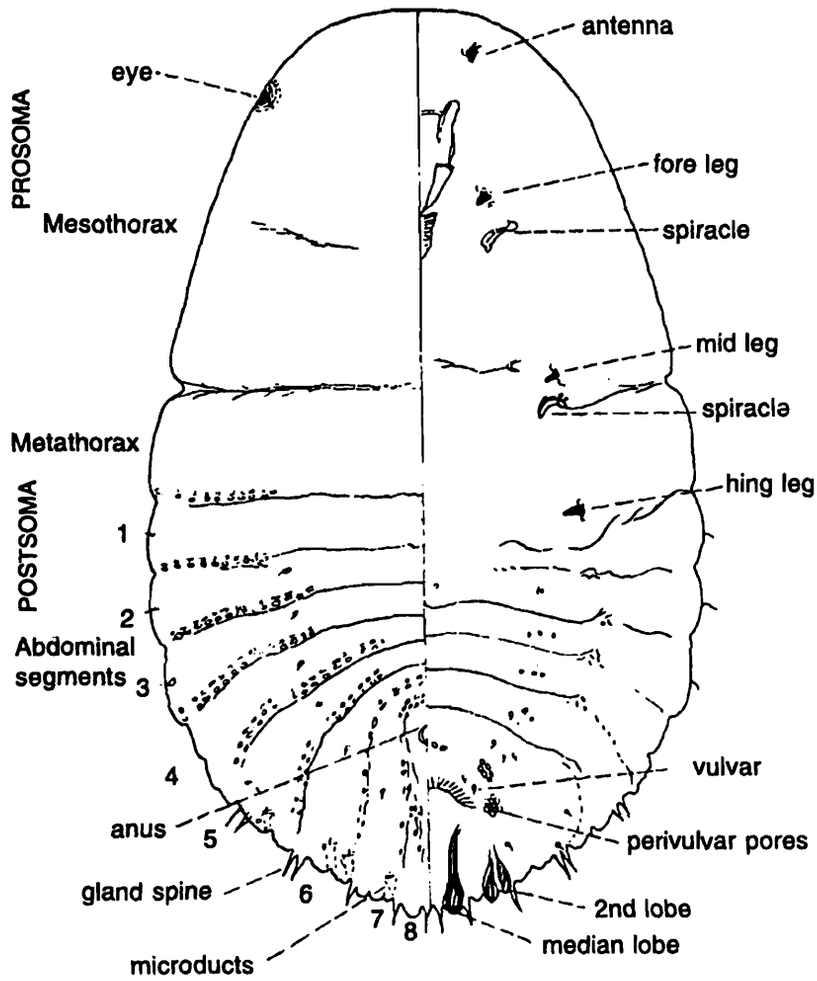


Fig. 336. A female of Diaspid coccid, showing general morphology

scale (hard waxy test) is circular, oval or oblong, often thin and pale, generally dull-coloured, rough or smooth, on the top of which one or two nymphal exuviae are embedded. The waxy ovisac in some cases in much extended. Abdominal spiracles, anal operculum and setigerous anal ring absent. These are small soft-bodied, freely covered under a hard scale (test), scales of variable shape and often coloured; adult body flattened, disc-like.

This is the largest family of Coccoidea and constitutes almost half of the total known coccids (Varshney, 1985). This group includes some serious pests of crops and fruit plants globally.

Key to genera of DIASPIDIDAE

1(2) Pygidium with paraphyses arising from the bases of lobes or at the site of obsolete pores 3

2(1) Pygidium without such scleroses, perivulvar pores present; 4th pygidial lobe not in the slightest degree developed ..... ***Aspidiotus***

3(4) Median and 2nd lobes well developed, sclerotised apically rounded, their axes somewhat diagonal so that the lobes seem to converge slightly ..... ***Quadraspidiotus***

4(3) Median and 2nd lobes not as above, if more than the median are present the axes are parallel; prosoma much swollen and strongly sclerotised, varying in form from slightly reniform to very markedly so, the lateral prosomatic lobes more or less enclosing the pygidium ..... ***Aonidiella***

Subfamily ASPIDIOTINAE

Genus 11 *Aonidiella* Berlese & Leonardi

1895. *Aonidiella* Berlese & Leonardi, in Berlese, *Riv. di Patol. Veg.* **4** : 1896) : 77, 83.

Type species : *Aspidiotus aurantii* Maskell, 1879.

Diagnosis : Pygidium with paraphyses; margin of pygidium with 3 pairs of lobes; a group of small scleroses present on ventral side of pygidium; adult with cephalothorax deeply sclerotised; prosoma much swollwn and strongly sclerotised; lateral prosomatic lobes moe or less enclosing the pygidium.

12. *Aonidiella aurantii* (Maskell)
Citrus Red Scale
(Fig. 337)

1879. *Aspidiotus aurantii* Maskell, *Trans Proc. New Zealand Inst.*, **11** : 199.

1930. *Aspidiotus aurantii* : Ayyar, *Bull. Deptt. Agr. Res. Inst. Pusa*, **191**(1929) : 25.

1969. *Aonidiella aurantii* : Ali, *Indian Mus. Bull.*, 4(2) : 33.

2000. *Aonidiella aurantii* : *In* : Varshney, *Fauna of Tripura, State Fauna Series*, 7(Part 2) : 390. Zoological Survey of India.

2002. *Aonidiella aurantii* : Varshney, *Rec. zool. Surv. India Occ. Paper No.*, **191** : 20.

Diagnosis : About 0.8 mm long, Cephalothoracic region of adult very heavily sclerotised and strongly reniform, the posteriorly produced angles crowding against the pygidium. The central region less heavily sclerotised. Perivulver pores absent. Margin of the pygidium with 3 pairs of lobes. The three plates which are present between 3rd and 4th lobes normally bear two long slender apical processes, dorsal ducts absent on the periphygidial abdominal segments. Ventral side of pygidium, anterior to the vulva, with a group of small scleroses.

Host Plants : The pest species is recorded on many plants including *Agave americana, Annona squamosa, Aegle marmelos Chrysanthemum indicum, Cycas* sp. *Cannabis sativa, C. crispus, Dodonaea viscosa, Eugenia cumini, Eriobotrya japonica, Furcraea foetida, Psidium guajava, Jasminum* sp., *Morus alba, Morinda* sp., *Murraya exotica, Nerium indicum, Olea* sp., *Pyrus* sp., *Prunus* sp., *Rosa* spp., *Tamarix articulata, Tamarindus indica, Ziziphus* sp., *Agave, Annona, Aegle, Cannalus, Chrysanthemum, Citrus, Eugenia, Psidium, Jasminum, Morus, Musa, Murraya, Nerium, Pyrus.* etc. (Varshney 1992).

Symptom and Damage : The scale insects first feed on plant juice and devitalize the plant; later, they inject a toxic substance into the plant sap. Yellow spots appear at the point of feeding which may be on the leaves, twigs or fruits. All the leaves may turn pale in case of severe infestation. It is not practicable to detach all the scales from infested fruits before marketing and, therefore, their value is lowered.

Biology : The female scales, instead of laying eggs, give birth to young nymphs. The first stage nymphs or crawlers have well developed legs and antennae and move about for an hour or so before settling down and cover themselves with a white waxy secretion. The female scales moult twice at 10-20 days intervals, lose their legs and antennae and incorporate their cast skins into waxy coverings. They reach sexual maturity in 10-15 weeks, do not acquire wings and may live for several months. The male scales, on the other hand, are elongated and develop into winged adults in 1-2 months. They fly around and fertilize the sedentary females. The pest species passes through a number of broods in a year.

Natural enemy-complex : Parasite : *Aphelinus* sp. (Aphelinidae); Predators : *Chilocorus nigrita* (Fabricius), *Scymnus quadrillum.*

Distribtuion : Widely distributed in *Citrus* growing areas of India.

Elsewhere : Nepal, Pakistan, Burma and Sri Lanka.

Remarks : The scales infest all the above ground parts of the tree. The leaves, branches and fruits may be covered with them. These scales have a distinct central

exuviae. Citrus plants and fruits in various countries of the world are known to be attacked by three species of armoured scales, *viz.*, *Aonidiella aurantii, A. citrina* (Coquillett) and *Chrysomphalus dictyospemi* (Morgan). Of these, the red scale (*A. aurantii)* is the most destructive and it also feeds on *Acacia eucalyptus,* fig, grape, rose, willow, *shisham (Dalbergia sissoo)* and many other plants. It is one of the most serious pests of *Citrus* from all parts of the Globe. The pest occurs on either leaves, bark or fruit. Scale of the female is circular, quite flat, exuviae central. Scale of the male is elongate oval, colour paler than in female, exuvia slightly toward one end. It is very close to *A. citrina* (Coquillet).

Management : (a) Conservation of natural enemies abundant in citrus growing areas may be effective. (b) Spraying 1.70 litres of dimethoate 30 EC or 1.25 litres of

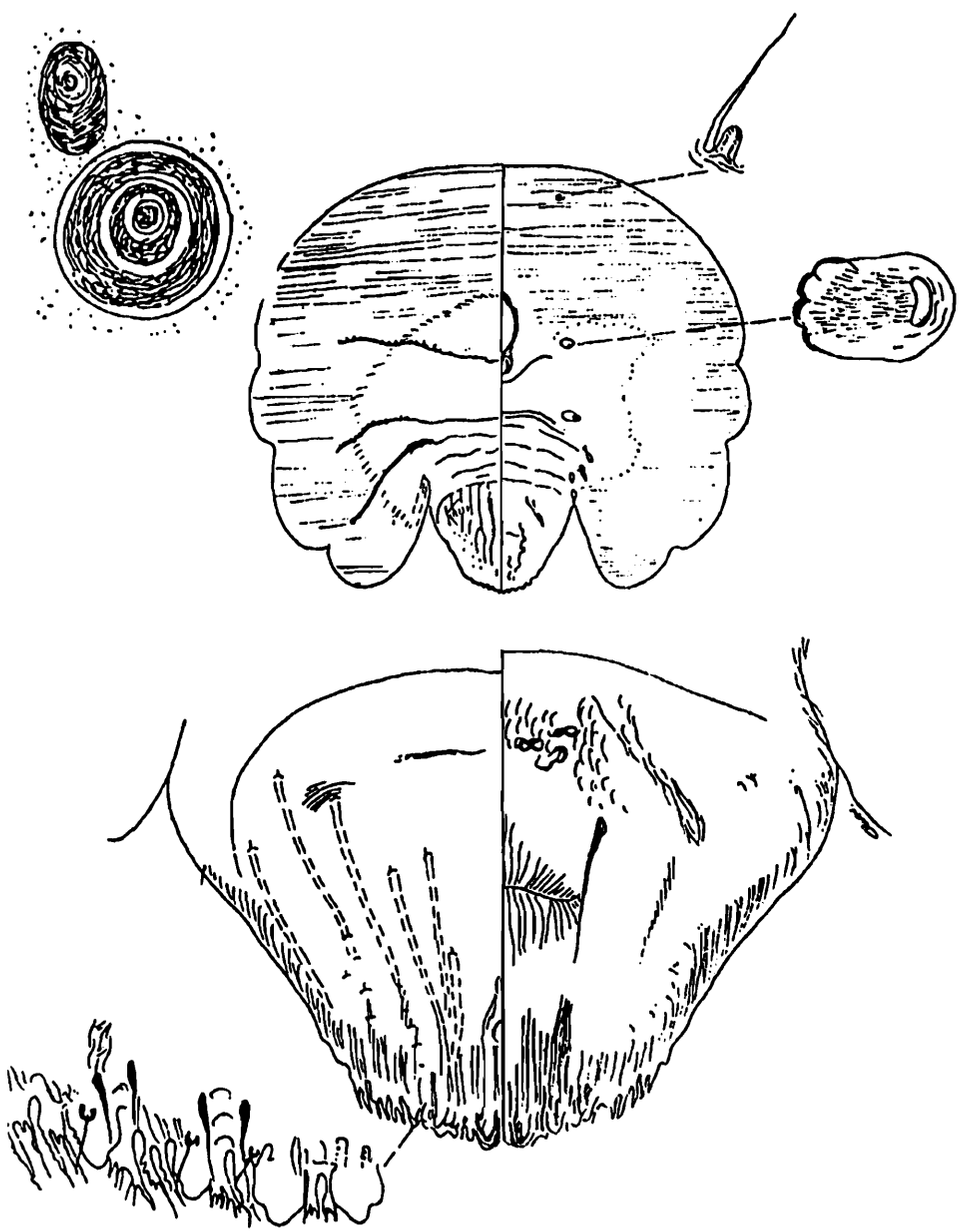


Fig. 337. *Aonidiella aurantii* (Maskell) (After Ferris).

malathion 50 EC or 500 ml of fenitrothion 50 EC in 1250 litres of water per ha may proove useful. (Atwal and Dhaliwal 1997).

Genus 12 ***Aspidiotus*** Bouche

1833. *Aspidiotus* Bouche, *Naturg. Sch. Nutz. Gard Ins.* : 52.

Type species : *Aspidiotus nerii* Bouche

Diagnosis : Pygidium without paraphyses, perivulvar pores present, median lobes small, sclerotised; dorsal ducts long and large; anal opening rather large; 4th pygidial lobe not in the slightest degree developed; inter-semented scleroses wanting.

13. ***Aspidiotus destructor*** Signoret
Coconut Scale
(Fig. 338)

1869. *Aspidiotus destructor* Signoret, *Ann. Soc. Ent. France,* (4) **9** : 120.

1896. *Aspidiotus lataniae* Signoret; Green, *Coccidae of Ceylon,* **1** : 49.

1899. *Aspidiotus transparens* Green, *J. Bombay nat. Hist. Soc.* **13** : 69

1930. *Aspidiotus destructor* and *A. lataniae* : Ayyar, *Bull. Dept. Agr. Res. Inst. Pusa,* **197**(1929) : 21-22.

1970. *Aspidiotus destructor* : Ali, *Indian Mus. Bull.* **5**(1) : 37.

1985. *Aspidiotus destructor* : Varshney, *Oriental Ins.,* **19** : 32.

2000. *Aspidiotus destructor* : Varshney, *In* : *Fauna of Tripura, State Fauna Series,* **7** : 391. Zoological Survey of India.

2002. *Aspidiotus destructor* : Varshney, *Rec. zool. Surv. India Occ. Paper No.,* **191** : 23.

Diagnosis : Derm membranous, Perivulver pores present in four groups of three to ten pores. Median lobes small, straight and parallel, strongly sclerotised, 2nd lobe at times actually longer and wider than the median lobes, usually less sclerotised than the median lobes; third lobe similar to and but slightly smaller than the second. Plates strongly fimbricate. Dorsal ducts relatively long and large. Inter-segmental scleroses entirely lacking. Anal opening relatively very large. The sclerotisation of the Pygidium is unusually weak and a somewhat more heavily sclerotised area at the base of the median lobes is quite noticeable. The arms of the V-shaped ventral sclerosis at the base of the anal lobes noticeably slender.

Host Plants : Many including *Areca catechu, Artocarpus heterophyllum, Adhatoda vasica, Banhinia variegata, Camellia sinensis, Sassia* sp., *Calotropis* sp., *Citrus* spp., *Cocos nucifera, Cordia oliqua, Capsicum minimum, Carica papaya, Crotalaria leschenaultii, Eugenia* sp., *E. cumini, Ficus carica, E. elastica, Gelonium lanceolatum, Hibiscus esculentus, Ipomoea batatas, Lycopersicum esculentum, Loranthus* sp., *Lawsonia inermis, Lagerstroemia indica, Mangifera indica, Musa paradisiaca,*

M. sapientum, Prunus persica, Psidium guajava, Psidium sp., *Phonnix* sp., *Piper nigram, Ricinus communis, Solanum melongena, Tinospora cordifolia, Tamarindus indica, Vitis vinifera, Ziziphus* sp. etc.

Symptom & damage : White circular scales occur in large numbers on the under surface of leaves. The circular females which cluster on the under surface of the leaves feed on the plant sap. The leaves turn yellowish and in severe cases wither and dry up. In extreme cases, entire fronds drop off, the crown dies and the whole crop is lost.

Biology : The female lays as many as 90 eggs under its shield-like scale. The crawlers (1st instar nymph) that hatch out more and distribute to healthy leaves. The male nymphs moult 3 times and the female twice. The adult male is winged. Males require about 32 days and females about 35 days for the completion of life cycle. There are 8-10 generations per year.

Alternate hosts : Coconut, Mango.

Natural enemy-complex : The coccinellid predators including *Chilocorus* sp., *Azy atrinitalis* Mshl., *Cryptognatha nodiceps* Mshl., *Rhyzobius lophanthae* (Blaisdell) and *Pentilia castanea* Muls. (Coleoplera : Coccinellidae) play a significant role as natural limiting factor for the coconut scale.

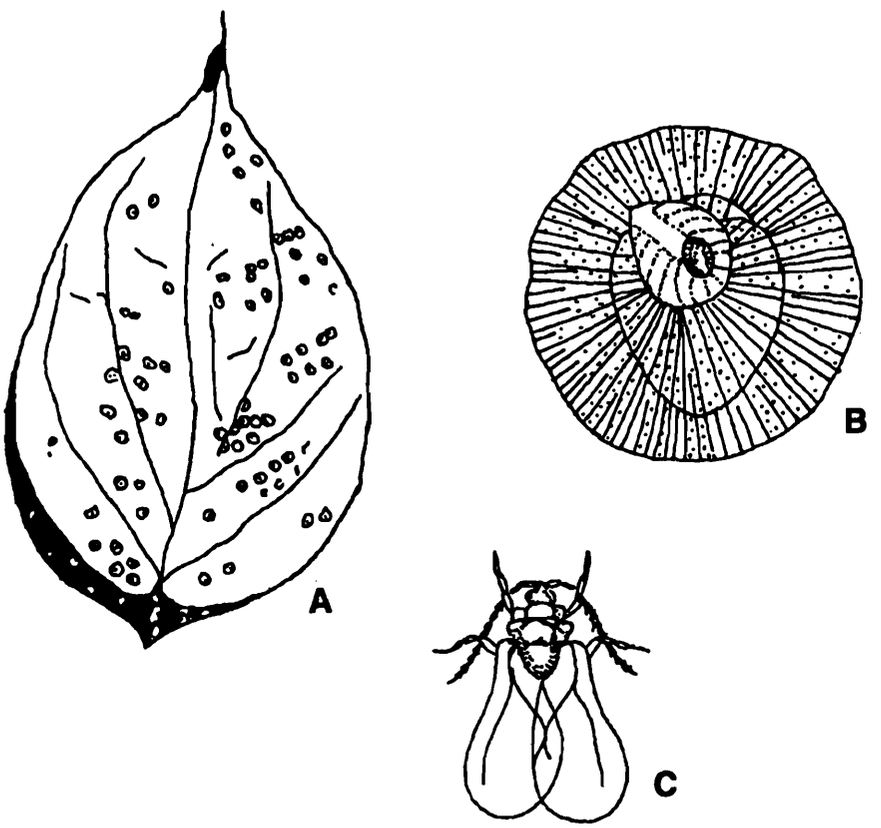


Fig. 338. *Aspidiotus destructor* Signoret : A. Scales on leaf; B. Female (magnified); C. Male (magnified) (after Green from T.B. Fletcher, 1914, modified)

Distribution : India : J. & K., Rajasthan, Maharashtra, Karnataka, Kerala, Tamil Nadu, Lakshadweep Is., Andhra Pradesh, Tripura West Bengal.

Elsewhere : Pakistan; Sri Lanka; Thailand; Indo-China and Philippine Is.

Remarks : This is a major pest on coconut and on pepper. The pest usually feeds on the leaves. Scale of the female somewhat straw-coloured, flat, circular, very thin and delicate, male slightly elongate, similar to that of the female in colour and texture. Cocount scale is found in India throughout the plains and low hills, on a number of host plants including coconut, tamarind, avocado, banana, *ber*, citrus, datepalm, fig., grapevine, guava, *jamun,* mango, papaya, peach, pear, sapota, etc.

Management : Recommended for spray 500 ml of malathion 50 EC in 250 litres of water per ha.

Genus 13 ***Quadraspidiotus*** Mac Gillivray

1921. *Quadraspidiotus* MacGillivray. The Coccidae : 388.

1966. *Quadraspidiotus* : Borchsenius, Catalogue Diaspidoidea of world : 327.

Type species : *Aspidiotus ostreaeformis* Curtis

Diagnosis : Median and 2nd lobes well developed; female body with derm membraneous except pygidium; circumgenital pores absent; dorsal ducts slender extending upto 3rd abdominal segment. *Perivulvar* pores absent.

14. ***Quadraspidiotus perniciosus*** (Comstock)
San Jose Scale
(Fig. 339)

1881. *Aspidiotus perniciosus* Comstock, *Report U.S. Deptt. Agr.* 1880 : 304.

1977. *Quadraspidiotus perniciosus;* Ali, *Indian Mus. Buss.* **5**(1) : 53.

1985. *Quadraspidiotus perniciosus;* Varshney, *Oriental Ins.,* **19** : 34.

2002. *Quadraspidiotus pernicious;* Varshney, *Rec. zool. Surv. India Occ. Paper No.*, **191** : 38.

Diagnosis : Yellow to grey, circular, slightly convex test, with exuviae subcentral. Female body having derm membraneous except pygidium. Circumgenital pores absent. First and second pairs of lobes well developed, third pair indicated as a slight triangular projection. Dorsal ducts few and slender and present upto third abdominal segment.

Host Plants : Almond, apple, apricot, beech, birch, cherry, crab apple, chestnut, currant, elm, eucalyptus, grapevine, lilac, mulberry, oak, persimmon, plum poplar, pumpkin, quince, raspberry, strawbberry, walnut, willow, wild pear, wild rose *Rosa* moschata, ghingharu *Crataegus crenulata, cydonia vulgaris, Malus punila, Prunus* spp., *Juglans regia, Prunns bokhariensis, P. armeniaca, P. domestica, Pyrus* spp.,

Pyrus, P. communis, P. cerasus, P. malus, P. sinensis and other temperate, forest trees and bushes. (Source : Varshney, 2002).

Symptom and Damage : The pest species attacks all parts of the plant except root and the injury is due to loss of cell-sap as a result of voracious feeding. The scale which forms a covering of the body of the insect is black or brown. The infested fruits also have a scaly appearance and each spot is surrounded by a scarlet or red area. At first, the growth of the infested plants is checked, but as the scales increase in number, the infested plants may die.

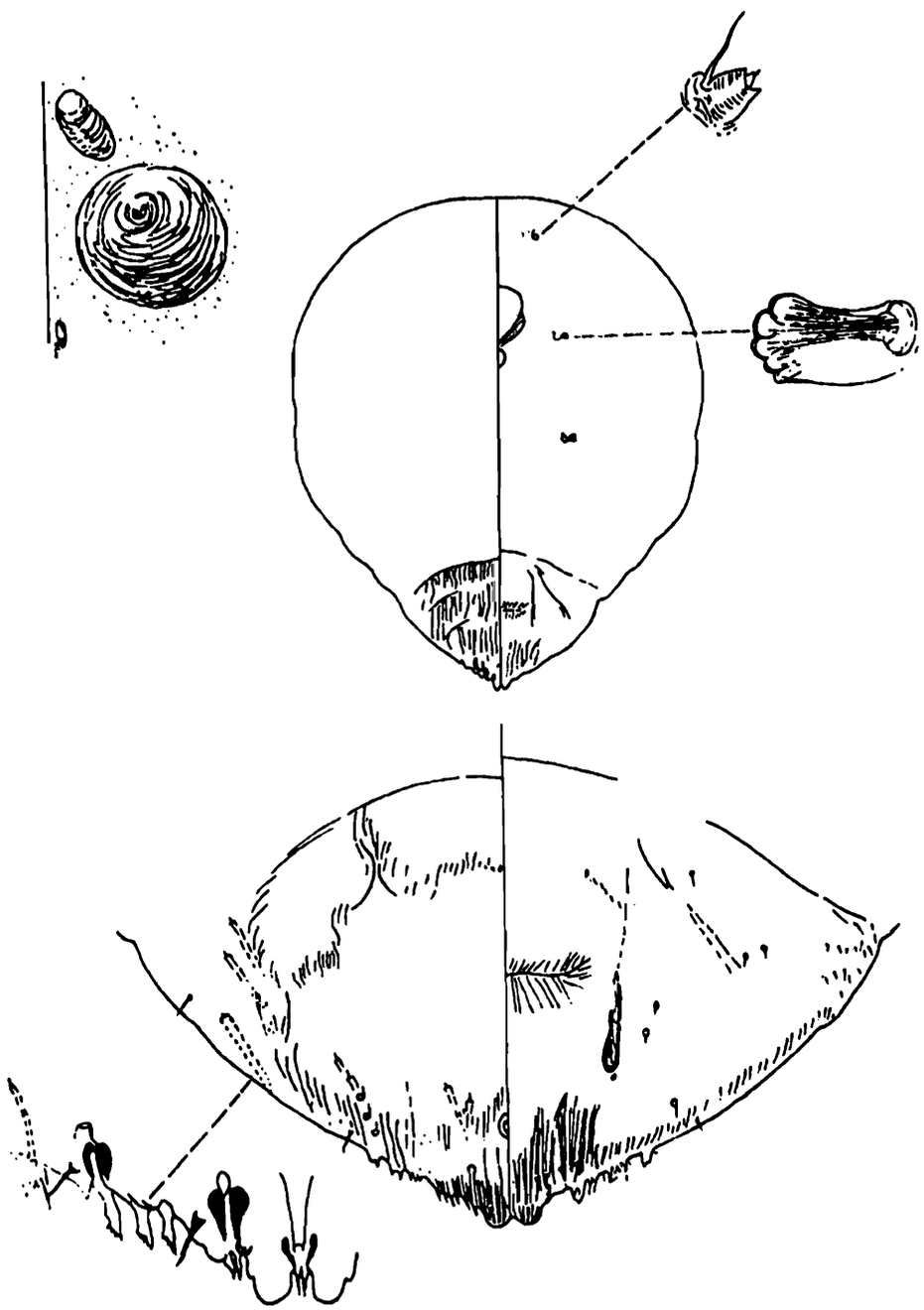


Fig. 339. *Quadraspidiotus perniciosus* (Comstock) (After Ferris)

Biology : The pest species is active from March to December and passes the winter in the nymphal stage. The overwintering nymphs resume activity in the spring and are full-grown by about April-May. They start to reproduce by mid May. The San Jose scale gives birth to young ones which hatch from the eggs developed within the body of the female. Each female may give birth to 200-400 nymphs. The newly born nymphs crawl out of the parental scale and lead a free life for 12-14 hours. On finding a suitable host plant, they insert their mouth-parts into the plant tissue and begin to feed by sucking the cell-sap. They become full-grown in 3-40 days and the females again start giving birth to young ones within the next 10-14 days. The mothers live for about 50 days. The male nymph has an elliptical or oval scale and develops into a winged adult in 25-31 days. The life of the male adult is short and hardly exceeds 24-32 hours, during which it fertilizes the non-winged females. Four overlapping generations are completed in a year and the fifth generation nymphs overwinter (Atwal and Dhaliwal, 1997).

Distribution : India : Northern part including Jammu & Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, Meghalaya, Orissa, West Bengal, Karnataka, Tamil Nadu & Maharashtra.

Elsewhere : Napal; Pakistan.

Remarks : The species is of Asiatic origin, although it was first described from North America. It is similar to *Q. forbesi* (Johnson), but it differs in the absence of the perivulvar pores. It also differs from another closely related species, *Q. socials* (Hoke) but in the latter the plates are practically lacking. The pest ordinarily occurs on the bark, although it may occur on the fruit of apples. Scale of the female gray, circular but slightly convex, exuvae subcentral, scale of male gray, slightly elongate, exuvia toward one end. It is world-wide and is the most serious pest in temperate regions on nearly 700 different species of fruits, shrubs and ornamental plants (Atwal and Dhaliwal 1997). It usually prefers plants belonging to the Rosaceae such as apple, plum, pear, peach and other closely related species such as the currant, willow, hawthorn and rose. The damage is caused by nymphs and feamle scales which suck the sap from twigs, branches and fruits.

Quadraspidiotus perniciosus is one of the most destructive coccid pests of fruit trees. The feeding by this scale causes loss of vigour, deterioration of fruit quality and even death of the plant. This pest is now spread all over Indian region, particularly in the hilly terrains of Kashmir, Himachal Pradesh, Uttar Pradesh and other parts of N.W. Himalaya where extensive horticultural advancements have been made in the cultivation of apple and other temperate fruits. The Government of India (Anonymous, 1954) made quarantine measures about it.

Management : Nursery stock should be fumigated with HCN or methyl bromide so that its spread to other areas can be prevented.

The parasite, *Encarsia perniciosi* (Tower) may be released to check the overwintering population on wild host plants growing around. Sprays of parathion 0.05%, methyl demeton 0.025% and malathion 0.1% have been reported to be of much effect in controlling the pest.

For effective management of San Jose Scale, orchard sanitation should be given priority. Infested pruned material should be collected immediately and burnt.

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INSECTA : HOMOPTERA : FULGOROIDEA

Fulgorids, usually known as "Lantern flies", are principally charactersed (Fig. 340) by reticulated anal area of the wing. They include wide variety of forms which are having antennae that are attached to the head below the compound eyes. The antennae are thickened at their base and terminate in a bristle-like process. Members of this group have rarely attracted attention by their feeding habits, but many of them are rather inconspicuous and interesting.

The group is abundant in tropical regions and also found in temperate zones.

A perusal of literature reveals that about 430 species of Fulgoroidea are known from India as against world fauna of nearly 6521 speices. In India, earlier contributions are made by Distant (1906, 1916), Paiva (1919), Menon & Prasad (1962), Chopra (1976), Dutta & Pramanick (1977), Dutta & Ghosh (1979), Ghosh and Ghosh (1998). Here the classification has chiefly been followed after Distant (1906, 1916) and Metacalf (1936, 1945).

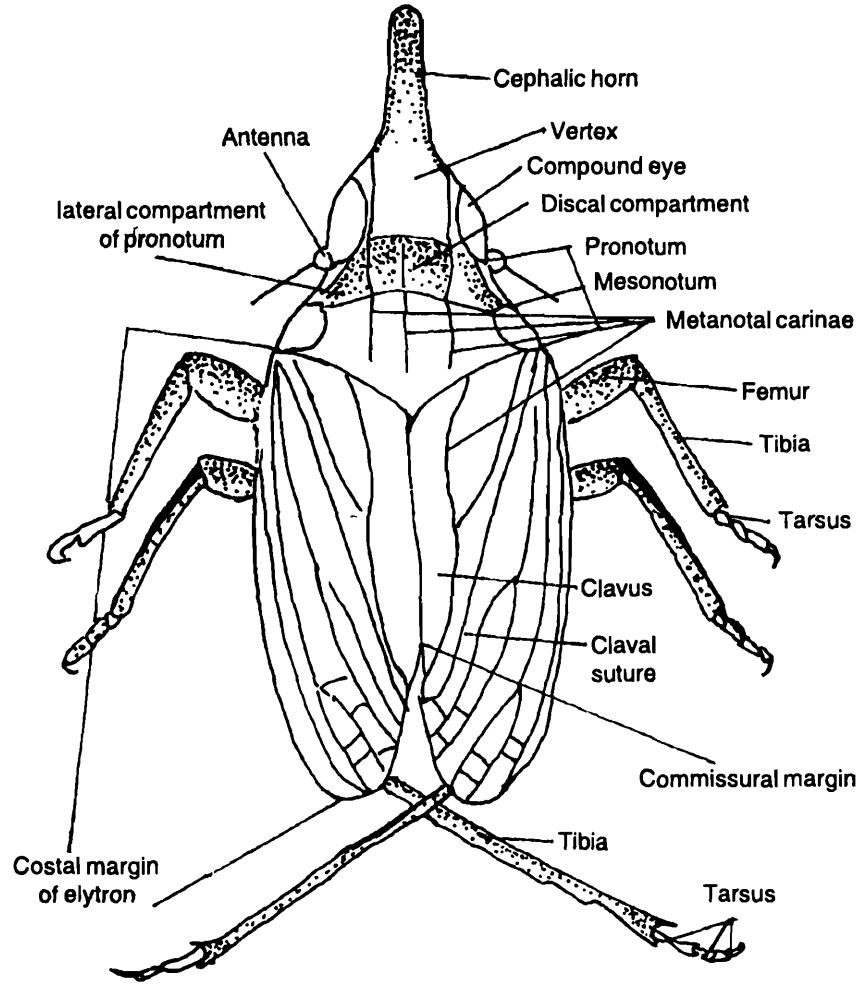


Fig. 340. External morphology of a Typical Fulgorid

Family I. FULGORIDAE

Diagnosis : The anal and jugal areas of hind wings strongly reticulate; Genae very often separated from frons by a ridge; tegmina at base with a concealed tegula; anterior coxae inserted near the sides of the body, very often elongate, posterior pair transverse, contiguous, extending to the lateral margin of body.

SYSTEMATIC ACCOUNT

Family FULGORIDAE

Subfamily DELPHACINAE

Genus 1 ***Pundaluoya*** Kirkaldy

1. *Pundaluoya simplicia* Distant

Genus 2 ***Chloriona***

2. *Chloriona (Sogatella) furcifera* (Horvath)

Genus 3 ***Nilaparvata*** Distant

3. *Nilaparvata lugens* Stal

Subfamily LOPHOPINAE

Genus 4 ***Pyrilla*** Stal

4. *Pyrilla perpusilla* (Walker)

Subfamily FLATINAE

Genus 5 ***Phyllyphanta*** Amyot and Servielle

5. *Phyllophanta sinensis* Kirby

Key to the subfamilies of FULGORIDAE

1(2). Posterior tibiae with a mobile spur at apex ..... DELPHAEINAE

2(1). Posterior tibiae without mobile spur at apex 3

3(4). Basal joint of posterior tarsi robust or incrassate and moderately short ..... LOPHOPINAE

4(3). Basal joint of posterior tarsi not as above, legs usually simple; clavus granulate, claval suture distinct ..... FLATINAE

Subfamily DELPHACINAE

Diagnosis : Vertex with lateral margins and two centrae fasciae testaceous; abdomen with lateral margins alternately spotted with black and yellow; face with lateral margins and a central line bifurcating anteriorly pale castaneous; body, legs, antennae ochraceous; pronotum and mesonotum with four central testaceous fasciae; tegmina

hyaline with a yellowish tint with apical black markings. The adult insect is yellowish brown, with translucent wings.

Key to the genera *Delphacinae*

1(2). Vertex of head longer than broad ..... ***Nilaparvata***

2(1). Vertex of head broader than long 3

3(4) Tegmina elongate, basal half of costal margin usually arched and gibbous, with a strongly sinuated transverse line formed of transverse veins crossing tegmen beyond middle ..... ***Pundaluoya***

4(3). Tegmina not as above, terminal margin with a dark elongate spot ..... ***Chloriona (Sogatella)***

Genus 1. ***Pundaluoya*** Kirkaldy

1902. *Pundaluoya* Kirkaldy, *J. Bombay nat. Hist. Soc.,* xiv : 52.

Type species : ***Pundaluoya ernesti*** Kirby

Diagnosis : Head narrower than pronotum; vertex of head broader than long; antennae inserted beneath the eyes, second joint very robust with short spiny hairs, clypeus medially and laterally carinate; pronotum about as long as vertex, marginally strongly and medially more obscurely carinate; posterior tibiae with a long robust apical spur; tegmina elongate, about thrice longer than broad, basal half of costal margin sometimes arched and gibbous, with a strongly sinuated transverse line formed of transverse veins crossing tegmen beyond middle.

1. ***Pundaluoya simplicia*** Distant
Sorghum short bug/corn plant hopper
(Fig. 341)

1906. *Pundaluoya simplicia* Distant, *Fauna Brit. India,* **3** : 468

1910. *Peregrinus maidis* Kirkaldy (nec. Ashmead), *Fauna Haw.,* ii : 577.

1914. *Pundaluoya simplicia* Bainbr. *Fletch. Some S. Ind. Ins.,* : 484.

1916. *Pundaluoya simplicia* Distant, *Fauna Brit. India,* **6** : 134.

1997. *Peregrinus maidis* (Ashmead) : Atwal and Dhaliwal, Agricultural Pests of South Asia and their management : 195.

Diagnosis : Body ochraceous, vertex with the lateral margins and two central fasciae testaceous lateral margins of the abdomen alteranately spotted with yellow and black; femora piceous, their apices and the tibiae and tarsi pale ochraceous; face with the lateral margins and a central line bifurcating anteriorly, pale castaneous; lateral margins of clypeus pale castaneous; antennae ochraceous with the apex of the

basal joint piceous; eyes piceous; pronotum with four central testaceous fasciae, mesonotum with four testaceous fasciae; tegmina hyaline with a yellowish tint, the veins yellow. with apical black markings rounding marginal cellular areas, wings hyaline with faint opaline lustre.

Length : 3-4 mm.

Host plants : Sugarcane, oats, and grasses.



Fig. 341. *Pundaluoya simplicia* Distant

Symptom and Damage : The adults and nymphs (light brown with prominent eyes and wing pads) suck the plant sap within the leaf whorls, the leaf sheaths and also on the leaves. As a result of their sucking the cell sap, the leaves become yellow and arrest the growth of the plants. When the attack is severe, the ears fail to emerge. The ears do not emerge as result of severe feeding to the pest species.

Biology : The female bug lays nearly 100 eggs which are white elongated and cylindrical. The oviposition period is about 7 days. The eggs hatch in 7-10 days. After emergence the nymphs feed at first within the leaf sheaths and leaf whorls. After 5 moulting, they attain adulthood in about 15-20 days. It takes about a month to complete life cycle.

Distribution : India : widely distributed in southern part.

Elsewhere : Barmuda, Cuba, East Africa, Hawaii, The Philippines.

Natural enemy-complex : Predator *Coccinella septempuncta* Linn. *Menochilus sexmaculatus* (Fabr.) [Coccinellidae : Coleoptera]. Parasite : *Anagrus optabilis* (Perkins) [Mymaridae] *Ootetrastichus indicus* Gir. [Eulopidae].

Remarks : The adults and nymphs are serious pest of millets, maize and sorghum particularly in southern part of India. The adults act as vector to transmit the viral diseases, "corn mosaic" and "freckled yellow" sorghun. Many other virus diseases of pearl millet and sugarcane, are caused by this sorghum shoot bug.

Management : Spray 625 ml. of malathion 50EC or one litre of endosulfan 35 EC or 3kg. carbaryl 50WP or 200 ml of phosphamidon 85 WSC in 500 litres of water per ha is effective.

Genus 2 ***Chloriona***

Diagnosis : Head narrower than pronotum; vertex a little longer than broad, slightly widened at base; face very long and narrow, more than twice as long as broad, carinate; autennae inserted near lower margins of eyes, second joint much longer than first and

moderately incrassate; clypeus slightly broader than face, carinate; pronotum tricarinate about as long as vertex, posterior femora without spine but with a long robust spur at apex; tegmina longly passing apex of abdomen, much longer than broad, veins longitudinal, crossed beyond middle by an irregulor series of transverse veins.

2. *Chloriona (Sogatella) furcifera* (Horvath)
White-backed plant hopper
(Fig. 342)

1899. *Liburnia furcifera* Horvath, *Termesz. Fiizetex.* xxii : 372.

1906. *Liburia furcifera* : Distant, *Fauna Brit. India,* **3** : 487.

1976. *Sagetella furcifera* : Nayar *et al.* General and Applied Entomology : 189

1999. *Sogatella furcifera* : Gunathilagaraj, Applied Entomology Vol. 1 : Insect pests of cereals and their management, AZRA, Cuttack : 44.

Synonyms : *Delphax furcifera* Horvath; *Sogata distincta* Distant; *Sogata pallescens* Distant; *Sogata kyusyuensis* Matsumura and Ishihara; *Sogata tandojamensis* Qadri and Mirza.

Diagnosis : Body elongate, face elongate, narrow, slightly narrowed between eyes black in male and yellowish brown in female, clypeus yellowish brown, carinae yellowish white; eyes brown; antennae yellowish brown. Pronotum white medially with two punctured dots, mesonotum black, apex of mesonotum yellowish white; tegmina hyaline veins brownish yellow, terminal margin with a dark elongate spot; wings hyaline, abdomen black; legs pale yellow. Both Macropterous and Brachypterous forms occur. The adult is with transparent wings with dark veins and tinted with brown.

Length : 3.5–5 mm.

Host Plants : The pest has a wide range of host plants in India.It has been observed on rice, finger millet, sorghum, wheat, jungle rice and *Leersia hexandra.* The barnyard grass, *Echinochloa crus-galli* var. *oryzicola* does not have antifeedant effect on this hopper which grows to become normal adults on grasses as on rice. It was observed to repeat some generation on graminaceous grasses like *E. glabreascens, Cynodon dactylon, Leersia japonica Zizania eaduciflora* and *Glyceria acutiflora.* Other common host plants are *Oryza sativa,* Linn. *Saccharum officinarum* Linn.; *Panicum crusgalli, Alopecurus pratensis, Poa annua, Carex, Elensine indica Digitaria decumbens.*

Distribution : In India, the attack of this bug on paddy was reported first from Surat, Pusa, Poona and Nagpur as early as 1903 (Lefroy, 1903-04). Subsequently, it was observed in Bihar and Bengal (Fletcher, 1919), Jabalpur and other neighbouuring districts in Madhya Pradesh (Berg, 1960). This hopper appeared for the first time in 1966 in Punjab (Jaswant Singh *et al.,* 1986) and in Rajasthan in 1986 (Tripathi and Pandya, 1987). It is a major pest of rice in hilly tracts of Uttar Pradesh (Sachan and Garg, 1992). It attained higher level of incidence in Gujarat, Haryana, Rajasthan,

Maharashtra. It has also been recorded in Andhra Pradesh, Assam, Bihar, Delhi, Haryana, Himachal Pradesh, Karnataka Madhya Pradesh, Maharashtra, Manipur, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal (Chelliah and Gunathilagaraj, 1999).

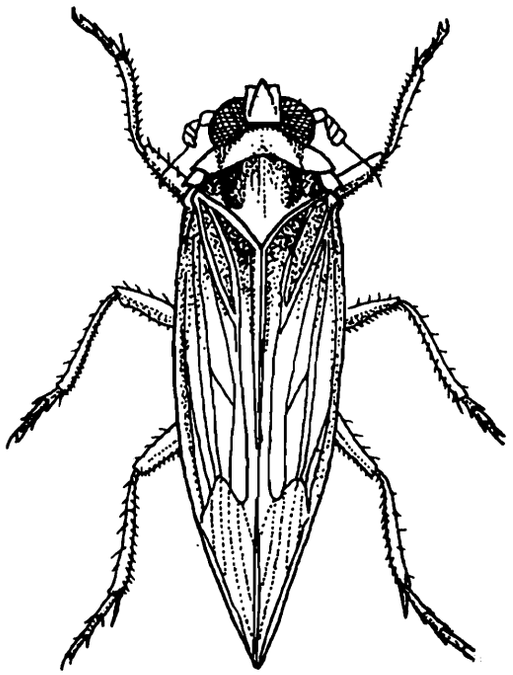


Fig. 342. *Chloriona (Sogatella) fercifera* (Horv.)

Elsewhere : It is widely distributed in the eastern Palaearctic, the Oriental region, the Western Pacific and Australia. It has been recorded in Australia, Bangladesh, Burma, China, Cambodia, Fiji, Hawaii, Indonesia, Japan, Korea, Malaysia, Manchuria, Micronesia, Solomon Islands, Taiwan, Thailand, the USSR, Vanuatu and Vietnam (Gunathilagaraj, 1983).

Symptom of Damage : The plant hopper is usually more abundant during the early stage of the growth of rice crop, especially in nurseries. It attacks plants of less than four-month old in fields with standing water and shows a marked increase with the age of the crop. Rice is more sensitive to attack at the tillering phase than at the boot and heading stages. Damages caused by the immigrants occur soon after their landing through feeding and egg-laying. Under favourable conditions, it produces several generations and can cause *hopper-burn* in the rice crop. Both nymphs and adults suck phloem sap causing reduced vigour, stunting, yellowing of leaves and delayed tillering and grain formation. It is seldom that rice plants are killed by this hopper except early stages. However, yellowing of grown up rice palnts has been reported. When the hoppers are present in large numbers late in the crop growth stage, they are seen infesting the flag leaves and panicles. Gravid females cause additional damage by making ovipositional punctures in the leaf sheaths. Feeding punctures and lacerations caused by ovipositor predispose the plants to pathogenic organisms and honey dew excretion encourages the growth of sooty mould such as *Cladosporium* spp. and *Dematium* spp (Mochida, 1964). Symptoms of rice plant attacked by this pest are variable according to the population density, duration of feeding, rice cultivars and stages of the plant. Damage in the form of hopper burn (Fig. 430) frequently appears in large areas of region.

Life Cycle : The life-cycle of the insect has been studied by Gunathilagaraj (1983). The description of different growth stages of the hopper has been given by Atwal *et al.* (1967). The adult hopper can tolerate a wide range (8-36°C) of temperature and remain active. The macropterous females are more tolerant to temperature extremes than the males.

Adult : The adult hopper has a distinctive rather long narrow face. The forewings are uniformly hyaline with dark veins. There is a conspicuous black dot about the middle of the posterior edge of each forewing which meets when the forewings come together. The pronotum is pale yellow, the body is black dorsally and creamy white elsewhere. There is a prominent white band between the junctures of the wings. Macropterous males and females, and brachypterous females are commonly found in the field.

Eggs : The eggs are commonly laid as egg-groups in sheaths when the rice plant is small but in the upper part of the rice plant when the plant is large. The number of egg masses laid by the bug is 85 per female and each egg mass contains 6 to 8 eggs. The brachypterous females produced more eggs (300 to 350) than the macropterous females (164 to 300). Eggs are cylindrical, laid on the plants with the micropylar end protruding from the tissue. The operculum is long and narrow. The incubation period varies considerably. Nymphal period usually ranges from 8 to 28 days and there are five nymphal instars. The five different instars took 2-3, 2-3, 3-4 and 2-3 days respectively to complete their development (Vaidya and Kalode, 1981; Gunathilagaraj, 1983).

Nymphs : Pale to light brown in colour and size ranges from 0.6 mm when young and newly hatched to 2.0 mm after 11-12 days. Fifth instar nymph with a narrow head and white or creamy white body. Dorsal surface of the thorax and abdomen marked with various amounts of grey and white marking.

The longevity of adult also varies from 1.9 to 31.8 days for macropterous male, 2.0 to 41.1 days for macropterous female and 5 to 21 days for brachypterous female. The average life-cycle in India was 23 days at Cuttack (Misra and Isreal, 1968), 11 to 56 days in the field and to 34 days in the laboratory in Madhya Pradesh (Kittur, 1969) and 12.3 to 17.7 days in Punjab (Atwal *et al.*, 1967). The generation time was prolonged from 20 to 91 days in Ludhiana, Punjab during winter (Shukla and Gupta, 1980). Temperature plays important role in the preoviposition period, duration of different stages and life-cycle of this white backed plant hopper.

Biology :

Characteristics	Duration (Days)/number
Pre-oviposition period	2-9 (Macropterous feamle) days 2-3 (2.7) days
Oviposition period	3-12 days
Incubation period	6-7 (6.4) days
Nymphal instars	5 days
Nymphal period	12-17 (14) days
I instar	2-3 days
II instar	2-3 days
III instar	3-4 days
IV instar	3-4 days
V instar	2-3 days
Total life-cycle	18-24(23) days

Adult longevity	1.91-31.80 (Macropterous female) days 2.00-41.10 (Macropterous female) days 5.00-21.00 (Brachypterous female) days
Fecundity	2-425 (162) numbers

[*Sources* : Gunathilagaraj (1999)]

There are several generations in a year. In south India these plants hoppers breed continually whereas in North India the pest becomes active in May. During August and September, the population attains peak.

Natural enemy complex : Parasites of the plant hopper comprise 11 hymenopterous insects as egg parasites, 5 hymenopterous, 2 strepsipterous, 1 dipterous insects, 4 nematodes and 1 mite as nymphal or nymphal-adult parasites. Egg parasites occur in the hymenopterous families of Eulophidae *(Tetrastichus* sp.), Mymaridae *(Anagrus* spp., *Gonatocerus* sp., *Lymaenon* sp. and *Mymar* sp.) and Trichogrammatidae *(Oligesita* spp.). Nymphal and adult parasites have been recorded in Dryinidae *(Gonatopus* sp., *Monogonatopus orientalis* (Rohwer) *Neogonatopus* sp. and *Pachygonatopus* sp.) and in Pipunculidae *(Tornosvaryella* sp.) (Diptera), Elenchidae (*Elenchus* spp.) (Strepsiptera).

Predatory insects include egg predators as the members of Lygeidae, Miridae (Hemiptera) and nymphal–adult predators as members of families Coccinellidae, Staphylinidae, Carabidae (Coleoptera), Syriphidae (Diptera), Tettigoniidae, Gryllidae (Orthoptera), (Odonata). In addition, several species of spiders (Lycosidae, Araneidae, Oxyopidae, Tetragnathidae; Araneida), birds, frogs and giant toad have also been recorded as nymphal-adult predators.

Spiders constitute an important constant mortality factor as they are present throughout the year.

Management : Mechanical : Earlier, the pest species was destroyed to a large extent by the use of field bags, by squirting kerosene in the infested fields and drawing a rope across the fields so as to get the nymphs as well as the adultsin contact with kerosene on the water. The cultivators also bagged their fields with *dhoties* turned into temporary bags, previously moistened with a little kerosene.

Cultural : Draining of water from the field for about 4 to 6 days was found effective in controlling the population build-up of the species by manipulating humidity. The incidence of the hopper was low when rice was intercropped with either soybean, pigeonpea or groundnut (Gangwar *et al.*, 1994).

Chemical : Insecticides effective against the pest are carbaryl WP 0.5 kg a.i./ha; endosulfan EC 0.35 kg a.i./ha; diazinon G 1.25 kg a.i./ha; phorate G 1.00 kg a.i./ha; carbofuran G 0.5 kg a.i./ha. Carbofuran and triazophos are also reported to be effective ovicides. It is also recommended spraying of quinalphos, or fenthion, or chlorpyriphos, or carbaryl, or monocrotophos @ 0.5kg a.i./ha or broadcasting of carbofuran3G @0.75 kg a.i./ha or phorate 10G 1.25 kg a.i/ha; depending upon the stage of the rice crop.

The insecticide application is recommended only when the population of the hopper exceeds the economic threshold level (10/hill during planting to mid-tillering stage; 5-10/hill during flowering and after). Pesticide application can be timed to coincide with the incipient outbreak of the pest.

Remarks : The pest species has a long history as a pest of rice. Its damage to the crop was noticed as early as AD 697 in Japan. Next to *Nilaparvata lugens,* this species is considered as serious pest of rice in Asia. The adults are characterised in having straw-coloured, wedge-shaped body with white back. The nymphs are greyish-white and turn dark grey when they near maturity. Both the nymphs and adults are very active and they can easily jump from one leaf to another when even a slight disturbance is caused. In the Panjab and the adjoining states of India the species was reported to be a serious pest in 1966.

Genus 3. ***Nilaparvata*** Distant

1906. *Nilaparvata greeni* Distant, *Fauna Brit. India,* **3** : 473.

Type species : *Nilaparvata greeni* Distant

Diagnosis : Head narrower than pronotum; vertex longer than broad, lateral margins strongly carinate, its anterior angle prominent, two oblique discal carination at middle and lateral margin, the basal margin ridged; face elongate, longer than broad, centrally and laterally prominently carinate, the central one furcate at base, apical margin strongly ridged; clypeus strongly medially carinate, antennae inserted beneath the eyes, pronotum about as long as vertex, centrally, laterally and anteriorly carinate, mesonotum faintly tricarinate; tegmina less than three times as long as broad, the apical margin rounded; wings at base broader than tegmina; posterior tibiae with a spine at middle, another at apex and with a long rubust apical spur.

3. ***Nilaparvata (Anderida) lugens*** Stal
Brown plant hopper
(Fig. 343, 429)

1854. *Delphax lugens* Stal *Ofv. Svenska, Vet. Akad. Forh.,* **11** : 246.

1906. *Nilaparvata lugens* Stal : Distant, *Fauna Brit. India,* **3** : 486.

1943. *Nilaparvata lugens* Stal; *General Catalogue of Homp.,* : 296.

2000. *Nilaparvata (Anderida) lugens* Stal : Ghosh *et al.* Insecta : Hemiptera : Cercopoidea : Cicadelloidea, Cicadoidea and Fulgoroidea *In* : *Fauna of Tripura, State Funa Series,* **7**(Part 2) : 338. Zoological Survey of India.

Synonyms : *Delphax lugens* stal; *Delphax sordescens* Motschuls ky; *Nilaparvata greeni* Distant; *Kalpa aculcata* Distant; *Delphax ordovix* Kick. *Delphax parysatis* Krikaldy; *Dicronotropis anderida* Kirkaldy; *Delphax oryzae* Mats; *Hikona formasome* Mats.

Diagnosis : Body brownish yellow; head castaneous brown; vertex brownish yellow, with anterior interspaces between central and lateral carination black; face brownish yellow, its carination pale yellowish, its margins pitchy black; clypeus castaneous, its carination pale yellowish; pronotum pale brownish yellow; mesonotum also with carinations faint pale brownish yellow; tegmina subhyaline with yellowish tint, veins smoky brown; an elongate black spot at apex of clavus; wings hyaline with an opaline lustre, the veins pale brownish.

Length : 3.5-5 mm (Female).

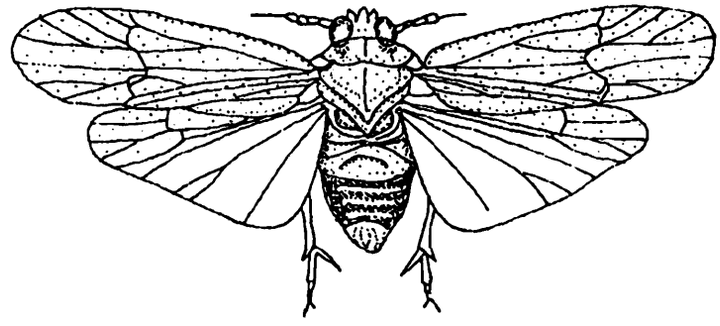


Fig. 343. *Nilaparvata lugens* Stal

Host plants : Rice is the most important host plant of the pest. However, a few alternate hosts have been noted in the literautre : *Eleusine coracana* (L) Gaertn. *Leersia hexandra* SW., *L. japonica* Makino, *Sccharum officinarum* L., *Setaria italica* Beauv., *Triticum aestivum* L., *Zea mays* L., *Zizania eaduciflora* Hand.-Mazz., and *Z. longifloia.* But several *Oryza species, O. granulata, O. longiglumis, O. meyeriana, O. minuta, O. officinalis, O. ridleyl* and *O. rufipogon* in addition to *O. sativa* have also been reported to serve as host plants for brown plant hopper in tropical Asia.

Distribution : In India, the pest species has been recorded in Andhra Pradesh, Bihar, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal.

Elsewhere : It is widely distributed throughout southeast Asia and parts of the Pacific and Australia. It has been recorded from Australia, Bangladesh, Bhutan, Burma, Cambodia, Caroline and Mariane Islands, China, Fiji, Indonesia, Japan, Korea, Laos, Malaysia, Micronesia, Nepal, New Caledonia, New Guinea, Pakistan, Papua New Guinea, Philippines, Sarawak, Solomon Islands, Soviet Maritime Territory, Sri Lanka, Taiwan, Thailand and Vietnam.

Symptoms of Damage : The damage to rice plants by brown plant hopper occurs directly by feeding of nymphs and adults, and indirectly by the transmission of diseases. It is typical vascular feeder primarily sucking the phloem sap leading to hopperburn. Fifth instar nymphs can suck the sap more than adults and adults females can suck more than adult males. During sustained feeding, the species excretes a large amount of honey dew.

The appearance of damage to rice plants is variable according to the population density and stages of plant hopper, duration of feeding, cultivars, stages of rice plants and probably the presence or absence of water in the rice fields. It prefers rainfed and irrigated wetland fields to upland rice and direct sown fields to transplanted fields.

It infests the rice crop at all stages of plant growth. At early infestation, round yellow patches appear which soon turn brownish due to the drying up of the plants (hopperburn). The patches of infestation then may spread out and cover the entire field.

During feeding, adults and nymphs of brown plant hopper inject a toxic saliva and suck the plant sap causing the development of rusty spots and lines which is followed by general drying of the tissues. The loss in yield may range from 10-70% (Atwal and Dhaliwal 1997). The brown plant hopper acts as a vector of Rice grassy stunt and Rice-ragged stunt disease.

Kuruvai crop in southern part of the country, is severely infested at the shoot blade stage in August. The crop shows a burnt up appearance with chaffy ears as a result of severe attack of the pest species and the crop suffers heavy loss in yield.

The more probable cause of hopperburn damage is the reduction in the rate of translocation of photosynthates to the root system, which results from the drain of phloem sap and the physiological disruption of active transportation in the phloem by sustained feeding. Disturbance of the physiological activities of the root system enhances leaf senescence (Sogawa and Cheng, 1979).

Besides, *N. lugens* is a vector of the virus diseases like grassy stunt and ragged stunt (Hibino, 1979; Chen and Chiu, 1981). Sheath blight disease incidence was high in brown plant hopper infested plants (Lee *et al.,* 1985). Similarly, stem rot caused by *Sclerotium oryzae* Tullis was more in hopper damaged plants (Narayanasamy and Baskaran, 1979).

Life Cycle : Adult : Adult has two characteristic wing morphs; macropterous (long-winged) and brachypterous (short-winged). The long-winged macropterous adults (macropters) can fly and are responsible for migratory movement and colonisation of new rice fields. The short-winged, flightless brachypterous adults (brachypters) can only hop within the field. The proportion of the two wing morphs within a given population fluctuates from time to time. However, the macropters dominate in rice fields at the time of colonisation, the subsequent two or three generations are largely brachypters. while towards crop maturity, the macropters become dominant again and disperse from the field. Wing morphism is influenced by several factors. Crowding during the larval stageand reduction in the quality and quanity of food, short day length and low temperature macroptery.

Egg : The eggs are usually laid as egg-groups in the leaf sheaths near the plant base or in the ventral midribs of leaf blades. Eggs are whitish or transparent, thrust in a straight line. They are covered with a dome-shaped egg plug secreted by the female. Only the tips of eggs protrude from the plant surface. The number of eggs laid at a site various from 2 to 12. The average number of eggs laid is 244/female with brachypterous females laying 300 to 350 eggs and macropterous females laying less than that.

Egg stage lasts for 6 to 9 days in the tropics–Nymphal period usually ranges from 10 to 18 days. *N. lugens* has five nymphal instars and the instars are distinguished by the shape of meso and metanotum and body size.

Nymph : Freshly hatched nymph is cottony white, 0.6 mm long and it turns purple-brown and 30 mm long in the fifth instar. Nymphal development takes place through 5 instars in 19-23 days and fifth instar nymph finally develops to adults. Adults emergence takes place at the basal part of the host plant.

Adult longevity varies between field populations (9 days) and laboratory populations of the hopper (37 days). The pre-ovipositional period is 3 to 4 days for brachyperous females and 3 to 8 days for macropterous females. At natural temperature (25-30°C), total life cycle takes 19-23 days. Temperature plays a major role in its life cycle. Adult longevity and rate of oviposition are also influenced by the temperature conditions of nymphal stage. A temperature range of 28 to 30°C during day time is ideal for the population development of the pest. In warm and humid climates of tropics, it remains active throughout the year and the population fluctuates according to the availability of host plants, activity of natural enemies and other environmental factors prevailing in the locality. In India, the peak population is observed during October–November. Another peak appears in April–May. The brown plant hopper enjoys several generations during the cropping season.

Biology : The optimum temperature for the activity of the plant hopper ranges from 10°C to 32°C.

Characteristics	**Duration/number**
Pre-oviposition period	3-4 days (Brachypterous female) 3-8 days (Macropterous female)
Oviposition period	11-39 days (Brachypterous feamle) 6-12 days (Macropterous female)
Incubation period	6-9 days
Nymphal instars	5 days
Nymphal period	10-18 days
Total life-cycle	19-23 days
Adult longevity	14-21 male
	14-30 feamle
Fecundity	300-350 numbers (Brachypterous female)

(*Source* : Gunathilagaraj 1999)

Natural enemy complex : Parasites : Egg parasitism is often very high, whereas numph and adult parasitism are generally low throughout most Asian countries.

Various parasites predominate different times during the crop-growing season and attack the hopper at different developmental stages. Egg parasites are found in the families of Mymaridae, Trichogrammatidae, Eulophidae and Scelionidae of Hymenoptera. The most important egg parasites belong to the general *Oligosita* (Trichogrammatidae), and *Anagus, Gonatsarus* and *Nymar* (Nymaridae). They were more effective perhaps by their remarkable capacity to realise most of the biotic potential, short life cycle and possibly by parasitising alternate hosts in weeds at times of low host population in paddy.

The nymphs and adults of *N. lugens* are attacked by several species of Dryinidae (Hymenoptera), Elenchidae, Halictophagidae (Strepsiptera), Pipunculidae (Diptera), Mermithidae (Nematoda), and Erythraeidae (Acarina). To date, six species of dryinids *viz. Dryinus* sp., *Echthrodelphax fairchildii* Fallen, *Gonatopus* sp., *Halplogonatopus* sp., *H. orientalis* Rohwer and *Neogonatopus* sp. three species of strepsipterans *(Elenchus* sp., *E. yasumatsui* Kfh and *Hatichophagus* sp.), and four species of pipunculids *(Pipunculus javanensis* de Meijere, *P. mutillatus* Loew, *Tomosvaryella oryzactora* Koizumi and *T. subvireocons* Loew.) have been recorded on brown plant hopper in India. The incidnece of parasitism by dryinids and strepsipterans is quite variable and increases in the latter half of the crop period.

Predators : Predators of eggs, nymphs and adults of the pest species are more important than parasites in controlling the hopper (Chatterjee and Dutta, 1969). The most commonly reported predator is the mirid bug, *Cyrtorhinus lividipennis.* It feeds on all developmental stages of the bug, but primarily on eggs. In addition, 36 species of spiders have been identified as preying on the hopper in India, among them *Lycosa* often predominate. Other predators include several species of bugs in the families of Anthocoridae,Lygaeidae, Miridae, Nabidae, Reduviidae, Nepidae, Veliidae, Mesoveliidae, Gerridae and Hydrometridae and beetles of the families of Carabidae, Coccinellidae and Staphylinidae. Among the coccinellids, *Coccinella arcuata* is the most important and common predator of brown plant hopper in India. Other predators include species of Odonata, Orthoptera, Hymenoptera, Mollusca and Amphibia. The wolf spider, *Lycosa pseudoannulata* is also recognised as a major regulator of hopper populations and probably is its most important predator. In addition, it is suggested that aquatic bugs of Veliidae, Mesoveliidae and Nepidae could be effective predators of the pest if they fall from the rice plant on to the water surface. Ants may prey on nymphs and adults, but may also feed on the honeydew secreted.

Integrated Pest Managment : Avoid use of excess nitrogen; provide rogue spacing at every 2 m to facilitate insecticide application; control irrigation by intermittent draining; setup light traps to monitor population and to control brown plant hopper; avoid use of insecticides causing resurgence such as synthetic pyrethroids, methyl parathion, fenthion and quinalphos; at pre-flowering stage apply phosphamidon 85 WSC 500 ml or monocrotophos 36 WSC 1250 ml or phosalone 35 EC 1500 ml or chlorpyriphos 20 EC 1250 ml or carbofuran 3G 17.5 kg per ha.; at post-flowering

stage apply carbaryl 10D 25 kg/ha. Drain water before use of insecticides. Direct the spray/dust towards the base of the plant. [Source : Regupathy *et al.* 1994].

Remarks : The brown plant hopper is the most destructive pest of rice in South and South-east Asia. China, Japan and Korea. In India, it has become very serious on the high-yielding varieties of paddy in many States including Uttar Pradesh, Madhya Pradesh, West Bengal, Tripura, Andhra Pradesh and Tamil Nadu.

Both adults and nymphs feed on paddy, sugarcane and grasses by sucking the cell sap. The brownish adults are with brown eyes. The nymphs are brownish-black in colour and have greyish-blue eyes. Their legs are light brown and the tarsal claws are black. The wings are hyaline with brown markings and dark veins.

The outbreaks of *N. lugens* on rice crop have been recorded in Korea since 18 AD and in Japan since 697 AD. But it has become a major pest in many tropical countries in the Oriental region and some Pacific islands since 1960s only (Mochida *et al.,* 1977).

Subfamily LOPHOPINAE

Genus 4. ***Pyrilla*** Stal

1869. *Pyrilla* Stal, *Ber. ent. Zeitshr.,* iii : 326.

Diagnosis : Head produced in a porrect cephalic process, tricarinate above, laterally broadly flattened; face broadly longitudinally excavate between two latral somewhat laminate ridges; clypeus with central and marginal ridges; antennae placed between the eyes, 2nd antennal joint subglobose; pronotum narrow, centrally tricarinate; mesonotum tricarinate; posterior tibiae with two spines, posterior tarsi with basal joint long and subglobose; tegmina truncately rounded apically; wings slightly wider than tegmina.

4. ***Pyrilla perpusilla*** (Walker)
Sugarcane Leaf-hopper
(Figs. 344, 435)

1889. *Zamila perpusilla* Walker, *List Hom.* ii : 269(1851).

1906. *Zamila perpusilla* Walker : Distant, *Fauna Brit. India,* **3** : 327.

1916. *Pyrilla perpusilla* : Distant, *Fauna Brit. India,* **6** : 85.

1994. *Pyrilla perpusilla* : Jha, *Applied Agric. Entomology* : 161, 164, 171.

1999. *Pyrilla perpusilla* : Gunathilagaraj, Insect pests of Cereals and their management, AZRAI, Cuttack : 52.

Diagnosis : The straw-coloured adult insect with two pairs of wings which are folded on the abdomen in the shape of a roof. This insect possesses long-pointed snout and prominent red eyes. When full-grown, a nymph is pale yellow, 10-15 mm long, and has two white prominent feather–like filaments at the tail end of its body. This

leaf hopper is very agile and jumps around in large numbers, making a faint noise when a person walks through a heavily inested field. The adult, equally active, is about 20 mm long and has body with dark patches or spots on the wings. Body ochraceous, paler beneath than above; tegmina yellowish-white, semi opaque, the apical area as other claval margin speckled with black spots; dorsal ridge to cephalic process much less prominent in front of central transverse ridge behind it, tegmina yellowish white; wings pale hyaline; legs ochraceous.

Host plants (Main) : Sugarcane alternative : Millet, wheat, jowar, barley, oats, sorghum, maize and other poaceous plants and also some dicotyledons. Occasionally, it is also seen in the fields of Lady's finger, cucurbit vegetables and certain legumes.

Length : With expansion of tegmen 18 mm.

Symptom and Damage : The two stages phloem nymph and adult suck the sap from sugarcane leaves and as a result of it, they look yellow and withered. The leaves which are haunted by nymphs, have, in the middle of them, black fungus which develop due to the "honey dew" exereted by innumerable individuals. It is detrimental to the growth of plant. It lowers both the quality and quantity of cane-juice and inevitably, the production of sugar and molasses diminishes to a formidable extent. From April to October, the damaging tendency or the pests is at its worst.

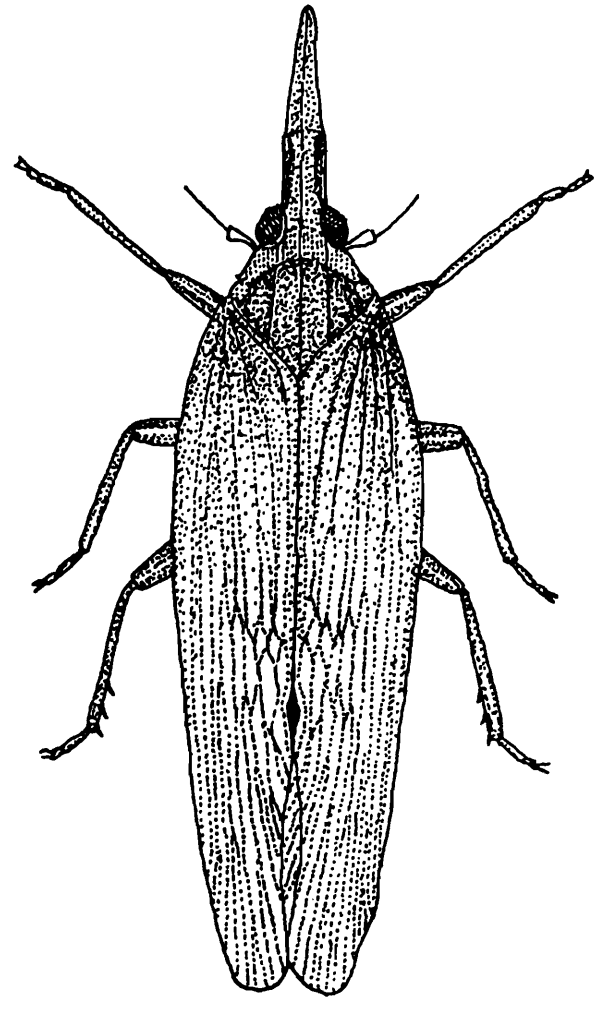


Fig. 344. *Pyrilla perpusilla* (Walker), General view

Biology : The female has a pair of pads on the abdominal end of the body. It is habitual with the female hoppers to lay eggs generally on the underside of the leaves, or inside leaf sheath and mantle them with white wax fibre from the anal tuft of the female. The eggs so laid vary in number from 10 to 65. The egg laying capacity of a female amounts to about 720 eggs. The eggs take a week to hatch into young nymphs. Soon after hatching, the young nymphs become brown in colour. Instars are five in number. The nymph persists in sucking the sap until it becomes adult. It takes nearly 65 days to become an adult. Their three to five generations get ready in a year. The pest species appears in the cane field in March and remains active upto the beginning of severe cold. During September it causes maximum damage. It prefers soft varieties of canes, having broad, succulent and drooping leaves and with loose leaf sheaths.

Natural enemy complex : Parasites : *Ooencyrtus papilionis* Ashmead (Encyrtidae), *Tetrastichus pyrillae* Crawford (Eulophidae), *Lestodrynus pyrillae* Kieffer, *Drynius pyrillae* Kieffer and *Epipyrops melanoleuca* Fletcer (Epipyropidae). Predators : The eggs and nymphs are attacked by lady bird beetles namely *Brunoides suturalis* (Fabricius), *Menochilus sexmaculatus* Fabricius and *Coccinella septempunctata* Linnaeus (Coccinellidae).

Distribution : India : Bihar, Haryana, Uttar Pradesh, West Bengal, Southern part.

Elsewhere : Afganistan; Burma; Pakistan; Sri Lanka; Thailand.

Remarks : Both the nymphs and adults suck the cell-sap usually from the undersurface of the leaves. It is a sporadic pest and causes considerable damage in all cane-growing bells of India. It appears in the field as serious epidemic form generally in Uttar Pradesh and the adjoining areas of the Punjab. The sugarcane leaf hopper is distributed throughout India and appears periodically as a destructive pest of sugarcane in Pakistan Punjab, Haryana and Rajasthan.

Management : Following cultural practices should be employed to minimise the pyrilla attack on sugarcane : (1) the egg masses should be collected and destroyed,

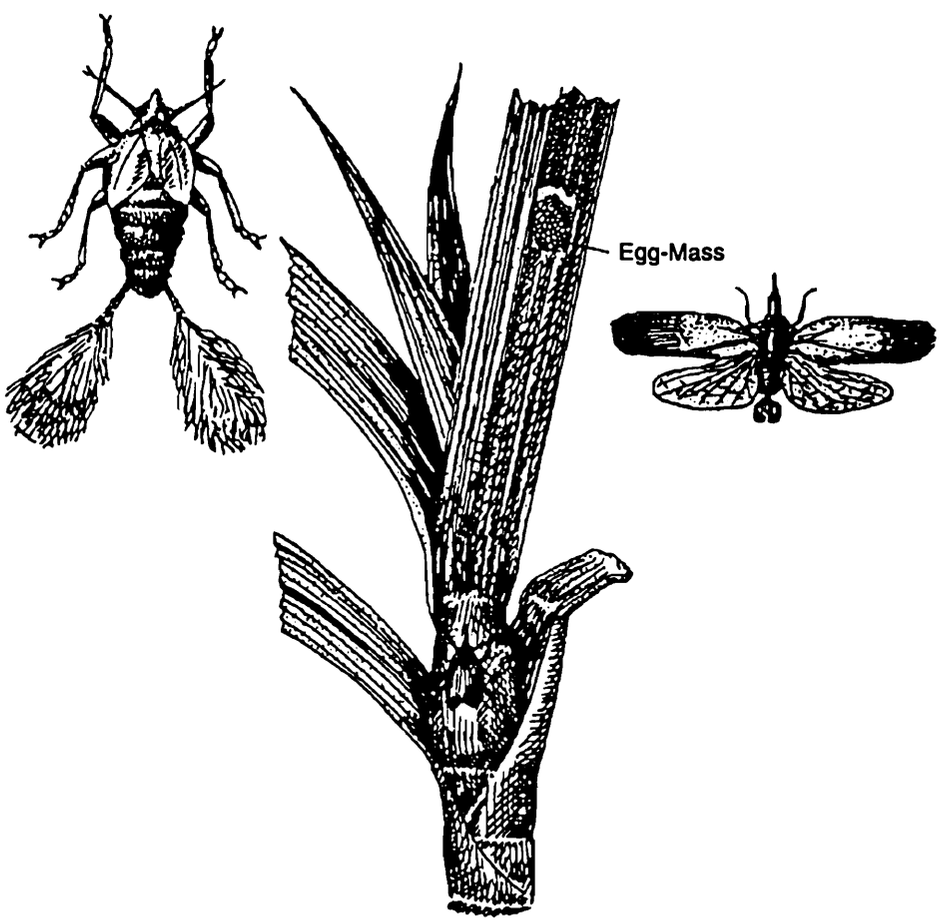


Fig. 345. *Pyrilla perpusilla* (Life cycle)

(ii) the cane-trash should not be burnt after harvesting as it kills their natural enemies, (iii) the amount of nitrogen fertiliser in soil should be kept moderate as high nitrogen content in soil makes the leaves succulent and attractive for the hoppers, (iv) resistant varieties of sugarcane should be planted, (v) for its biological control, its egg parasitoid, *Tetrastichus pyrillae* and the ectoparasitoid moth *Epiricania melanoleuca* (15000 cocoons/ha.) should be introduced in the infested fields, (vi) if 20-30% nymphs and 40-60% adults are parasitised, application of any insecticide should be avoided, and (vii) if the crop is heavily infested before monsoon, endosulfan 35 EC @ 1.5 ml/1 of water should be sprayed.

Subfamily FLATINAE

Genus 5. ***Phyllyphanta*** Amyot and Servielle

1843. *Phyllyphanta* Amyot and Servielle, *Mem.*, : 522.

Type species : ***Phyllyphanta producta*** **Spinola**

Diagnosis : Head narrower than pronotum; vertex somewhat produced in front, ridged centrally; face longer than broad, base angularly narrowed; pronotum extends before the anterior margins of eyes, centrally carinate; mesonotum tricarinate; clypeus obliquely striate; posterior tibiae bispinose; tegmina about as broad as wings, apically ampliate, costal margin arched and convex, apical margin truncate; tegmen transversely reticulate except on apical margin; clavus transversely veined above the claval vein; wings with one or two transverse veins near apex.

5. ***Phyllyphanta sinensis*** Walker
(Fig. 346, 347)

1851. *Phyllyphanta sinensis* Walker, *List Hom.* ii : 451.

1906. *Phyllyphanta sinensis* : Distant, *Fauna Brit. India,* **3** : 415. Synonym .: *Perkinsiella sinensis* Kirkaldy

1976. *Perkinsiella sinensis* : Nayar, Ananthakrishnan and David, General and applied Entomology : 189.

Diagnosis : Head, narrower than pronotum, vertex subacutely produced in front; head, pronotum and mesonotum virescent; margian and central carination to pronotum darker green; mesonotum pale testaceous, the lateral areas darker green; abdomen, face, body beneath, and legs pale greenish-ochraceous; tegmina creamy-white with the venation very pale ochraceous, costal membrane and apical area more virescent, a series of very small fuscous spots on apical margin extending to apex of costal margin and to apical third of posterior margin; wings creamy-white; pronotum with lateral margins granulose.

Length : 22 mm (with expanded tegmen).

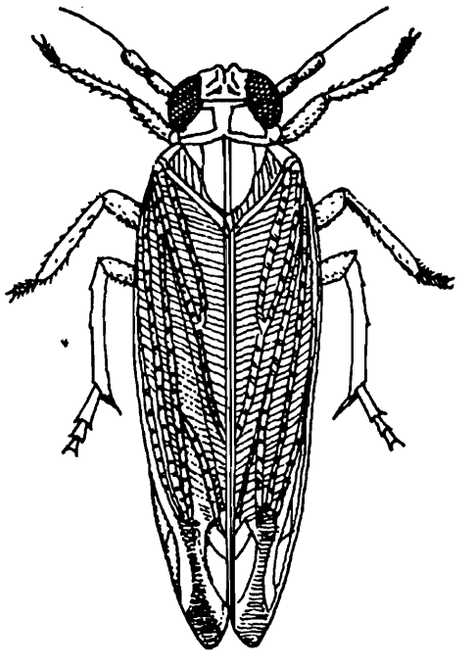


Fig. 346. *Phyllyphanta sinensis* Walker

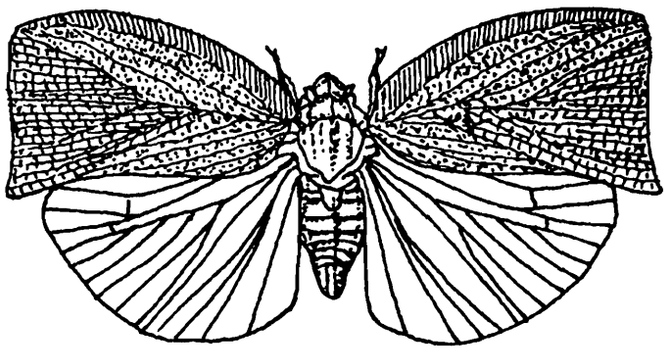


Fig. 347. *Phyllophanta sinensis* Walker showing wing expanse.

Distribution : India : Rice growing areas.

Elsewhere : Burma; Cambodia; Celebes, China; Srilanka.

Remarks : The bug infests rice in India.

Management : As in case of *Pundaluoya simplicia* Distant.

Minor pests (Delphacinae) :

(i) *Nilaparvata bakeri* (Muir) : It is slightly larger and darker than *N. lugens.* It is widely distributed in Asia and has been recorded from India, China, Sri Lanka, Taiwan, Indonesia, Korea, Thailand, West Malaysia, Japan and the Philippines. Apart from Rice fields, the species has been reported to feed on *Leersia* spp. (Mochida and Okada, 1979).

(ii) *Sogatella vibix* (Haupt) : It has been implicated in the transmission of rhabdo virus of finger millet, *Eleusine coracana* in India (Yaraguntaiah and Keshavamurthy, 1969). The species has been recorded as a pest of rice in Egypt and is a vector of maize rough dwarf virus in the middle east.

(iii) *Laodelphax striatellus* (Fallen) : Commonly known as "Smaller brown plant hopper." Though it is a severe pest of rice in China, Japan, Korea and Europe has been also recorded in India (Shukla, 1979). It is a vector of black-streaker dwarf virus and stripe virus in rice and rough dwarf virus in maize.

(iv) *Unkanodes sapporonus* (Matsumura) : It was recorded in India during December 1967 to March 1968 on rice under non-irrigated condition in the fields of Central Rice Research Institute, Cuttack, in association with white-backed plant hopper. It attacked the lower leaves which became greenish yellow, yellowish and then dried up completely (Misra and Isreal, 1968; Misra, 1975). The species is known from Korea, Japn, China, Taiwan, Soviet Maritime Territory and India.

(v) *Tagosodes pusanus* (Distant) : This is a minor pest of rice in Asia and is known from India, Sri Lanka, Philippines, Taiwan, China, Indonesia, Malaysia and Pakistan.

(vi) *Euidellana celadon* Fennah : It is rarely found in rice fields of India, Sri Lanka and the Philippines (Wilson and Claridge 1991). The species is cheracterised by dark brown veins on the forewings.

(vii) *Nisia nervosa* (Motschulsky) (Meenophlidae : Hemiptera) : Commonly known as white striated plant hopper. The characteristic feature of this bug is the granulated veins in the forewing clavus and the tent-like forewings when folded over the body. The mirid bug *Cyrtorhinus lividipennis* predates on this bug. In Tamil Nadu, an indet. nematode was found to attack the bug during winter (Jayanthi *et al.* 1987).

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INSECTA : HEMIPTERA : HOMOPTERA : MEMBRACIDAE

The tree hoppers (Fig. 348) are members of the family Membracidae (Auchenorhyncha : Homoptera) and constitute one of the largest families in the order Hemiptera. The group is economically important. They are considered close to Leaf hoppers (Cicadellidae) from which they differ in having great development of the pronotum, particularly its pronotal process. These insects can be diagnosed by ocelli placed between the eyes, antennae inserted in front of head and between eyes, pronotum prolonged backward into a hood or process of variable length and structure. They suck the plant sap with the help of their piercing and sucking type of mouth parts. They are further diagnosed by the presence of mesopleural processes. Horn-like processes of the pronotum very often assuming curious shapes in different species, have earned the name "Cow Bugs" or "Horn Bugs" Although endowed with powers

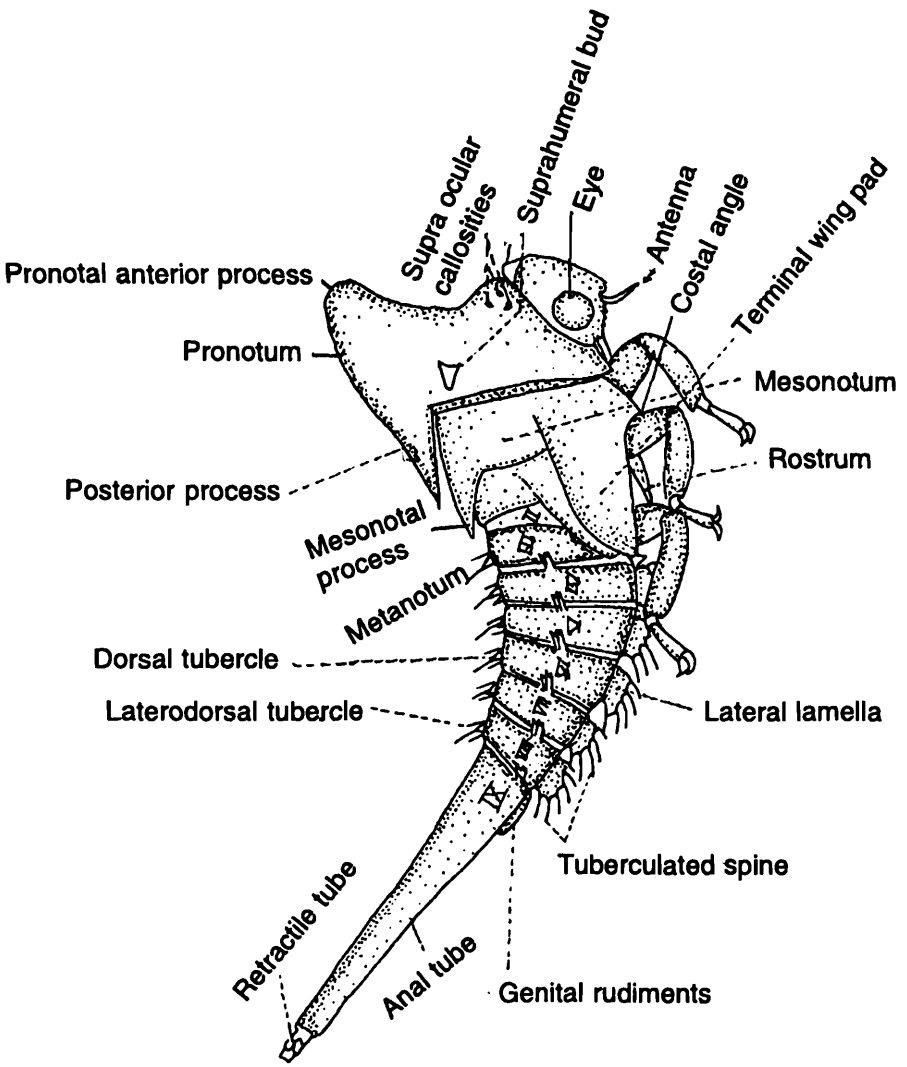


Fig. 348. A Generalised Fifth Instar Nymph of Membracidae (Lateral view)

of flight, these insects prefer to hop about on disturbance and this habit has earned them the popular name—"tree hoppers" Membracids colonise on a number of plant species. They are both solitary and gregarious in habit but very sluggish and rarely fly. On the whole, membracids in India are not destructive to the extent of assuming the pest status, though some injury to host plants is inflicted either due to feeding or oviposition.

In the recent years treehoppers have been gaining importance as pests of economically important plants, often causing direct damage by desapping them.

The group represents about 2300 species in the world. A little over 200 species are so far known from India. Important contributions are : Buckton (1903); Distant 1908, 1916; Funkhouser 1922, 1929, 1933; 1951; Lefroy 1919; Ananthasubramanian and Ananthakrishnan 1975a, 1975b; Paiva 1917; Goding 1903, 1926, 1931, 1934, 1939; Evans 1948; Menon and Das 1958; Metcalf and Wade 1965; Dutta *et al.* 1978; Ananthasubramanian, 1978, 1980a, 1980b, 1982, 1984, 1996; Thirumalai & Ananthasubramanian 1981, 1985; Ananthasubranamian and Ghosh 1987a, 1987b; Biswas *et al.* 1994; Ghosh *et al.* 1986, 2000.

SYSTEMATIC ACCOUNT

Subfamily 1 OXYRHACHINAE

Tribe I OXYRHACHINI

Genus 1 ***Oxyrhachis*** Germar

1. *Oxyrhachis taranda* (Fabricius)

Subfamily 2 CENTROTINAE

Tribe II TRICENTRINI

Genus 2 ***Tricentrus*** Stal

2. *Tricentrus bicolor* Distant
3. *T. congestus* (Walker)

Tribe III LEPTOCENTRINI

Genus 3 ***Leptocentrus*** Stal

4. *Leptocentrus taurus* Fabricius

Genus 4 ***Otinotus*** Buckton

5. *Otinotus elongatns* Distant
6. *Otinotus mimicus* Distant
7. *Otinotus oneratus* (Walker)

Tribe IV CENTROTINI

Genus 5 ***Anchon*** Buckton

8. *Anchon pilosum* (Walker)

Key to Subfamilies

1. Scutellum completely concealed by sides of pronotum; propleural and metapleural processes developed; tibiae foliaceous ..... OXYRHACHINAE

— Scutellum not completely concealed by sides of pronotum; propleural and metapleural processes absent; pronotum with posterior process .... CENTROTINAE

Subfamily 1 OXYRHACHINAE

Tribe I OXYRHACHINI Distant

Posterior pronotal process long and narrow, broad at base, extending beyond posterior angle of inner margin of tegmina; wings with 3 to 4 apical cells; tibiae dilated; sides of the pro-and mesonotum are armed with a small lobe or tooth.

Genus 1 ***Oxyrhachis*** Germar

1835. *Oxyrhachis* Germer, *Rev. ent. Silb.*, **3** : 232.

Type species : *Membracius taranda* Fabricius

Diagnosis : Head wider than long; mouth a little elevated; eyes large and globate; ocelli equidistant from each other and located above the centro-ocular line; pronotum with the lateral angles more or less produced; posterior process tricarinate, long, narrow, broad at base, with or without a ventral carina or keel on apical half; wings with 3 or 4 apical cells and tegmina with 5 apical and 3 discoidal cells.

Remark : The genus is predominant in Oriental and Ethiopian regions.

1. ***Oxyrhachis taranda*** (Fabricius)
(Fig. 349, 350)

1798. *Membracis taranda* Fabricius, *Ent. Syst. Suppl.*, : 514.

1803. *Centrotus tarandus* Fabricius, *Syst. Rhyng.*, : 19.

1835. *Oxyrhachis tarandus* Germar, *Res. ent. Silb.*, **3** : 232.

1903. *Polocentrus rufus* Buckton, *Mon. Memb.* : 254.

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1996. *Oxyrhachis taranda* : Ananthasubramanian, *Fauna of India* : Membracidae, Zoological Survey of India, Calcutta : 50.

Diagnosis : Head frontally piceous, vertex nearly twice as wide as long, sparsely covered with hairs; ocelli equidistant from each other and located on centro ocular line; pronotum with a central longitudinal carination which traverses the length of the posterior process; posterior process extending beyond the tips of tegmina, upwardly recurved, beneath laminately ampliate and finely serrate; tegmina dull hyaline, the veins fuscous; legs pilose. *Genitalia* : Male plate (Fig. 350A) robust, lateromedially deeply emarginate, apex smoothly rounded, mesal margin bifurcate from beyond the middle, lateral margin with a row of long hairs, ventral surface densely setose. Pygofer simple. Stylar shaft (Fig. 350B) deeply concavous, apex hood-shaped, with a few minute setae on surface. Aedeagus (Fig. 350C) cylindrate, surface nodulate, apex smooth, rounded with a few minute hairs apically.

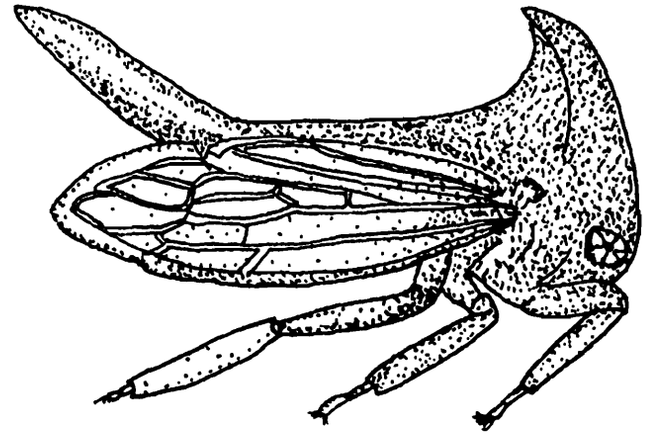


Fig. 349. *Oxyrhachis taranda* (Fabricius) : Female, lateral view.

Length : 4.5 mm (♂) 6.5 mm (♀)

Host plants : *Acacia arabica, Prosopis spicigera, Cassia spp., Peltophorum sp., Cuesalpina coriaria, Sesbania grandiflora, Erythrina indica.*

Distribution : India : allover.

Elsewhere : Africa; Algeria; Arabia; Europe; France; Germany; Northern Asia; Oriental; Tunisia.

Remark : The membracid species is a gregarious one living with other gregarious species as both nymphs and adults. This is a minor pest on pigeon pea and very common species abundantly found throughout India including Calcutta where it is recorded in good numbers during September and February. This species is predominant in south India but rather rare in western India. The species can easily be recognised by its large size, dark brown colour and thickly punctate body with the posterior pronotal process curved up from the apex of wings, the anterior lateral processes in the form of short tricarinate throns. It breeds upon Babul (*Acacia arabica*), Labrum (*Casia fistula*) Pigeon pea (*Cajanus indicus*) etc. where the female usually attends the eggs untill they hatch (Lefroy 1917).

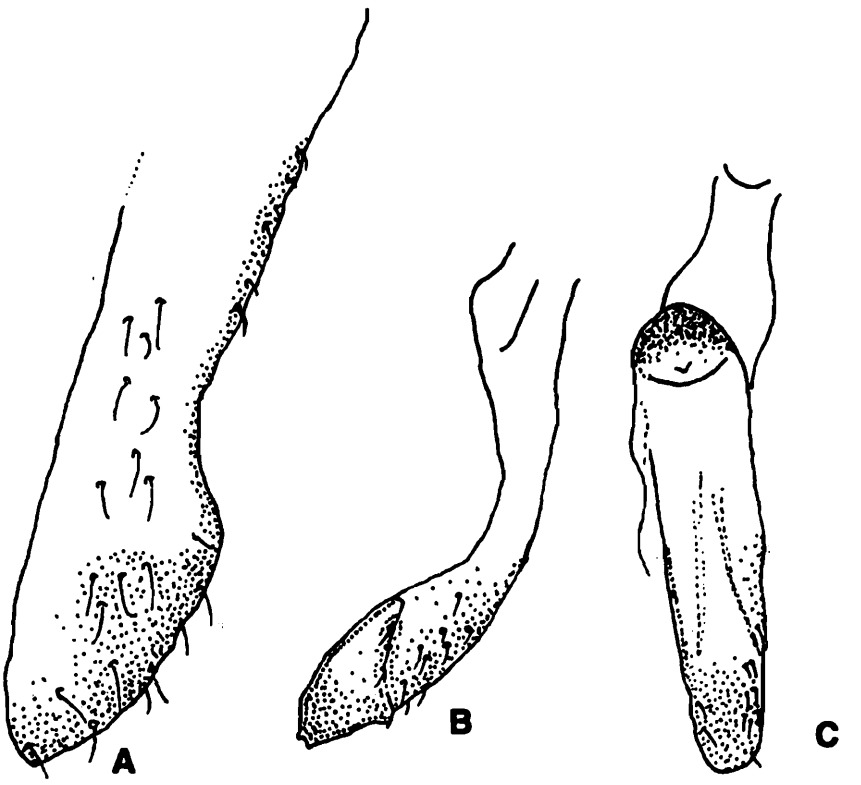


Fig. 350. *Oxyrhachis taranda* (Fabricius) : A. Male plate; B. Style; C. Aedeagus.

Biology : The female lays eggs (48-240) in two rows at an angle on the twigs of one or two years old slender twiners of the host plant. 7-10 days after oviposition the nymphs emerge. After emergence, a nymph becomes adult through 5 instars covering about 30 days. The ant *Camponotus compressus* attends these membracids.

Subfamily 2 CENTROTINAE

Key to the tribes of the Subfamily CENTROTINAE

1(2) Pronotum with or rarely without suprahumeral horns; hind trochanters armed internally with teeth ..... **Tricentrini**

2(1) Pronotum with suprahumural horns, hind trochanters unarmed 3

3(4) Hind wing with 4 apical cells ..... **Leptocentrini**

4(3) Hind wing 3 apical cells ..... **Centrotini**

Tribe II TRICENTRINI Ahmed & Yasmeen

Scutellum normal and exposed; hind wings with three apical cells; a distinct pterostigma may be present or absent; frontoclypeal lobes either partially or completely fused to the frontoclypeus on their inner margins. Hind trochanters elevated into a disc inwardly, armed with spines.

Genus 2 ***Tricentrus*** Stal

1866. *Tricentrus* Stal, *Hem. Afr.*, **4** : 89.

Type-species : *Tricentrus convergens* Walker

Diagnosis : Body rather ovate, head about three times wider than long, obliquely directed backwards, upper margin of vertex arcuate and sinuate, eyes subglobate; ocelli nearer to eyes than to each other; pronotum with posterior process longer than broad; lateral angles prominent; posterior process moderately short, contiguous with scutellum; tegmina with 5 apical and two discoidal cells, hind wings with 3 apical cells. Scutellum as wide as long concavely emerginate, hind trochanters elevated into a disc inwardly, armed with spines.

Remark : The genus is predominant in oriental and Ethiopian regions.

Key to the species of *Tricentrus* Stal

1(2) 1st discoidal cell petiolate; suprahumeral horns as long as the space between their bases..... *bicolor*

2(1) 1st discoidal cell not petiolate; suprahumeral horns shorter than the space between their bases ..... *congestus*

2. ***Tricentrus bicolor*** Distant
(Figs. 351, 352)

1908. *Tricentrus bicolor* Distant, *Fauna Brit. India,* **4** : 55.

1979. *Tricontrus bicolor* : Ahmad and Yasmeen, *Oriental Ins.,* **12**(4) : 537.

1996. *Tricentrus bicolor* : Ananthasubramanian, Fauna of India : Membracidae, Zoological Survey of India : 76.

Diagnosis : Head vertical, very finely punctate, densely pubescent, vertex about twice as wide as long, upper margin arcuate, lower margin broadly rounded; eyes large, brown; ocelli black, closer to eyes than to each other; frontoclypeus narrow at base; pronotum black, thickly coarsely punctate; supraochler callosities prominent, jet black, impunctate; humeral angles large, black, extending beyond the level of eyes; suprahumaral horns as long as the space between their bases; posterior process short, robust, centrally and laterally carinate, tegmina bronzy ochraceous, basal area black, punctate; 1st apical cell 5.0 times as long as wide, 1st discoidal cell petiolate, apical limbus broad. Legs with femora except their apices black. *Genitalia* : Male plate simple as figured (Fig. 352A); pygofer (Fig. 352B) also simple. Style (Fig. 352C) slender, shaft on lateral margin setose, apex hooked-shaped, apical third narrowed, base cymbiform, elevated margin on one side serrate from middle upto apex. Aedeagus (Fig. 352D) slender, geniculate at base, gradually tapering, serrations along the line of curvature.

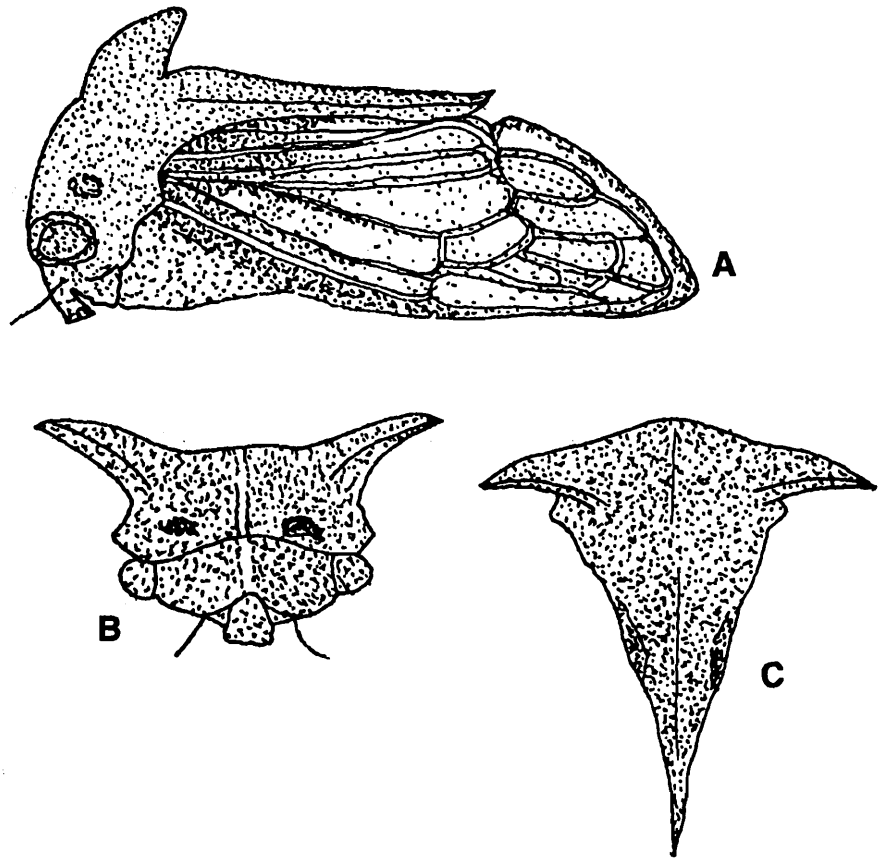


Fig. 351. *Tricentrus bicolor* Distant (Female) : A. Lateral view; B. Frontal view of head and pronotum; C. Dorsal view of pronotum.

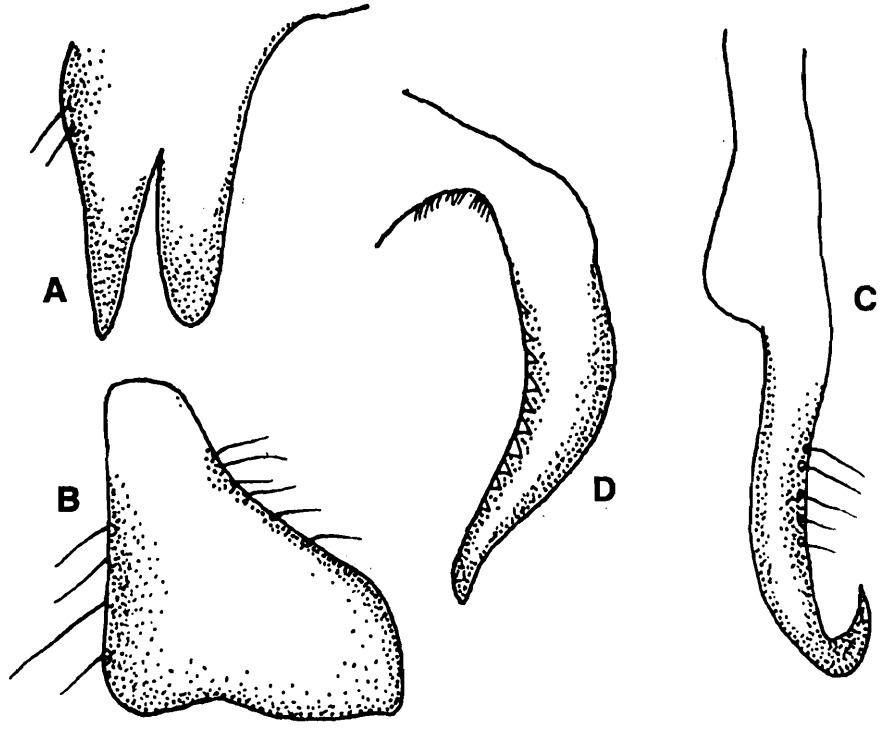


Fig. 352. *Tricentrus bicolor* Distant (Male) : A. Male plate; B. Pygofer; C. Style; D. Aedeagus.

Length : 5 mm (female); 4 mm (male).

Alternative hosts : Bhendi, cereals, cotton, brinjal, potato, tomato, various fruit trees and wild grasses.

Symptom and Damage : Both nymphs and adults suck the plant sap and exude honeydew which attracts the black ant *Camponotus compressus*. The damage caused is seldom severe.

Biology : After copulation the female selects the lower surface of the tender branches of the plant not exposed to the sun directly and oviposits. Eggs may be laid along the midribs of the plant, petiole or lamina of leaf of the host plant. The female cuts a longitudinal slit on the bark and inserts the eggs, the first few being embedded completely, and the subsequent ones appear only partly within. The eggs lie parallel to the twig or arranged obliquely in two rows. A freshly laid egg is translucent and pale green but changes to clark brown later, measuring about 0.13 mm × 0.15 mm. Incubation period ranges from 8 to 13 days. The nymphs after emerging, remain congregated in the axils of the branches or near mid ribs of leaves on abaxial sides and suck the cell sap with the help of piercing and sucking type of month parts. The newly hatched nymph is sedentary, more or less soft-bodied and shining greenish brown in colour. The 5th instar nymph is brown with lateral dark bands. The membracid undergoes five moults with 33-55 days.

Distribution : India : Maharashtra, Uttar Pradesh : Dera Dun, Mussorree, Garhwal.

Elsewhere : Bangladesh; Pakistan.

Remarks : This membracid is usually known as 'CowBug' The species closely resembles *Tricentrus gibbosulus* (Walker) in the nature of suprahumeral horns and posterior process but can be separated from the same in having obliquely projecting horns and also by the presence of petiole for the 1st discoidal cell of tegmina.

Management : Lindane, phosphamidon and malathion give good result.

3. ***Tricentrus congestus*** (Walker)
(Fig. 353)

1858. *Centrolus congestus* Walker, *Ins. Sound. Hom.*, : 79.

1908. *Tricentrus congestus* : Distant, *Fauna Brit. India,* **4** : 54.

1934. *Otaris congestus* : Goding, *Jt. N. Y. ent. Soc.,* **42** : 480.

1975. *Tricentrus congestus* : Ananthasubramanian and Ananthakrishnan, *Rec. zool. Surv. India,* **68** : 231.

1996. *Tricentrus congestus* : Ananthasubramanian, *Fauna of India* : Membracidae, Zoological Survey of India, Calcutta : 81.

Diagnosis : Body brown; head, pronotum, body beneath and legs piceous, "thickly ochraceously pilose"; head about twice as wide across extremities of eyes as length of

vertex; eyes moderately large, dull ochraceous; ocelli slightly closer to eyes than to each other; pronotum dark brown, finely punctate, lateral pronotal processes somewhat long, moderately broad, obscurely carinate behind middle; tegmina pale bronzy brown, about thrice as long as wide, 1st discoidal cell not petiolate, slightly longer than the 2nd; legs black up to tibiae (reddish brown), tarsi light brown.

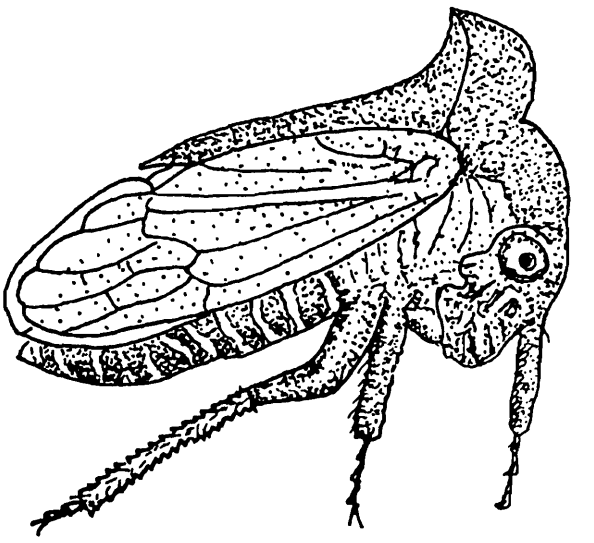


Fig. 353. *Tricentrus congestus* (Walker) (after Ananthasubramanian)

Length : 5.5 mm.; pronotal process 3 mm.

Host plant : *Vernonia* spp.

Distribution : India : Tamil Nadu, Uttar Pradesh, West Bengal.

Elsewhere : Burma; China; Malaysia; Philippine Islands; Singapore; Sula Islands.

Remark : The species is characterised by its suprahumeral horns being longer and broader. It is attended by the ant *Camponotus compressus.*

Tribe III LEPLOCENTRINI

Scutellum fully exposed; hind wings with 4 apical cells; frontoclypeal lobes prominent.

Key to the genera of Leptocentrini

1. Posterior process slender, not arcuate, base of posterior process apart from scutellum ..... ***Otinotus***

— Posterior process rather stout, arcuate, base of posterior process very close to scutellum and tegmina. .....***Leptocentrus***

Genus 3 ***Leptocentrus*** Stal

1866. *Leptrocentrus* Stal, *Hem. Afr.*, **4** : 87-90.

Type species : Centrotus altifrons Walker

Diagnosis : Upper margin of vertex arcuate and sinuate; eyes hemispherical; ocelli closer to eyes; pronotum with anteriorly produced transverse processes; posterior process slender, tricarinate, well separated from the scutellum and abdomen; scutellum triangular about as wide as long, apex emarginate; tegmina without pterostigma, with five apical cells and two discoidal cells; hind wing with 4 apical cells.

4. ***Leptocentrus taurus*** Fabricius
(Fig. 354)

1775. *Leptrocentrus taurus* Fabricius, *Syst. Ent.*, : 675.

1908. *Leptrocentrus taurus* : Distant, *Fauna, Brist, India,* **4** : 25-29.

1975. *Leptrocentrus taurus* : Ananthasubramanian and Ananthakrishnan, *Rec. zool. Surv. India,* **68** : 195-201.

1986. *Leptrocentrus taurus* : Ghosh, L.K., Biswas and Das, *Rec. zool. Surv. India,* **83**(1&2) : 103.

1989. *Leptrocentrus taurus* : Ghosh, L.K., Biswas, Chakraborty and Sen, *In* : *Fauna of Orissa, State Fauna Series,* **1**(Part 2) : 199.

1996, *Leptrocentrus taurus* : Ananthasubramanian, Fauna of India : Membracidae, Zoological Survey of India, Calcutta : 187.

1997. *Leptrocentrus taurus* : L. K. Ghosh *et al., Fauna of Delhi, State Fauna Series,* **6** : 245. Zool. Surv. India.

Diagnosis : Head about three times wider than long; basal margin of vertex, lateral margins obliquely sloping downwards, ocelli black, nearer to eyes than to each other; suprahumerals robust, strongly curved; pronotum black, thickly punctate; posterior process strongly tricarinate above, abruptly elevated from near base passing beyond 5th apical cell, apex black; tegmina pale bronzy, ochraceous, base and apical half of costal margin black, three and a half times longer than wide; hind wing with 4 apical cells; scutellum as broad as long; tip narrowly emerginate; tibiae reddish brown.

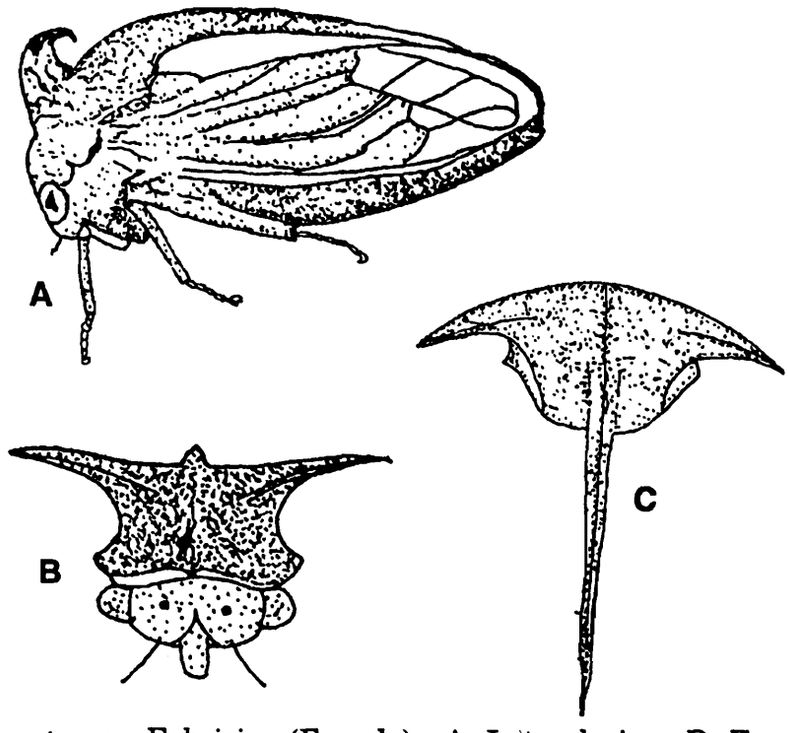


Fig. 354. *Leptocentrus taurus* Fabricius (Female) : A. Lateral view; B. Frontal view of head and pronotum; C. Dorsal view of pronotum

Length : 6-8 mm.; width of lateral pronotal process 5-6 mm.

Biology : The female lays 18-27 eggs on young and woody twigs of the host plant. The duration of egg-stage is 6-14 days; the nymphal stages (5) include 25 days. The species is solitary on different hosts but living together on the same host plant.

Distribution : The species is predominant in Oriental and Ethiopian region and abundantly found in South and Eastern India in comparison to Western India.

Elsewhere : Borneo; Burma; East Indies; Malaysia; Philippines; Sri Lanka.

Host plants : *Abrus precatorius, Arachis hypogaea, Butea frondosa, Canavalia ensiformis, Clitoria ternatea, Crotalaria juncea, Crotalaria verrucosa, Cyamopsis tetragonoloba, Dolichos biflorus, Erythrina indica, Lablab purpureus, Lathyrus aphaca, Lathyrus odoratus, Phaseolus mungo, Sesbania aegyptiaca,* (N.O. Fabaceae); *Cassia auriculata, Cassia fistula, Caesalpinia coriaria, Caesalpinia pulcherrima, Parkinsonia aculeata, Poinciana regia, Tamarindus indicus* (N.O. Caesalpiniaceae); *Acacia arabica, Albizzia lebbek, Mimosa rubicaulia, Parkia biglandulosa, Prosopis juliflora, Prosopis spicigera,* (N.O. Mimoceae); *Psidium guajava* (N.O. Myrtaceae); *Cinnamomum zeylanicum* (N.O. Lauraceae); *Capparis sepiaria, Crataeva religiosa* (N.O. Capparidaceae); *Zizyphus jujuba, Zizyphus oenoplia,* (Rhamnaceae); *Ipomea biloba* (N.O. Convolvulaceae); *Hibiscus rosasinensis, Gossypium herbaceum, Sida cordifolia* (N.O. Malvaceae), *Casuarina equisetifolia* (N.O. Casuarinaceae), *Datura fastuosa, Eronthimum sp, Lycopersicum esculentum, Solanum melongena, Solanum nigrum, Solanum torvam, Solanum trilobatum* (N.O. Solanaceae), *Feronia elephantum, Murraya koenigii* (N.O. Rutaceae), *Cissus quadrangularis* (N.O. Vitaceae), *Anacardium occidentale, Mangifera indica* (N.O. Anacardiaceae), *Morinda tinctoria* (N.O. Rubiaceae), *Artabotrys odoratissimus, Polyalthia longifolia* (N.O. Anonaceae).

Remarks : The insects are generally found sucking sap near the axils of the leaves and small twigs of the host plants. The species breeds on *Dalbergia sissu,* ber (*Zizyphus jujuba*) on brinjal (*Solanum melongena*) etc. Hymenopteran parasites are located from the eggs of the species. One of the diagnostic features of the species is the body which is more pigmented and punctate. *L. taurus* closely resembles *L. substitutus* in its general appearence, but the latter is rather smaller in size, its posterior process less arched at base, suprahumeral horns also less prominently recurved than in *L. taurus.* They are usually found attended by the common ant *Camponotus (Tanaemyrmex) compressus* Latr.

Genus 4 ***Otinotus*** Buckton

1903. *Otinotus* Buckton, *Monogr. Membrace* : 232.

Types species : *Otinotus ammon* Buckton

Diagnosis : Pronotum with transverse lateral angle produced and either directed horizontally or forwardly, posterior process slender, sinuate, scarcely or only a little

separated from scutellum which is about as broad as long and its apex emarginate, central carination & posterior process continued through pronotum.

Key to the species of *Otinotus* Buckton

1(2). R1 of tegmina straight to subcosta, 1st apical cell long, narrow, not based on rs; suprahumeral horns longer than space between their basis 3

2(1) R1 of tegmina oblique to subcosta; 1st apical cell short, wedge-shaped and based on rs; suprahumeral horns shorter than the space between their bases .... *mimicus*

3(4) Apices of suprahumeral horns acute, piceous brown ..... *oneratus*

4(3) Apices of suprahumeral horns obtuse; suprahumeral horns upwardly directed and strongly recurved ..... *elongatus*

5. ***Otinotus elongatus*** Distant
(Figs. 355, 356)

1908. *Otinotus elongatus* Distant. *Fauna Brit. India.* **4** : 41.

1986. *Otinotus elongatus* : Ghosh L.K., Biswas and Das, *Rec. zool. Surv. India,* **83**(1&2) : 105.

1994. *Otinotus elongatus* : Biswas, Basu, Ghosh, L.K., *In* : *Fauna of West Bengal; State Fauna Series,* **3**(5), ZSI : 77.

1996. *Otinotus elongatus* : Ananthasubramanian, *Fauna of India, Homoptera : Membracidae,* Zoological Survey of India : 207.

Diagnosis : Body rather elongate and compressed; head about thrice as wide as long; vertex arcuate, eyes hemispherical, dark brown ocelli nearer to eyes than to each other and located on the centro ocular line. Pronotum very finely pilose; lateral processes moderately broad, upwardly directed and apically strongly recurved, laterally carinate, apices subacute, in front these processes are much narrower in appearance; posterior process long, sinuate, scarecely elevated above scutellum, its apex considerably passing posterior angle of inner margin of tegmina, tricarinate, the central carination continued through pronotum, tegmina semi hyaline, narrowly dull, piceously opaque at base, narrowly elongate, somewhat compressed; legs piceous brown. R1 straight to subcosta; scutellum long as wide, white tomentose. *Genitalia* : Male plate (Figs. 356A) broad at base, converging apically, emerginate lateromedially, apical margin truncate; ventral surface densely setose; sparsely spinulate on mesal margin. Pygofer simple. Stylar shaft (Fig. 356C) at the apex cuneiform with well developed rounded heel, lateral margin concavous ending as obtuse. Aedeagus (Fig. 356B) bent medially, directed posteriorly, 1/3 of inner margin serrate, densely nodulate on concave surface extending close to middle, gently twisted subapically.

Length : 6 mm (female); 5 mm (male)

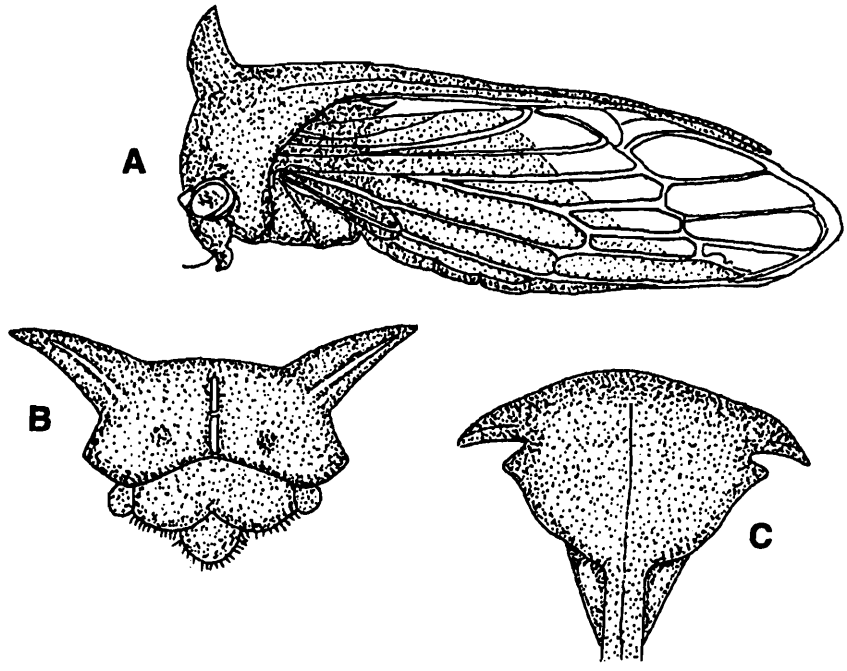


Fig. 355. *Otinotus elongatus* Distant (Female) : A. Lateral view; B. Frontal view of head and pronotum; C. Dorsal view of pronotum

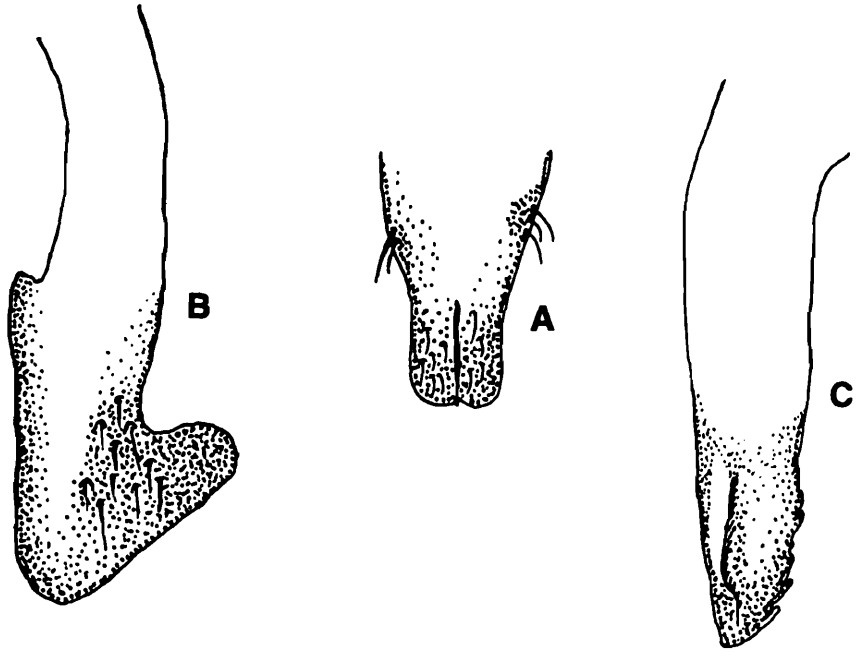


Fig. 356. *Otinotus elongatus* Distant (Male) : A. Male plate; B. Style; C. Aedeagus

Host plant : *Lagerstroemia* sp.

Distribution : India : Assam, Orissa, West Bengal, Karnataka, Kerala.

Remarks : The species is closely related to *O. pallescens* Distant but differs in having quite elongate and compressed body, the tegmina about 4 times as long as wide and the apices of suprahumeral horns subacute. It is a minor pest on jute (Sengupta and Behura 1957)

6. ***Otinotus mimicus*** Distant
(Fig. 357)

1916. *Otinotus mimicus* Distant, *Fauna Brit. India,* **6** : 159.

1975. *Otinotus mimicus* : Ananthasubramanian and Ananthakrishnan, *Rec. zool. Surv. India,* **68** : 217.

1996. *Otinotus mimicus* : Ananthasubramanian, Fauna of India : Membracidae, Zoological Survey of India : 210.

Diagnosis : Head dark brown, about 3.5 × as wide across extremities of eyes as length of vertex; ocelli equidistant from each other and from eyes; pronotum dark reddish brown, finely punctate; metopodium about 2 × as wide as high, convex, nearly vertical; suprahumeral horns short, stout, directed onward, apices slightly recurved, anterior carina strongly backwardly recurved; posterior process slender, emerging from posterior margin of pronotum, slightly raised, directed backward; scutellum triangular, wider than long, with a pair of white spots at the basal angles; tegmina about thrice as long as wide, pale ochraceous, basal area dark brown; 1st apical cell wedge-shaped; legs dark brown, tibiae yellowish brown, tarsi black towards apices.

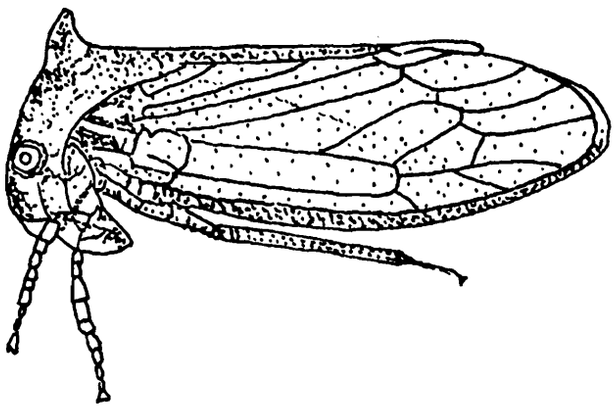


Fig. 357. *Otinotus mimmicus* Distant (Female) : Lateral view

Length : From frontal margin to tips of tegmina 8.0 mm; to tip of posterior process 6 mm.

Host plant : *Cytissus scoparius, Artocarpus integrifolia.*

Biological notes : The female lays usually 3-8 eggs on young and old twigs of the host plant. Nymphal period is about 23 days.

Distribution : India : Tamil Nadu (Nilgiri Hills).

Remark : This is a minor pest occurring in southern India.

7. ***Otinotus oneratus*** (Walker)
(Figs. 358, 359)

1858. *Centrotus oneratus* Walker, *Ins. Saund. Hom.,* : 78

1869. *Centrotypus oneratus* : Stl, *Ofv. Vet.-Ak. Forh.,* : 256.

1903. *Oxyrhachis lignicola* : Buckton, *Monogr. Membrace.,* : 261.

1908. *Otinotus oneratus* : Distant, *Fauna Brit. India,* **4** : 40.

1975. *Otinotus oneratus* : Ananthasubramanian and Ananthakrishnan. *Rec. zool. Surv. India,* **68** : 214.

1986. *Otinotus oneratus* : Ghosh, L.K., Biswas and Das, *Rec. zool. Surv. India,* **83**(1&2) : 104.

1994. *Otinotus oneratus* : Biswas, Basu and Ghosh L. K., *In* : *Fauna of West Bengal, State Fauna Series,* **3**(Part 5) : 77.

1996. *Otinotus oneratus* : Ananthasubramanian, *Fauna of India,* Homoptera : Membracidae, Zoological Survey of India : 213.

1997. *Otinotus oneratus* : L. K. Ghosh *et al., Fauna of Delhi, State Fauna Series,* **6** : 245.

2000. *Otinotus oneratus* : Ghosh, M., Biswas and Ghosh, L. K. Insecta : Hemiptera : Cercopoidea, Cicadelloidea. *In* : *Fauna of Tripura, State Fauna Series,* **7**(2) : 334.

Diagnosis : Head finely punctate, greyish, with short, nearly 3.0 × as wide across extremities of eyes as length of vertex, vertex nearly 2.0 × as wide as long, base of vertex shallowly arcuate, frontoclypeus 2.0 × as long as wide, sides parallel, tip truncately rounded, longly pilose, frontoclypeal lobes small, indistinct; eyes hemispherical, ocelli a little elevated, almost equidistant from each other and from eyes. Pronotum dark brown, supraocular callosities black, entire, bare; humeral angles broadly conical, apices obtuse; suprahumeral horns longer than space between their bases, flattened, basal areas darker, gradually narrowing from base to apex, directed outward and obliquely forward, tips slightly recurved; posterior process slender, gradually tapering from base to apex, tricarinate, apex acute, passing well beyond the tegmina, 3.0 × as long as wide, pale semihyaline, veins ochraceous, R_1 straight to subcosta, 1st apical cell long, narrow, parallel-sided, 7.0 × as long as wide, 2nd discoidal cell slightly longer than the 1st. Scutellum slightly wider than long, tip emarginate. Abdomen dark brown. Legs dark brown upto distal half of femora, tibiae brown, tarsi pale. *Genitalia* : Male plate (Fig. 359A) on inner margin united, caudal

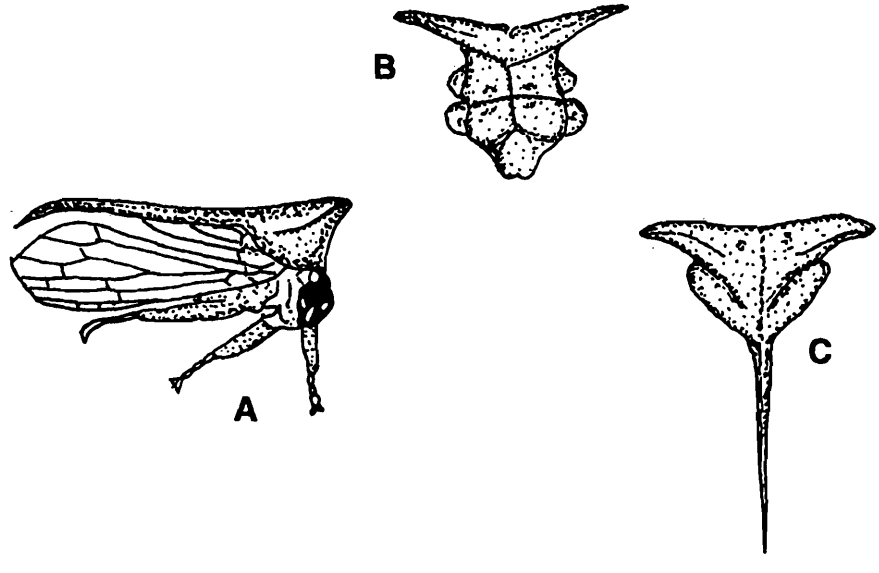


Fig. 358. *Otinotus oneratus* (Walker) Female : A. Lateral view; B. Frontal view of head and pronotum; C. Dorsal view of pronotum

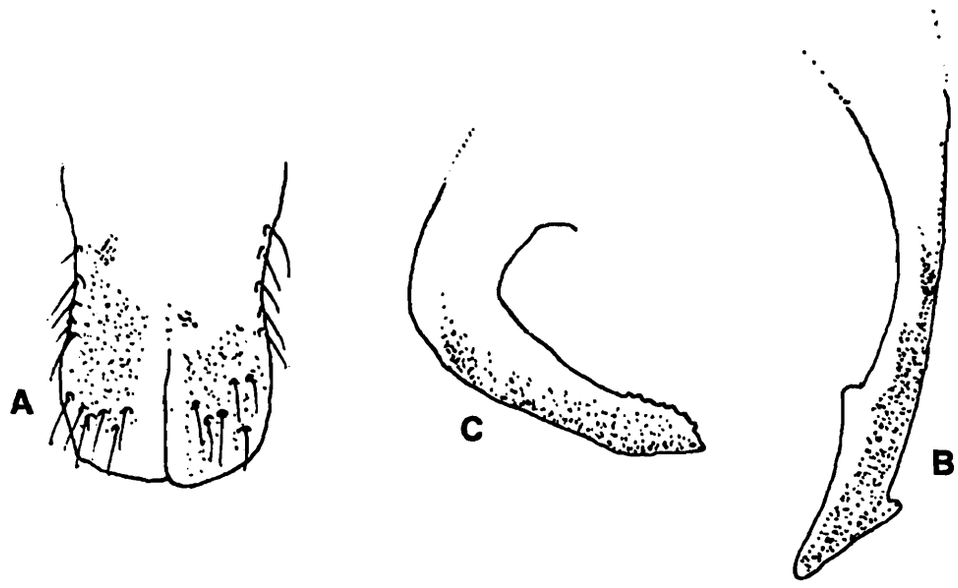


Fig. 359. *Otinotus oneratus* (Walker) Male : A. Male plate; B. Style; C. Aedeagus.

margin truncate, setose. Style as figured (Fig. 359B) Aedaegus (Fig. 359C) abruptly bent at base, shaft tapering distally, strongly serrate on dorsal aspect, serration near apex distinct.

Length : 5-7 mm (Female), 4.5-5.5 mm (Male); lateral pronotal process 3-3.5 mm.

Host plants : *Cajanus cajan, Crotalaria juncea, Lablab purpureus, Bauhinia purpurea, Bauhinia tomentosa, Bauhinia variegata, Caesalpinia coriaria, Caesalpinia pulcherrima, Cassia augustifolia, Cassia marginata, Citrus* sp. *Tamarindus indicus, Prosopis spicigera Prosopis juliflora, Bauhinia tomentosa, Pithecolobium dulce, Enterolobium saman, Cestrum diurnum, Cestrum nocturnum, Datura fastuosa, Eugenia jambolana, Solanum lycopersicum, Solanum torvum, Zizphus jujuba, Zizphus oenoplia, Aegle marmelos, Anona reticulata, Feronia elephantum, Capparis sepiaria, Morinda tinctoria, Morinda citrifolia, Thespesia populnea, Lagerstroemia flosreginae, Psidium guajava, Ficus religiosa, Fiscus bengalensis, Atrocarpus integrifolia, Mangifera indica.*

Biology : The female of the species lays 3-16 eggs on young or old twigs of the host plant. The eggs are laid in irregular clusters often on row being partially or entirely overlapped by another. The incubation period is 7-13 days. After emergence, one nymph involves 5 instars. It takes about a month to become adult. It is gregarious in habit and lives with other gregarious ones as both nymphs and adults.

Distribution : India : throughout.

Elsewhere : Sri Lanka.

Natural enemy : *Indoxenos* species (Insecta : Strepsiptera).

Remarks : This species resembles *Otinotus pallescens* Distant in size and in the long posterior process scarcely raised above scutellum and its apex considerably passing the posterior angle of the inner margin of tegmina. But can be easily separated in the

general colour including tegmina and its veins and in the apices of supra humeral horns which are acute. This is the most common species of Membracidae and is found all over the country on a variety of host plants. They are most abundant during monsoon and autumn. The species is attended by the ants *Camponotus compressus* and *Crematogaster* spp. It is a minor pest of cotton.

Tribe IV CENTROTINI

The scutellum is always exposed and well developed; hind wing with three apical cells; frontoclypeal lobes fused to frontoclypeus on their inner margins for almost its entire length; tegmina with a well developed pterostigma at R1.

Genus 5 ***Anchon*** Buckton

1903. *Anchon* Buckton, *Monogr. Membrac.* : 214.

Type species : *Centrotus nodicornis* Germar

Diagnosis : Scutellum about as broad as long; pronotum above lateral angles produced into strong processes directed obliquely upward and at apices strongly recurved, posterior process rising obliquely near base of pronotum and then rectangularly directed to about posterior angle of the inner margin of tegmina having five apical areas.

8. ***Anchon pilosum*** (Walker)
(Fig. 360, 361)

1851. *Centrotus pilosus* Walker, *List. Hom.*, **ii** : 606.

1869. *Xiphopoeus pilosus* : Stal, *Ofv. Vet. Ak. Forh.*, : 285.

1903. *Platybelus pilosus* : Melichar, *Hom. Faun. Ceylon* : 119.

1908. *Anchon pilosum* : Distant, *Fauna Brit. India*, **4** : 49.

1996. *Anchon pilosum* : Ananthasubramanian, *Fauna of India* : Homoptera : Membracidae, Zoological Survey of India : 239.

Diagnosis : Head (Fig. 360) densely pilose with greyish hairs, thrice as wide across extremities of eyes as length of vertex, vertex about twice as wide as long, upper margin arcuate and sinuate, lower margins obliquely continued to frontoclypeus; ocelli closer to eyes than to each other and situated above c-o line; frontoclypeus densely pilose, apex broadly rounded; pronotum densely pilose metopidium densely longly pilose, vertical, supraocular

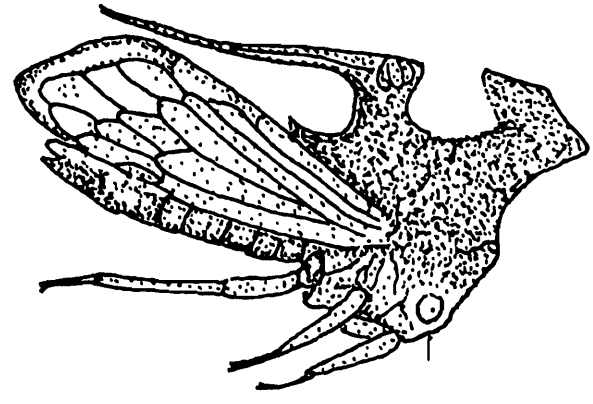


Fig. 360. *Anchon pilosum* (Walker) : Lateral view.

callosities obsolete; humeral angles prominent, suprahumeral horns twice as long as space between their bases, thickly pilose at basal area, posterior process obliquely erect at base and then obliquely sinuately directed backward, extends a little beyond the posterior angle of the inner margin of tegmina, strongly centrally ridged above, tegmina thrice as long as wide, greyish, semi-opaque, tale-like; pterostigma black, prominent, 1st apical cell partially encroached by pterostigma, 1st and 2nd discoidal cell subequal; legs pale testaceous, greyish, pilose. *Genitalia* : Male plate (Fig. 361A) rather concave on lateral margin, setose, bluntish apically, subapically rugulose; style (Fig. 361B) slender, swollen basally, stylar shaft uniformly narrowed, setose, apex somewhat foot-shaped; aedeagus (Fig. 361C) curved basally, anteriorly directed.

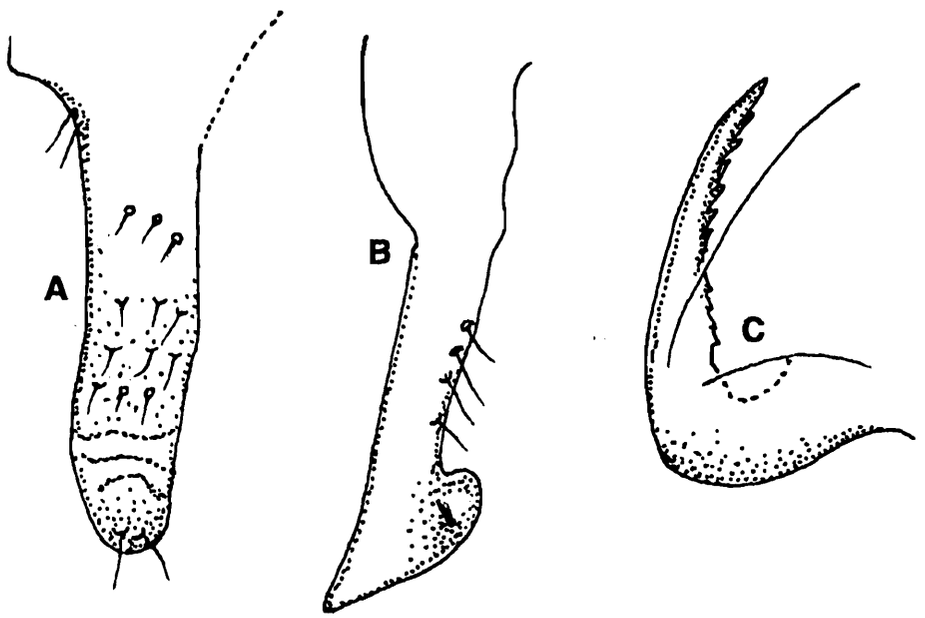


Fig. 361. *Anchon pilosum* (Walker) : A. Male plate; B. Style; C. Aedeagus

Length : From frontal margin to tips of tegmina 5.5 mm, to tip of posterior process 4 mm (♂); from frontal margin to tips of tegmina 6 mm, to tip of posterior process 4 mm (♀).

Host plant : *Vigna catjang* (Fabaceae)

Distribution : India : Karnataka, Kerala, Maharashtra, Tamil Nadu.

Elsewhere : Sri Lanka.

Remarks : The species is characterised in the basal angle of the posterior process rounded and the short suprahumeral horns.

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INSECTA : HOMOPTERA : PSYLLIDAE

The psyllids or jumping plant lice are small sternorrhynchous homopteran insects sucking plant sap and infesting both aerial and subaerial parts of plants including the economically important ones. As a result of their attack the plants show various damage symptoms. The damages which are due to their salivary injection, may range from necrosis to severe gall formations on plant organs. These insects exhibit considerable diversity in habits as some are free-living while others are gall-makers. They are phytophagous in both larval and adult stages. Psyllids are phloem feeders and more feeding damage to plant tissues is usually caused by nymphs rather than mature forms. Psyllids also act as vectors as bacterial and plant viral diseases such as "Greening disease" Secretion of honey dew in the form of threads through specialised wax gland pores is characteristic of Psyllids, particularly of developing nymphs. The life cycle of Psyllids generally involves 5 stages in nymphal condition. Generations are usually continuous throughout the year. Psyllids (Fig. 362) are common in forest and over 100 species are known to occur on about 95 species of trees and other vegetations growing in the forest.

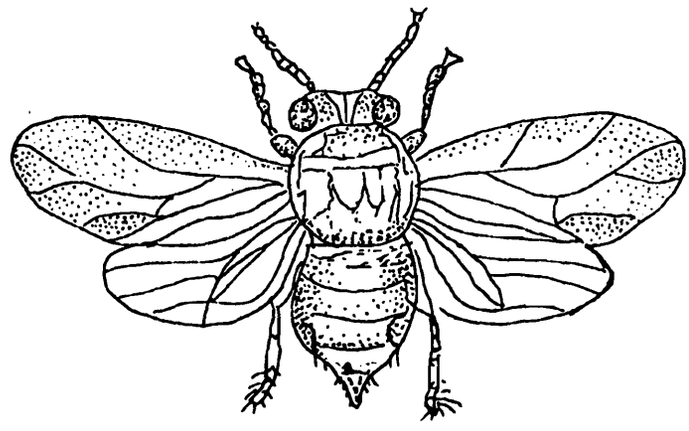


Fig. 362. A Typical Psyllid

A total of about 126 species of Psyllids are so far known from India through the following contributions–Lethierry (1890), Kieffer (1905), Lefroy (1909), Crawford (1912), Ramakrishna Ayyar (1924), Bhanotar *et al.* (1971), Mathur (1975), Lahiri and Biswas (1979), Kandasamy (1986), Ghosh, L. K. (1994), Ghosh, L. K & Ghosh, M. (1998).

The present contribution is a consolidated account on the pest species of Psyllids which cause enormous damage to Mango and *Citrus* spp. in India.

SYSTEMATIC ACCOUNT

Family PSYLLIDAE

Subfamily I PAUROPSYLLINAE

Genus 1 ***Apsylla*** Crawford

1. *Apsylla cistellata* (Buckton)

Subfamily II PSYLLINAE

Genus 2 ***Diaphorina*** Loew

2. *Diaphorina citri* Kuwayama

Key to the subfamilies of PSYLLIDAE

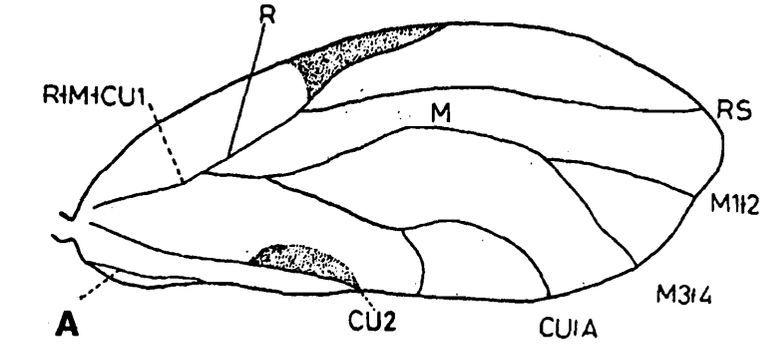
1(2) Frons covered by genae; genae usually produced into conical processes; media and cubitus constitute a common cubical petiole ..... PSYLLINAE

2(1) Frons not covered by genae, visible as a small sclerite; genae not produced into conical processes; vertex round downward in front; wings usually membranous, head strongly deflexed ..... PAUROPSYLLINAE

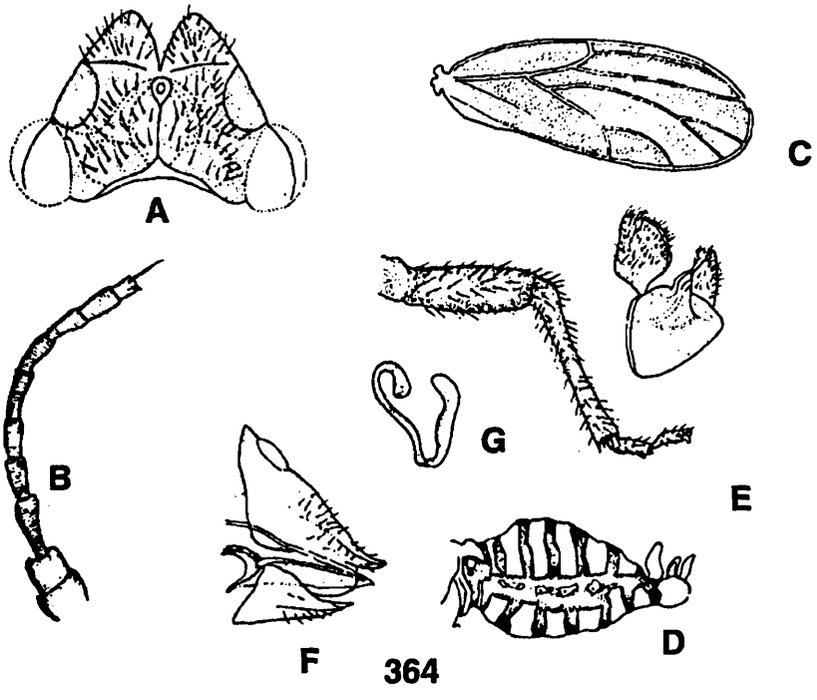
MORPHOLOGICAL CHARACTERS

The family Psyllidae is characterised by two pairs of membranous wings (Figs. 363, 364C) normally held in stegopterous manner, ten-segmented antennae (Fig. 364B), 3 ocelli widely placed on the vertex (Fig. 364A), thickened hind femora, (Fig. 364E) and uniformly dimerous tarsi terminating in two equal claws, the venation is simple and exhibits relatively few marked deviations among various genera. The most striking feature in the forewing is the presence of a principal basal vein formed by the fusion of the stems of R. M and Cu (Fig. 363A). The venation in the hind wing is extremely simple.

The various morphological parts of taxonomic value are briefly given : 1. *Head* (Fig. 364A) : Globular or elongated or horizontal or deflexed downward or triangular. The prolongation of genae in the form of genal cones and various shapes of vertex are the distinct features by which the family Psyllidae could be distinguished from other homopteran families. The clypeus occupies an inferior position and is not visible from above. The large dorsal sclerite covering most of the head is the vertex, which is divided by a prominent median suture and bears generally two foval impressions, and two basal posterior, and lateral ocelli. Frons, the smallest sclerite of the head, is scarcely visible in some genera and very prominent in others. It always bears the anterior ocellus in the centre. The relatively large clypeus, usually covers the frons and is inferior in position. The rostrum consists of much reduced labrum and well developed labium which is sharply flexed between fore coxae. The eyes are hemispherical and project laterally from the side of the head. *Antennae* (Fig. 364B) : Usually 10-segmented, attached to the genae near the anterior margin of vertex, with well developed 4 or 5 sensoria at the apices. The first two basal segments are larger and less hirsute than the rest of the segments, the third is always longest. The thickened terminal segment bears two thick sease of unequal length. *Thorax* : Large and strong, prothorax short when compared to meso and metathorax. The notum is of single sclerite and arched behind the head. Sometimes it extends only upto half the way towards the coxae, while in others it extends upto forecoxae. Mesothorax is the longest part. Metathorax includes the scutum which articulates with the wing process of hind wings and scutellum is generally smaller. The postscutellum is larger than mesothorax and produced into prominent ridges. *Wings* : The General shape 'elongate-ovate to rhombodal', four in number, anterior pair thicker than posterior, venation



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Fig. 363. Generalised wing venation of Psyllid : A-Anal Vein; Cu-Cubitus; M-Media; R-Radius; Rs-Radial Sector

Fig. 364. Structural features of generalised adult Psyllid : A-Head; B-Antenna; C-Fore wing; D-Male Abdomen; E-Hing leg; F-Female genitalia; G-Aedeagus; H-Male genitalia (Entire).

simple and shows striking differences. The venatuion of forewings, unlike the hind wings, are used as a specific character. Basal vein branches into three principal veins viz., radius, median, and cubitus. The radius branches into a short R1 and a long stigma. The median vein forks into M 1–2 and M3–4, joining near the apex or at the apex; the latter with the posterior margin, and the cell formed between these forks is the second marginal cell. The first marginal cell is formed by the forking of Cubitus into Cu1 and Cu2. A short basal vein is present. Sometimes cross veins may also occur connecting the above vein. Usually the hind wings show no remarkable specific variations. *Legs* (Fig. 364E) : Among the 3 pairs of legs, the hind pair is distinctly modified and the structure varies from species to species; generally tibia is larger

than fomur; two short tarsal segments almost of equal length present, of which the apical segment bears two claw-like spines with pulvillus. The number of basal tibial spurs, comb of apical spines and thick large black spines in the apex of tibia vary from species to species. The apex of basal tarsal segment also possesses spines in varying numbers. *Abdomen* (Fig. 364D, F and G) : The abdominal segments in psyllids are comparatively fewer than in the typical generalised insect. Out of a total of 11 segments, the abdomen shows only 5 segments. The first two are wanting, the third is reduced to a small sclerite; 4th to 8th are distinctly visible. In female (Fig. 364F), the 9th and 10th are represented as ventral valve and ovipositor sheath of genitalia respectively while the 11th forms the dorsal valve. In male (Fig. 364H), the 9th segment is suppressed, the 10th is represented by hypandrium bearing a pair of forceps (Fig. 364G) or parameres, and the 11th represents anal valve which bears the anal opening at its extremity.

METHOD OF COLLECTION AND SLIDE PREPARATION

For collections, a sweeping net and a sucking tube (aspirator) are used for capturing the adults. The collected psyllids are killed by placing them in a cyanide bottle and preserved in specimen tubes (15 cm × 5 cm) containing alcohol. The natural colour of the adults is noted before changing them into permanent preservation tubes with 70% ethyl alcohol. A part of each collection is mounted on card points or pinned with micropins on pith, and the rest is preserved in alcohol in small vials. The field data are maintained. For study of finer details of each part of both sexes and nymphal stages of each species, the following method is adopted :-Soak the material in KOH for 8-10 hours, boil in water bath for sometime till the specimen is clear, wash in distilled water, transfer in glacial acetic acid to dissolve organic matter, if any. Wash again in distilled water, dehydrate in alcohol and stain in eosin. Clear in clove oil and the specimen is dissected. The dissected parts are mounted in balsam and examined under the microscope.

Subfamily I PAUROPSYLLINAE

Diagnosis : Robust psyllid, head rounded and deflexed; frons not covered by genae, genae almost absent; front ocellus at extreme frons; vertex flexed downward in front; thorax arched; forewings rounded at apex; pterostigma long; antennae short, sometimes with equally long apical setae; hind tibiae with apical comb of setae, usually gall forming.

Genus 1 ***Apsylla*** Crawford

1912. *Apsylla* Crawford, *Rec. Indian Mus.*, **7** : 421

Type species : *Apsylla cistellata* (Buckton)

Diagnosis : Head narrows; vertex with emerginate posterior margin; genal cones swollen; lateral ocelli elevated; antennae 10-segmented, segments with characteristic biramous setae, apex with two equal apical setae; hind coxae unusually small; forewings clear and transpresent, hind wings with prominent veins. 1st marginal cell smaller and narrower than second, radial sector short, curved to costa.

1. *Apsylla cistellata* (Buckton)
Mango shoot gall insect
(Fig. 365)

1893. *Psylla cistellata* Buckton, *Indian Mus. Notes,* **3** : 91-92.

1912. *Apsylla cistellata* (Buckton) : Crawford, *Rec. Indian Mus.,* **7** : 421-422.

1975. *Apsylla cistellata* (Buckton) : Mathur, *Psyllidae of the Indian subcontinent* : 44.

1986. *Apsylla cistellata* (Buckton) : Kandasamy, *Rec. zool. Surv. India, Occ. Paper No.,* **84** : 59.

Diagnosis : Body black; head concolourous with body, smaller than thorax, width of head across the eyes subequal to antenna; genal cones deflexed downward; antennal segments porrect, apical segment with two equal spines; apical tarsal segment black; hind tibia longer than mid and fore legs with 8-10 long pointed apical spines; forewings broadly rounded at apex; basal vein longer than M +Cu; Cubital petiole more than twice as long as cubitus; R1 longer than radius; medial vein shorter than cubital petiole; marginal cells subequal, second nearly twice as long as first. The species is characterised by having metacoxae similar to mesocoxae and both nearly of equal size, peculiar type of thick antennae and venation of forewings.

Host plant : *Mangifera indica* Linnaeus (N.O. Anacardiaceae)

Symptoms and damage : The species causes plant deformities in the form of regular galls, blisters or pits on leaves and stems. This gall maker psyllid usually produces the same type of gall on the host plant (Mango) and such galls are abundant, colourful and often grotesque upon individual tree. Incidentally, it is generally believed that a secretion from the nymph stimulates gall formation. The galls are usually formed on meristematic tissue and are the result of abdominal cell multiplication. The pit galls generally occur on the under surface of the leaf and appear as roughened elevations on the upper side. The nymphs cause a distortion and folding of the leaves. One or both margin of the leaves are rolled into the mid-rib on the upper surface and the rolled margins gradually become thickened. The nymphs take shelter in these rolled leaves and are often covered with a copious secretion of white wax. The nymphal stages are often covered in a small mass of flocculent matter, produced usually from the caudal end of the abodmen. They also secrete an abundance of a sweet, sticky substance knwon as honey dew which on falling on the lower branches and leaves causes a disagreeable condition, especially when a black sooty mould develops and thus seriously injuring the Mango Tree.

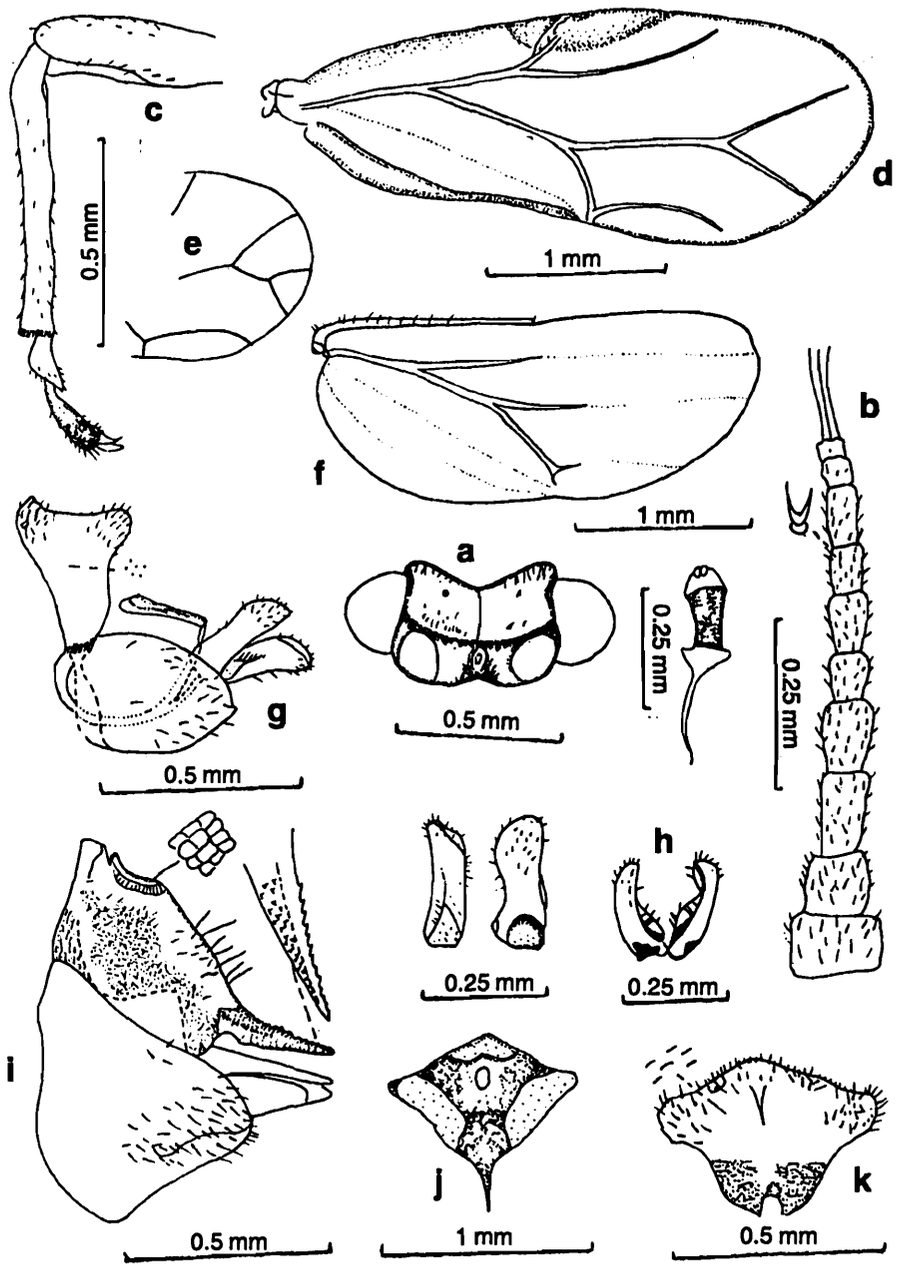


Fig. 365. *Apsylla cistellata* (Buckton) : a, head; b. antenna; c, leg; d, forewing; e, magnification of wing; f, hind wing; g, male genitalia; h, paramere; i, female genitalia; j, dorsal plate; k, proctiger.

Biology : The pest species breeds continuously during the growing season so long as new buds or foliage are available. The nymphal stages are often covered in a small mass of flocculent matter, produced usually from the caudal end of abdomen.

Distribution : India : Bihar, Tamil Nadu, Uttar Pradesh, West Bengal. The pest species is known to occur throughout the Terai area of northern India (Mathur, 1975).

Remarks : The species has been declared as a serious pest of mango due to its extreme potentiality in damaging buds of mango trees by making galls. According to Mathur (1975) this species is responsible for heavy destruction of buds of certain varieties of mango trees, growing in the terai area of northern part of India.

Subfamily II PSYLLINAE

Head vertical or deflexed, vertex quadrate; general cones always present; frons visible only as a small sclerite with anterior ocellus as it is almost covered by genae; antennae ten-segmented, terminal segment with two unequal spines; thorax arched; hind tibia with spines at apex; apical tarsal segment of hind tarsus with two claw-like spines at apex; forewings thick, transparent, mostly ovate, rounded at apex; pterostigma and M–Cu present.

Psyllinae forms one of the largest subfamilies of Psyllidae of the Indian subcontinent, which includes 35 species distributed under 7 genera.

Genus 2 ***Diaphorina*** Loew, 1879

1879. *Diaphorina* Loew, *Verh. zool. bot. Ges. Wien.*, **29** : 567.

Type species : *Diphorina putonii* Loew.

1975. *Diaphorina,* Mathur : *Psyllidae of the Indian subcontinent* : 189.

Head rugulose, dark brown, pubescent; vertex horizontal; genal cones large, broadly rounded apically, as long as or a little longer than wide, punctate; antennae 10-segmented, all the apices of segments distinctly larger than base; legs hirsute; hind tibia with apical spines; apical larsal segment with 2 claw-like spines; forewings maculate; broad subapically, apex rather rounded; pterostigma narrow and long; raidal sector long; first marginal cell shorter than second marginal one.

2. ***Diaphornia citri*** Kuwayama
Citrus Psylla
(Fig. 366)

1907. *Diaphorina citri* Kuwayama, *Trans., Sapporo nat. Hist. Soc.,* **2** : 160.

1975. *Diaphorina citri* Kuwayama : Mathur, *Psyllidae of Indian subcontinent* : 198.

1986. *Diaphorina citri* Kuwaynma : Kandasamy, *Rec. zool. Surv. India. Occ. Paper No.,* **84** : 25.

Diagnosis : Head narrowed than thorax, vertex wider than long, lateral margins almost parallel to each other, frons concealed by genace; antennae about 3 times as long as genal cones, apical segments black; femur more than twice the width of tibia; Hind tibia without apical spines; apical tarsal segment with two black short spines at apex; forewings partially maculate; radial sector joining near centre of anterior margin, radius about 2.5 times as long as cubital petiole; fork M1+2 longer than fork M3+4; Cu1 more than twice as long as Cu2.

Symptom and Damage : This is the most destructive and, consequently, the most important of all the insect pests of citrus. Although there is a visible difference in the rise and fall of its population in various seasons, yet the ill-effects of its damage are so long-lasting that the trees may look sickly even when the population is not high. Thus, sooty and sickly plants seen in the winter are the victims of insects which

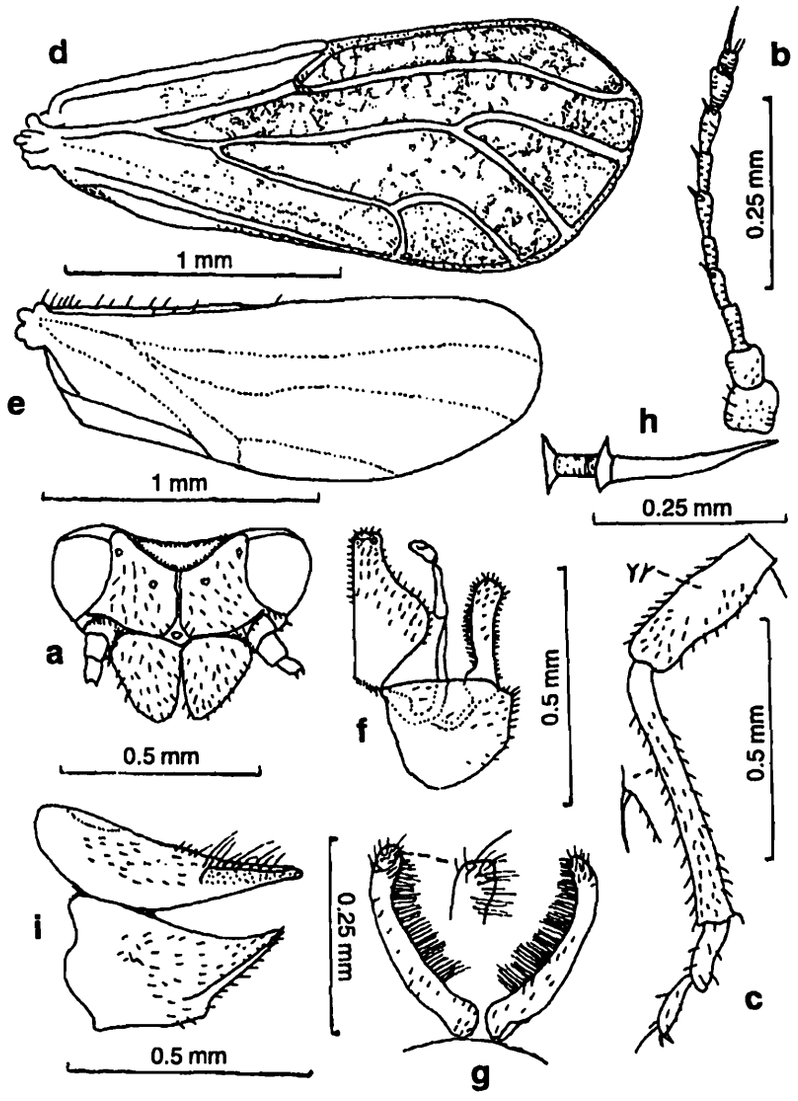


Fig. 366. *Diaphornia citri* Kuwayama : a, Head; b, antenna; c. leg; d, forewing; e, hindwing; f, male genitalia; g, paramere; h, plate; i, female genitalia (after Mathur, 1975)

caused damage during the previous summer (Atwal and Dhaliwal, 1997). Only the nymphs are harmful to the plants. With the help of their sharp, piercing mouthparts, they suck the cell-sap in millions. The vitality of the plants deteriorates, and the young leaves and twigs stop growing further. The leaf-buds, flower buds and leaves may wilt and die. Whatever little fruit is formed in the spring, falls of prematurely. Moreover, the nymphs secrete drops of a sweet thick fluid on which a black fungus develops, adversely affecting photosynthesis. It is also thought that the insect produces a toxic substance in the plants as a result of which the fruits remain undersized and poor in juice.

Biology : The pest is active throughout the year but its life-cycle is greatly prolonged in the winter. Only adults are to be found when it is very cold. They resume breeding in February-March and lay, on an average, 500 almond-shaped, orange and stalked eggs on tender leaves and shoots of citrus trees. The lower end of the egg stalk is

embedded in plant tissue. The eggs are laid either singly or in groups of two or three and are arranged in straight line, there being as many as 50 eggs in one place. The eggs hatch in 10-20 days in winter and 4-6 days in summer. On emerging, the light-yellow nymphs have a tendency to stick close to the egg-shell. They are found congregated on young half-open leaves. but in the later stages of development they may also migrate to the older leaves. There are five nymphal stages and the development is completed in 10-11 days from April to September, 15-20 days in the spring and autumn, and 34-36 days in December-January.

Natural mortality among nymphs varies in different seasons and during the greater part of the year, 20-30 per cent of nymphs die a natural death. However, in December and January, the mortality may be as high as 58 per cent. The most favourable conditions for development are found in March, when there is only about 4 per cent mortality. When the nymphs are full-grown they migrate to the lower surface of leaves, where they change into adults.

The adults copulate 4-8 days after emergence and the females start laying eggs immediately afterwards. There is a great variation in the longevity of adults in various seasons. The females live longer than males, and the duration may be as long as 190 days in winter and only 12-26 days in the summer. During the hot period of May-June, the adults are predominant although other stages may also be found. In july, they start reproducing once again, there being a second lower peak of population in August. Towards autumn, there is again a decline in the population. In summer, the life-cycle is completed in 14-17 days. There are 8-9 overlapping generations in a year. (After Atwal and Dhaliwal.)

Host plants : *Citrus aurantium* (orange), *C.medica limonium* (Lemon), *C. medica lunetta* (sweet line), *C. medica acida* (Sour lime) *C. medica citron*, *C. decumana* (Pomelo); Also recorded on *Murraya koeniggi* at Coimbatore, South India.

Natural enemies : Parasitoid : *Tetrastichus radiatus* Waterston (Fam. Eulophidae). Predators : *Coccinella septempunctata* Linn., *C. transverslis* Fabricius, *Menochilus sexmaculatus* (Fabricius), *Chiloconus nigrita* (Fabricius) and *Brumoides suturalis*(Fabricuius) (Coccinellidae), and *Chrysoperla carnea* (Stephens) (Chrysopidae) larvae also feed on nymphs.

Distribution : Known from many high altitude regions of North India and from the Western ghats of South India. Widely distributed in *Citrus* growing area of India including southern part.

Elsewhere : China, Formosa, Japan, Myanmar, Philippine Is., Sri Lanka, the East Indies and New Guinea.

Remarks : The species commonly known as "Citrus Psylla" is of the greatest importance all over India. It causes very severe lossess to *citrus* Cultivation. This species is also suspected to cause a serious virus disease "Greening disease" in *Citrus* orchards. It is said that the "Greening" virus disease to citrus is quite prevalent in India and investigations are being carried out to assess its virulence. Afzal Hussain

and Dina Nath (1927) provides detailed account on the pest's systematic position, distribution, description of various stages, bionomics economic importance, parasites and predators and control measures. Damage is cuased by nymphs and adults. The adult is small, 3 mm in length, active in habits and rests on the leaf surface with closed wings, the tail end of the body being turned upwards. The insect is brown with its head lighter brown and pointed. The wings are membraneous, semi-transparent, with a brown band in the apical half of the fore wings. The hind wings are shorter and thinner than the fore wings. The nymphs are flat, louse-like and orange yellow creatures and are seen congregated in large numbers on young leaves and buds.

The species is characterised by Media and cubitus without bands, head with somewhat parallel sides, longer genal cones and maculated wing.

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HEMIPTERA : HETEROPTERA : COREOIDEA

Coreids, commonly known as the leaf-footed bugs, are commonly phytophagous insects abundantly occur in Indian plains as well as the hills. Some of them are reported as economically important pests particularly in cereals, pulses, vegetables and fruits. They often produce obnoxious odour to avoid their predators. The coreid bugs (Fig. 367) in India are represented by four families *viz.* Coreidae, Alydidae, Rhopalidae and Stenocephalidae.

Diagnosis : Generally medium to large insects, head much narrower than pronotum, antennae four-segmented inserted well on sides of the head, ocelli present and rostrum four-segmented. Clavus of wing extending beyond scutellum. The tarsi are 3-jointed and pulvilli present. Scent glands opening on thorax, conspicuous. Mostly dull-coloured and capable of producing pungent scent, in some genera they exhibit extraordinary dialation of the antennae, many species have flattened and leaf-like legs, hence called

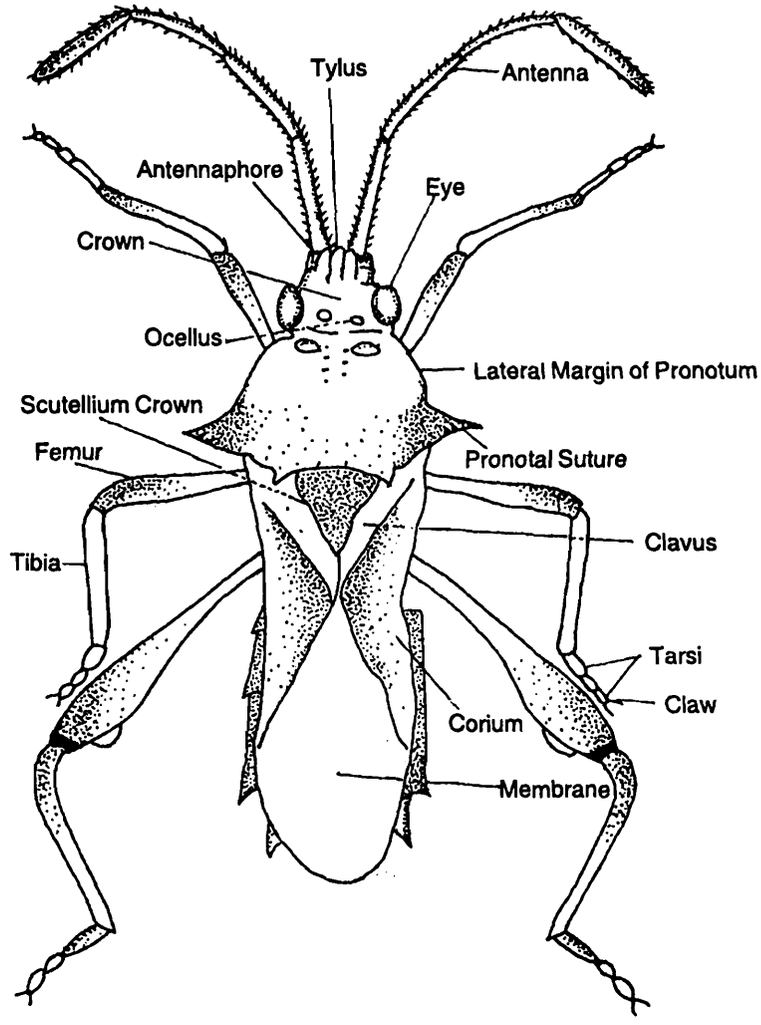


Fig. 367. External Morphology of a Coreid Bug

leaf-footed bugs (Fig. 368). A few species are known to be predaceous also. Mostly dull coloured and phytophagous. Coreid fauna in oriental region comprises about 212 species. The Indian fauna pertains to about 148 species (11% of the world fauna) belonging to 53 genera through the works of Distant 1904, 1908, 1918; Paiva 1919; Kumar 1965; Basu and Mitra 1977; Dolling 1978; O'shea and Schaefar 1980; Basu and Mitra 1994; Chakraborty, Ghosh, L.K. and Basu 1994; Basu, Bal and Mitra 1998, 2000; Basu and Mitra 2003; Hegde 1995. Chopra (1967) had produced an excellent contribution on the higher classification of the family Rhopalidae. Here, classification is based upon Richards and Davies, 1977.

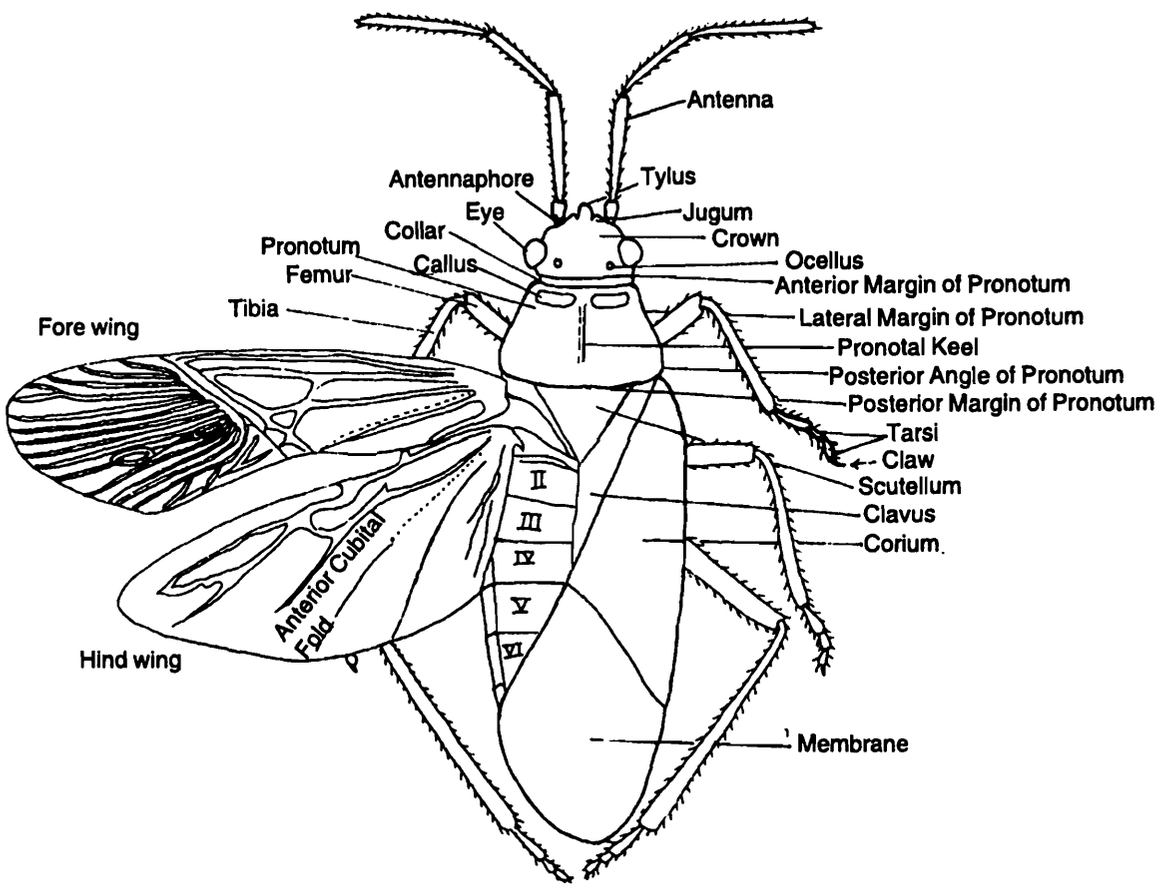


Fig. 368. External features of a Coreid Bug : Left hemelytron and wing extended in flight position to show structural terms

MATERIAL AND METHOD

Coreids like most of the hemipteran insects are phytophagous in nature and feed on agricultural fields, vegetable gardens, crop fields etc. As these insects are well fliers like other hemipteran insects they are collected by sweeping the habitat with insect net or by hand picking with forceps and light trapping during night time.

The collected materials are killed in a killing jar using benzene or chloroform vapour and preserved dry with paradichlorobenzene and napthelene. The insects are

kept in the insect envelops and labelled properly mentioning locality, altitude, date of collection and name of the collector with ecological notes etc. In the laboratory the specimens are set, pinned and mounted to display properly for easy handling under binocular microscope during the process of identification. For detailed specific identification the genital structures are also dissected out and mounted on slides for further study.

SYSTEMATIC ACCOUNT

Superfamily COREOIDEA

Family I ALYDIDAE

Genus 1 ***Leptocorisa*** Latr.

1. *Leptocorisa acuta* (Thunberg)

Genus 2 ***Riptortus*** Stal

2. *Riptortus linearis* (Fabricius)
3. *Riptortus pedestris* (Fabricius)

Family II COREIDAE

Genus 3 ***Clavigralla*** Spinola

4. *Clavigralla gibbosa* Spinola

Genus 4 ***Cletus*** Stal

5. *Cletus bipunctatus* (Westwood)

Genus 5 ***Paradasynus***

6. *Paradasynus* sp.

Key to the families of COREOIDEA

1. Bucculae usually long and extending to near insertion of antennae; pronotum posteriorly usually thrice or more than the length of head; scutellum reaching or passing base of metanotum, more often broader than head across eyes ..... COREIDAE

– Bucculae short, not extending posteriorly beyond the insertion of antennae; pronotum posteriorly slightly broader than width of head; scutellum usually not reaching base of metanotum, somewhat narrower than head between eyes ... ALYDIDAE

Family ALYDIDAE

Key to genera of the family ALYDIDAE

1. Pronotum with a distinct central carinate line; body above brownish, beneath pale greenish ..... ***Leptocorisa***

– Pronotum without central carinate line as above; body dark cinnamon brown; posterior pronotal margin with a small spot ..... ***Riptortus***

Genus 1 *Leptocorisa* Latr.

1825. *Leptocorisa* Latr. *Fam. Nat.*, **3** : 86.

Type species : *Leptocorisa tipuloides* de Geer

Diagnosis : Body long and elongate, ochraceous; head long, lateral lobes porrect and produced in front of the central lobe; eyes black; pronotum long, slightly deflected anteriorly; antennae with the 1st joint thickened, it's apex obscurely incrassate; mesosternum sulcate; abdomen above reddish brown with margins pale greenish yellow.

1. *Leptocorisa acuta* (Thunberg)
Gandhy Bug
(Fig. 369)

1783. *Cimex acuta* Thunberg, *Nov. Ins. Sp.*, **2** : 34.

1904. *Leptocorisa acuta* Distant, *Fauna Brit. India, Rhynchota,* **1** : 410.

1965. *Leptocorisa acuta* : Ahmad, *Bull. Brit. Mus. (Nat. Hist.) Entom.*, 78-80.

1978. *Leptocorisa acuta* : Basu and Mitra, *Sci. Cult.*, **44** : 413.

1994. *Leptocorisa acuta* : Basu and Mitra, *Fauna of West Bengal, State Fauna Series,* **3** : 450-451. Zoological Survey of India.

2000. *Leptocorisa acuta* : Basu, Bal and Mitra, *Fauna of Tripura, State Fauna Series* **7**(2) : 407. Zoological Survey of India.

Diagnosis : Body above brownish-olivaceous, cylindrical, beneath pale greenish; abdomen above reddish-brown with the margins pale greenish-yellow; head elongated; antennae 4-joined, dark brown with bases of 2nd, 3rd and 4th segments deep yellowish with reddish tinge, 1st and 4th segments longest and subequal in length while 2nd and 3rd shortest and subequal, a small prominent tubercle near each lateral pronotal angle; rostrum short, hardly reaching 2nd coxae; a distinct central carinate line to pronotum. The newly hatched nymphs are about 2 mm long, pale green. As they grow the green colour deepens. The grown up nymphs are very much alike the adults both in size and colours. In the males, the harpagons (hook-shaped structure of the exterior genitalia) are pointed at their ends. The male claspers are wide at base with the extremity curved and tapering.

Length : 13-17 mm.

Host Plants : The adults feed and breed on rice, a number of wild grasses, and other weeds, millets, forest trees etc. belonging to 81 important species. Other alternate host plants of the Rice Bug are Catechu-*Acacia catechu;* Siris-*Albizzia*; Jack tree-

Artrocarpus, Conifers-Indian red wood; *Dalbergia sisoo,* Bean, Mango, Champa, Tobacco, Pea, Guava, Sugarcane, Sal, Brinjal, Maize, Tea etc.

Ecology : Early rains in May & June encourage the prolific growth of weeds and grasses on which the pest species feeds. In subsequent months these result a severe outbreak of the bug in the paddy crop. The multiplication of bugs is favoured by light, intermittent rainfall throughout the season.

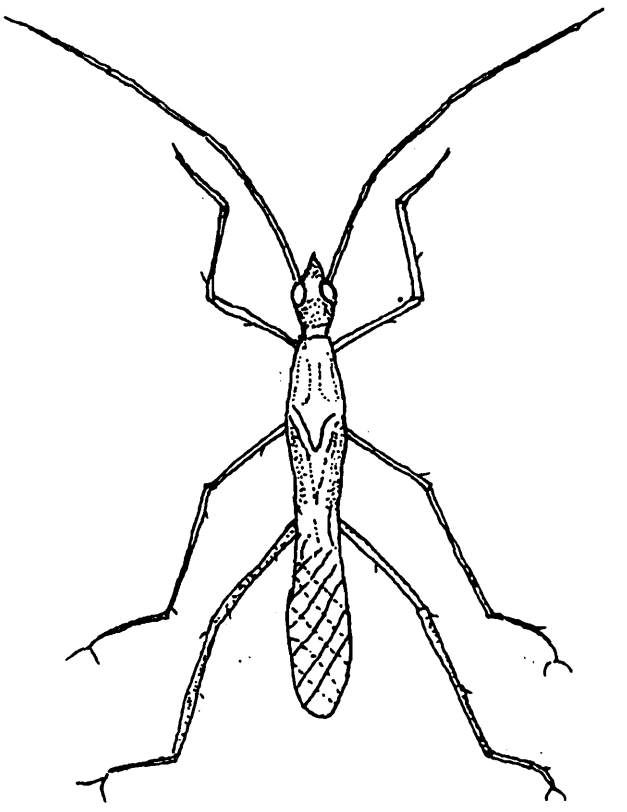


Fig. 369. A dorsal view of *Leptocorisa acuta* (Thunb.)

Symptom and Damage : Both nymphs and adults suck the milky juice from developing grains. As a result, the grain fails to develop or shrivel up completely. The chracteristic symptom is white-ring ear. The entire field often turns coloured in this way. It remains until the paddy grain hardens. Late varieties of paddy escape damage since they mature late in November when pest incidence is very low. As a result of damage, brown or black spots appear around the holes made by the pest species on which a sooty mould may develop. This bug attacks the rice crop periodically. In case of serious infestations the crop yield may be depressed by more than 50%.

Biology : The longevity of the adults is 45-60 days in the field but they can live for 15-115 days under controlled condition. The adults are active during early morning and in the evening while during day the insects hides in the shade of basal parts of the plants, the females are stronger fliers than the males. The males are generally ready for copulation soon after the last moult but the females mate when they are 7-25 days old. 3-4 days after copulation the females lay 250-300 eggs by gradually moving forward and deposit one egg after another in 1-3 rows on the upper leaf surfaces; The egg is yellowish brown but its colour soon deepens. The incubation period varies from 5-8 days. Newly hatched nymph is green and later become brownish. The nymphal stages last from 14-24 days. Each ecdysis takes about 10-15 minutes. The 5 instars are 2, 5, 8, 11, 14 mm long and last 2-3, 2-5, 7, 3-8 and 4-9 days respectively. The insects overwinter from December—March and pass the summer (April-June). Later, the pest migrates to the paddy crop in the flowering and milk stages. In single cropping areas, the insect usually has 4 overlapping generations but in areas where tamperature is optimum and rice is grown all the year, the bugs remain active throughout the year without a distinct diapause. In such areas there is heavy infestations.

Natural enemy complex : There are 26 species of parasites and predators of *Leptocorisa* and the common ones are *Cicindella sexpunctata, Omnatius* sp., *Ooencyrtus analyensis, Telinomus comperei.* The bugs *Asopus malabaricus* and *Rhinocoris fucipes* are predaceous on the pest species. *Hydronotus flavipes* is parasitic on eggs of the pest.

Distribution : Oriental and Palaearctic Regions; India : Assam, Bihar, Karnataka, Kerala, Meghalaya, Sikkim, Tamilnadu & West Bengal.

Elsewhere : Australia; Bangladesh; Bhutan; Myanmar; New Caledonia; Sri Lanka; China; Hong Kong; West Iran; Indonesia; New Hebrides; Northern territory of Australia; Malaysia; New Guinea; Pappua; Pakistan; Philippines; Samoa; Sarawak; Solomons; Taiwan; Tonga; Thailand; Quensland & Vietnam.

Remarks : This Gandhy Bug is a serious pest of rice in Uttar Pradesh and some other rice growing states of India. It also feeds on maize, millets, sugarcane and some grasses. It occurs in epidemic form in India-Indonesia, Pakistan, Japan, Malaysia, Sri Lanka, Myanmar, Fiji, Australia and the Philippines where it causes 10-40% loss of crop. In cases of carrier infestation it may cause complete loss. Rice bugs are very destructive in areas where rainfall is evenly distributed throughout the year, and also in irrigated crops. Six species of *Leptocorisa* are pests of rice in different parts of the tropics.

Management : Alternate hosts should be removed from the nearby paddy field bunds to minimise bugs incidence. Chemical control using malathion dust or spray applications 15 days after flowering only when its population is more than 5 bugs/m^2 are affective. Neem based products like achook or nimbecidine (1%) sprays are also effective (Rao and Prakash, 1995)

Genus 2 ***Riptortus*** Stal

1859. *Riptortus* Stal, *Ofv. Vet. Ak. Forh.*, : 460

Type species : *Riptortus dentipes* Fabricius

Diagnosis : Posterior femora well developed and armed with spines beneath; rostrum with second segment not or slightly longer than the fourth segment, eyes prominent, subpedunculate, 4th antennal joint longer than the 2nd and 3rd joints taken together; basal margin of pronotum bisinuate before scutellum; tibiae moderately compressed.

Injury is caused by both nymphs and adults sucking the sap from the leaves and stems of host plants. This feeding causes wilting and when severe, the leaves become black and crisp. The adult is dark brown and measures about 15 mm. Only the adult bugs live through the winter. They are found in all kinds of protected places. Long before the cultivated food plants are to be found, the adults may be collected. The adult female lays masses of orange yellow to bronze-brown eggs, each containing almost a dozen or more, deposited usually on the undersides of the leaves. Hatching

takes place in about 10 days or more and the nymphs pass through 5 instars, requiring 4-6 weeks to reach maturity. Early instars are coloured. The legs, antennae and head are red and abdomen green. A few hours after each moult the red parts gradually turn blackish. Later, instars are of a dark greenish gray colour. Apparently one generation develops in a year.

Key to the species of the genus *Riptortus* Stal

1. Body dark cinnamon brown, apparently not pilose; pronotal disk without distinct rugosities; posterior tibiae ochraceous; posterior pronotal margin with a small spot at the middle ..... *linearis*

— Body dark brown ochraceous, finely and obscurely pilose; posterior tibiae with bases and apices reddish brown; posterior pronotal margin without such spot ..... *pedestris*

2. *Riptortus linearis* (Fabricius)
(Figs. 370, 438)

1775. *Lygaeus linearis* Fabricius, *Syst. Ent.*, : 710

1904. *Riptortus linearis* Distant, *Fauna Brit. India,* **1** : 415.

1994. *Riptortus linearis* (Fabricius) : Basu and Mitra, *Fauna of West Bengal, State Fauna Series* : 451. ZSI

1995. *Riptortus linearis* (Fabricius) : Hegde, *Rec. zool. Surv. India Occ. Paper No.,* **168** : 53.

2000. *Riptortus linearis* (Fabricius) : Basu, Bal and Mitra; *Fauna of Tripura, State Fauna Series,* **7**(2) : 407. Zool. Surv. India.

Diagnosis : Dark cinnamon–brown body; antennal segment I, II and III blackish; pronotum with lateral angular spine black; abdomen black; posterior pronotal margin with a small spot near at the middle; pronotal disc without distinct rugosities, scutellum pale luteous at the apex; posterior femora with a ventrolateral row of thin spines.

Length : Adult 14-16 mm.

Biology : Not known.

Distribution : India : Karnataka, Maharashtra, Meghalaya, Sikkim, Tripura, Tamil Nadu, West Bengal.

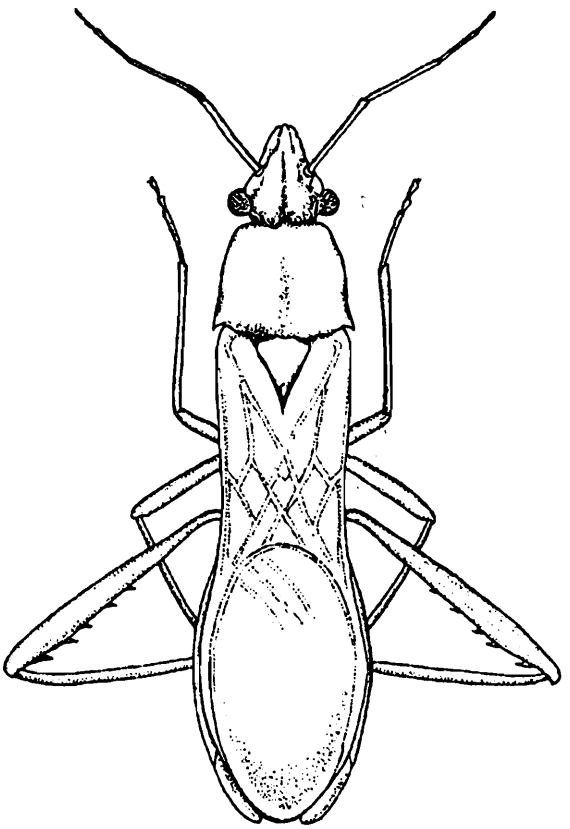


Fig. 370. *Riptortus linearis* (Fabricius)

Elsewhere : Myanmar, Malayan Archipelago, Sri Lanka.

Remarks : The nymph and adult infest cowpea, pigeonpea or red gram, fig etc. and sucks plant sap from the tender leaves, stems and immature pods of the host plants.

Management : As in case of *Clavigralla gibbosa* Spinola (Page 364).

3. ***Riptortus pedestris*** (Fabricius)
(Fig. 371)

1775. *Lygaeus pedestris* Fabricius, *Syst. Ent.*, : 727.

1904. *Riptortus pedestris* Distant, *Fauna Brit. India,* **1** : 414.

1994. *Riptortus pedestris* : Basu and Mitra, *Fauna of West Bengal, State Fauna Series,* **3** : 452. Zool. Surv. India.

2000. *Riptortus pedestris* : Basu, Bal and Mitra; *Fauna of Tripura, State Fauna Series,* **7**(2) : 408. Zool. Surv. India.

Diagnosis : Body dark brownish ochraceous, finely and obscurely pilose,; pronotal disk with scattered rugosities; lateral pronotal angle with two spines on each side, the spines being acute, long and black; posterior femora with moderate spine row on ventrolateral side; posterior tibiae with the bases and apices reddish brown; lateral pronotal spine black; posterior margin of the pronotum (dark castaneous) and a lateral fascia on each side of the head, not extending beyond base of antennae; hind femora thickly mottled reddish brown; tibia with apical spine.

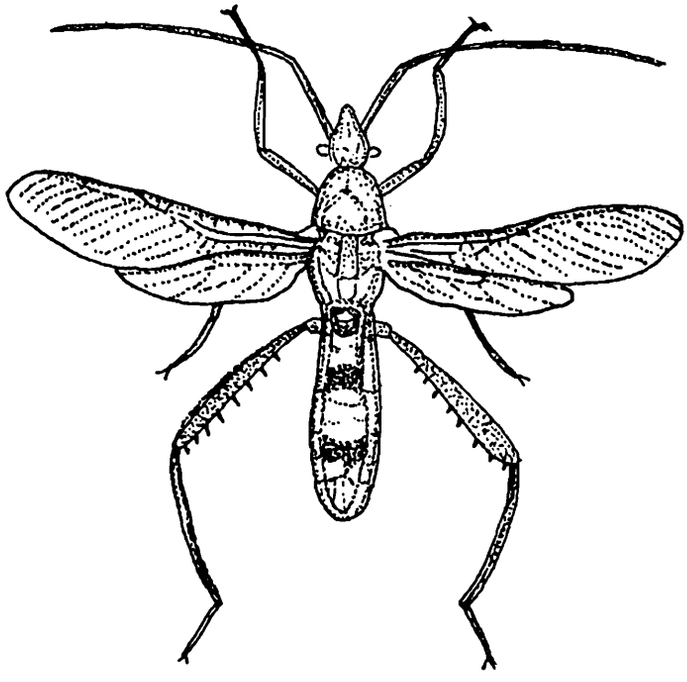


Fig. 371. *Riptortus pedestris*

Length : 15-18 mm.

Distribution : India : Arunachal Pradesh, Assam, Karnataka, Maharashtra, Meghalaya, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal.

Elsewhere : Myanmar; Malay Peninsula; Malayan Archepelago; Sri Lanka.

Biology : Not known.

Remarks : The species infests various crops and vegetables like pigeon pea or red gram, black gram, cow pea and also occurs on cardamam. It is known to be pest of

orange–growing areas of the country. It sucks sap from the tender stems, leaves and immature pods.

Management : As in *Clavigralla gibbosa* Spinola

Family II COREIDAE

Key to the genera

1. Pronotal lateral angles produced into acute spines, apices of the spines being black; posterior femora spined beneath near apices; femora moderately clavate towards apices ..... ***Clavigralla***

– Pronotal lateral angles shortly but acutely produced, the apices of the spines fuscous; posterior femora apparently without spine beneath near apices; femora not clavate as above ..... ***Cletus***

Genus 3 *Clavigralla* Spinola

1837. *Cravigralla* Spinola, *Ess.*, : 200

Type species : *Cravigralla gibbosa* Spinola

Diagnosis : Body elongate, pronotum with the lateral angles more or less spinously produced with their posterior margins distinctly dentate; scutellum elevated and covex; rostrum with 2nd and 4th joints about equally long; antenniferous tubercles unarmed. Posterior tibiae shorter than the posterior femora, femora moderately clavate towards apices; 2nd and 3rd antennal segments subequal in length; lateral segmented angles spinously produced.

4. *Clavigralla gibbosa* Spinola
(Fig. 372, 439)

1837. *Clavigralla gibbosa* Spinola, *Ess.*, : 202

1902. *Clavigralla gibbosa* Spin. : Distant, *Fauna Brit. India,* **1** : 401.

1994. *Clavigralla gibbosa* Spin. : Basu and Mitra, *Fauna of West Bengal, State Fauna Series,* **3**(5) : 454.

1995. *Clavigralla gibbosa* Spin.: Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 50.

Diagnosis : Greenish brown bugs with a spined pronotum; and the femur swollen at apical end. Body punctate, moderately pilose; 2nd and 3rd antennal segments subequal; pronotum transversely and somewhat conically tuberculate on disk, the lateral angles produced into acute black spines; scutellum elevated and convex and thickly pilose; posterior area of pronotum, apical area of corium, and spots on connexivum castaneous; femora swollen at apical end; the young nymphs are reddish and show prominent lateral spines on the prothoracic and abdominal segments.

Length : 17 mm. approximately.

Host plants : Pigeon pea, lab-lab, cowpea, chickpea, kidney bean, cluster bean etc.

Symptom and Damage : Damage is caused by both the adults and the nymphs sucking cell sap from the stem, leaves, flower-buds and pods. As a result of this damage, pale yellow patches appear in the pods which later on shrivel up. The grain inside remains small in size and the yield suffers much.

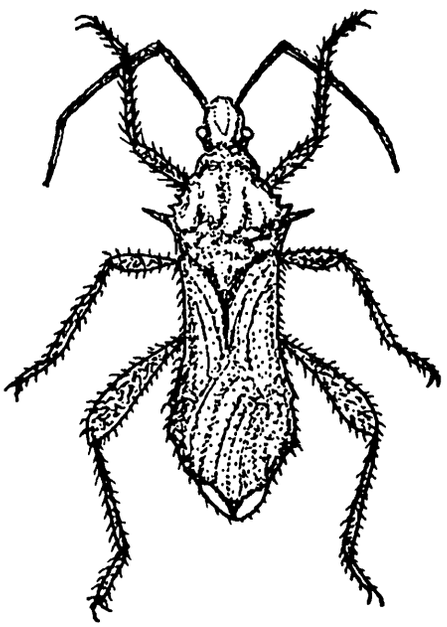


Fig. 372. *Clavigralla gibbosa*

Biology : The pest species appears in the field during October. They mate several times. The copulation period varies from an hour to nearly 24 hours. After 11 days or so the females lay eggs. The eggs are usually laid on pods and less frequently, on leaves or the floral buds in clusters of 5-25 each. A female, usually lays about 60 eggs during an oviposition period of 15 days. The eggs hatch in about 8 days and the newly hatched nymphs move away the egg shells within 10-15 minutes and congregate at a suitable feeding spot. They are gregarious in habit and feed in groups. The nymphs take about 17 days to complete development, five nymphal stages are involved. The pest species is active from the middle of October to the end of May and completes six overlapping generations during this period.

Natural enemy complex : *Hadronotus antestiae* Dodd (Scelionidae) parasitises the eggs. In nature, the parasite has the potentiality to destroy 55% of the eggs.

Distribution : India : Andhra Pradesh, Bihar, Delhi, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamilnadu, Uttar Pradesh, West Bengal.

Elsewhere : The species is widely distributed in the Indian subcontinent and adjoining countries including Myanmar and Sri Lanka.

Management : Spray one litre of endosulfan 35EC or 1.25 litres of monocrotophos 40EC or one litre of trichlorphon SOEC or fenitrothion 50EC in 625 litres of water per ha. Two sprays during flowering and three during pod formation are quite effective (Atwal and Dhaliwal, 1997)

Genus 4 ***Cletus*** Stal

1859. *Cletus* Stal, *Freg. Eng. Resa. Ins. Hemp.*, : 236

Type species : *Cletus triginus* Thunberg

Diagnosis : Body oblong, subcompressed; head subquadrate, not prominently or

distinctly produced in front of the antenniferous tubules, its apex deflected; anterior lateral margin of the corium and lateral margins of the abdomen very minutely crenulate or serrulate; lateral angles of the pronotum acutely produced.

5. ***Cletus bipunctatus*** (Westwood)

1842. *Coreus bipunctatus* Westwood, In *Hope Cat.*, **2** : 23.

1904. *Cletus bipunctatus* : Distant, *Fauna Brit. India, Rhynchota,* **1** : 393.

1919. *Cletus bipunctatus* : Paiva, *Rec. Indian Mus.,* **16** : 359.

1999. *Cletus bipunctatus* : Basu, Bal and Mitra, *Fauna of Meghalaya, State Fauna Series,* 4(4) : 376. Zool. Surv. India.

2000. *Cletus bipunctatus* : Basu, Bal and Mitra; *Fauna of Tripura, State Fauna Series,* 7(2) : 410. Zool. Surv. India.

Diagnosis : Body beneath and legs luteous, a small spot on the lateral area of each sternal segment and a few small discal spots to abdomen black; antennae pale reddish ochraceous, the apical joint fuscous. Lateral angles of pronotum acutely upwardly produced; abdominal segmental angles not exteriorly acutely produced; pronotal angles shortly but acutely produced, apices ending with sharp pointed fuscous spines; femora without castaneous spots.

Length : 10 mm approximately; width between pronotal angles 3.5-4 mm,

Distribution : India : Karnataka, Maharashtra, Meghalaya, Tripura, West Bengal.

Elsewhere : Myanmar; Sri Lanka.

Biology : Not known.

Remarks : This coreid bug is usually known as Sugarcane black bug which also infests Paddy.

6. *Paradasynus* sp.

Host plant : Cashew

Symptom and Damage : Both nymphs and adults suck the plant sap. As a result, the tender leaves and nuts shrivel and dry up.

Biology : (after Nayar *et al.* 1976) : The insect takes about 10 days to attain maturity. The adult males and females mate repeatedly. A pair may be in copulation for a longer period. Preoviposition period is 4 days. The female bug lays the boat-shaped yellowish eggs on the leaf surface in groups of upto 52 in five or more regular rows. The egg measures 2×1 mm. Incubation period of the egg ranges from 8 to 11 days. The insect passes through five nymphal instars, the successive nymphal instars occupying respectively 3-6, 3-8, 4-6, 3-6 and 8-10 days. In the nymphs the antenna

is four-segmented with the terminal segment largest and the preterminal segment flat and expanded. The greyish brown adult bug is stout with long legs and without flat expanded preterminal antennal segment.

The eggs are heavily parasitised by *Hadrophanurus* sp. (Scelionidae) and *Anastatus* sp. (Eupelmidae).

Remarks : This coreid bug occurs on cashew during May-June in Trivandrum (Kerala).

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INSECTA : HEMIPTERA : HETEROPTERA : LYGAEIDAE

The Lygaeids (Fig. 373) are small to medium-sized oval and elongated insects which are second largest heteropteran ones. These are mostly phytoghagous but a few are thought to be predaceous. They are cosmopolitan in distribution. The majority are dull or black coloured, some are brightly coloured. They mostly occur on moss surface, rubbish beneath stones or low plants (herbs and shrubs).

A little over 250 species belonging to nearly 100 genera are known from Indian subregion (Distant 1904, 1910, 1918; Pruthi 1925; Cherian 1933; Chatterjee 1937; Rangarajan *et al.* 1964; Subba Rao *et al.*, 1965; Kiritshenko and Scudder, 1969; Chopra and Rustogi 1980 a,b; Mukhopadhyay, 1980, 1988; Mukhopadhyay and Ghosh, 1982), Hamid and Meher, 1973, 74; Ghosh *et al.* 1989; Chakraborty and Ghosh, 1994.) Also, Malipatil (1978) included many genera and species common to oriental region including India.

Diagnosis : The Lygaeids are characterised by short head, 4-segmented antennae situated below a line drawn from the centre of the eye to the apex of the face, eyes normal to large and exerted; tarsi 3-jointed; ocelli present; rostrum 4-jointed; absence of cuneous and abdomen without pore-bearing plate or disc; legs short, forelegs normal or raptorial, with rotatory coxae; hemelytra with elongated clavus and membrane prominent with 4-5 loose veins; pulvilli present; thoracic gland openings evident.

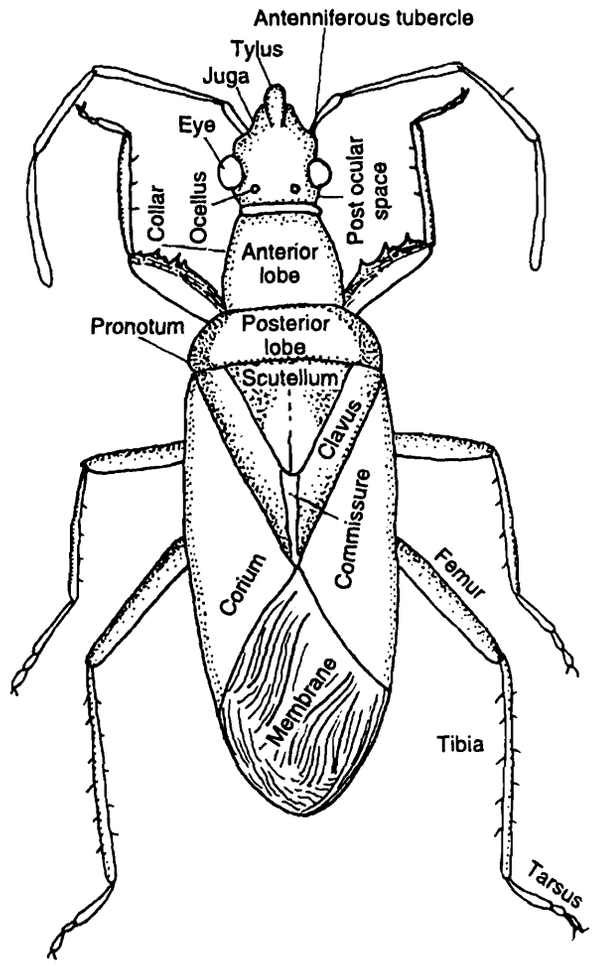


Fig. 373. Structural features of a generalised adult Lygaeid.

MATERIAL AND METHOD

Collection and Preservation

The insects are usually collected with the help of arial nets which are usually handled for catching these insects in flight and sweeping nets are swept through vegetations. They may be collected by beating of branches with a stick over a sheet

of cloth or rexin (preferably white). Picking up of individual specimens from the bark or on lower side of leaves, with the help of forceps. These insects can also be collected in light trap method. Specimens are killed in an insect killing bottle. They are removed from the bottle as soon as killed, then dried on blotting paper and finally set and pinned. All the specimens set on pin and labelled are finally stored in boxes with preservatives for study.

SYSTEMATIC ACCOUNT

Family LYGAEIDAE

Subfamily I LYGAEINAE

Genus 1 ***Spilostethus*** Stal

1. *Spilostethus hospes* (Fabricius)
2. *Spilostethus pandurus militaris* (Fabricius)

Subfamily II OXYCARENINAE

Genus 2 ***Oxycarenus*** Fieber

3. *Oxycarenus laetus* Kirby

Subfamily III ORSILLINAE

Genus 3 ***Nysius*** Dallas

4. *Nysius inconspicuus* Distant

Subfamily IV BLISSINAE

Genus 4 ***Cavelerius*** Distant

5. *Cavelerius excavatus* Distant

Key to subfamilies of the family LYGAEIDAE

1(2) Abdominal spiracles on segments II to VII located dorsally 3

2(1) Not all abdominal spiracles dorsal; single abdominal spiracle between segments II to VII dorsal; fore femora with spines 5

3(4) Apical margin of the corium straight; usually brightly coloured with red and black combinations ..... LYGAEINAE

4(3) Apical margin of the corium sinuate at inner angle ..... ORSILLINAE

5(6) Single abdominal spiracle between segments II and VII dorsal; fore femora with spines; bucculae long, commonly extending to the base of head. ..... OXYCARENINAE

6(5) More abdominal spiracle dorsal; abdominal spiracle of only segment VII ventral; hemelytra impunctate or very weakly or sparsely punctate ..... BLISSINAE

Subfamily I LYGAEINAE

Genus 1 ***Spilostethus*** Stal

1868. *Spilostethus* Stal, *Kongl. Svensk. Vet. Akad. Handl.*, **7**(11) : 72.

Type-species : *Cimex militaris* Fabricius, 1775. = *Cimex pandurus* Scopoli, 1763.

Diagnosis : In male, femora of legs usually spinose; lateral margins of the pronotum rolled and metathoracic scent gland orifices obsolete; brightly coloured, usually with a combination of red and black.

Key to the species of SPILOSTETHUS

1(2) Membranal suture with central white spot and two cresent white markings; labium reaching or passing mid coxae ..... *militaris*

2(1) Membranal suture without such white spot; labium passing hind coxae ..... *hospes*

1. ***Spilostethus hospes*** (Fabricius)

1794. *Lygaeus hospes* Fabricius, *Ent. Syst.*, **4** : 150.

1904. *Lygaeus hospes* Fabricius : Distant, *Fauna Brit. India*, **2** : 6.

1914. *Spilostethus hospes* Bergroth, *Ent. Mitteil*, **2** : 356.

1988. *Spilostethus hospes* : Mukhopadhyay, *Rec. zool. Surv. India*, **107** : 15.

1989. *Spilostethus hospes* : Ghosh *et al.*, In : *Fauna of Orissa, State Fauna Series*, **1** : 202. Zoological Survey of India.

1994. *Spilostethus hospes* : Chakraborty and Ghosh, Insecta : Hemiptera : Lygaeidae, *In* : *Fauna of West Bengal, State Fauna Series*, **3**(pt. 5) : 419. Zoological Survey of India.

1997. *Spilostethus hospes* : Ghosh, L.K. *et al.*, *In* : *Fauna of Delhi, State Fauna Series*, **6** : 251. Zoological Survey of India.

Diagnosis : Body finely pilose, pale sanguineous, head with a spot at inner margins of eyes, with two broad central discal fasciae to pronotum; rostrum reaches the posterior coxae; scutellum with a large central spot to corium; membrane, disks of sternum and abdomen black; legs also black, femora unarmed.

Length : 10-13 mm.

Host plants : *Calotropis gigantea, C. procera, Solanum melongena, Antirrhinum* sp., *Morus indica.*

Distribution : India : Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Australia; China; Malayan Archipelago; Myanmar, New Caledonia; Pakistan; Sri Lanka.

Remarks : The species is recognised by red-white or black spots or bands on body; wings are characterised by 4-5 simple veins in the membrane of hemelytra. It is of common occurrence on sugarcane and sorghum ears in south India. According to Mukhopadhyaya (1983), this bug may play important role in controlling the noxious weed like *Calotropis* spp. (Family-Asclepiadaceae).

2. ***Spilostethus pandurus militaris*** (Fabricius, 1775)

1775. *Cimex militaris* Fabricius, *Syst. Ent.*, : 717.

1763. *Cimex pandurus* Scopoli, *Ent. Carn. Exhib. Ins. Corniol,* IV : 126-127, 368.

1912. *Spilostethus pandurus* Oshamin, *Kat. Hem.*, **1** : 27.

1988. *Spilostethus pandurus militaris* (Fabricius) : Mukhopadhyay, *Rec. zool. Surv. India. Occ. Paper No.,* **107** : 15.

Diagnosis : Body pale sanguineous; presence of a spot at inner margins of eyes; pronotum with two large obscure ochraceous spots on basal area; scutellum with a small spot near apex of clavus, a transverse fascia to corium, pro-sternum, abdominal segmental margins and with stigmal spots; Membrane black, with a central white spot and two crescent white markings on membranal suture; labium reaches or passes 2nd coxae; legs black, femora distinctly spined beneath.

Length : 13–16 mm.

Host plants : *Calotropis* spp. (N. O. Asclepiadaceae).

Distribution : India : Karnataka, Maharashtra, Madhya Pradesh, Orissa, Punjab, Uttar Pradesh, West Bengal and commonly found in South India.

Elsewhere : Australia; Myanmar; Malayan Archipelago; Mandalay; Minhla; Pakistan; Palaearctic region.

Remarks : The species feeds on *Calotropis gigantea*, and *C. procera* (N.O. Asclepiadaceae). There is little variation in the population found in West Bengal, but being of all India distribution some specimens incidentally examined from desert area of western India (Rajasthan, Gudha) were found to have a yellow-ochraceous colour as compared to the dull red coloured ones from eastern India. (Mukhopadhyay, 1988).

Management : Dusting BHC 5% may be effective.

Subfamily II OXYCARENINAE

Genus 2 ***Oxycarenus*** Fieber

1835. *Stenogaster* Hahn, *Wanz. Ins.*, **3** : 15-16.

1837. *Oxycarenus* Fieber, *Beitr. Nat. Ges, Heilwiss* : 339-340.

Type-species : *Stenogaster tardus* Hahn, 1835 = *Acanthia lavaterae* Fabricius, 1787.

Diagnosis : Ovoid and elongate head accommodated in anteriorly narrowed and punctate pronotum; elongated bucculae reaching base of head; anterior femora spined below; corium flat expanded, wider than abdomen; clavus with two rows of punctures.

3. ***Oxycarenus laetus*** Kirby, 1891
Dusky Cotton Bug
(Fig. 374)

1891. *Oxycarenus laetus* Kirby. *Jour. Linn. Soc. Lond.*, **24** : 102.

1988. *Oxycarenus laetus* Kirby : Mukhopadhyay, *Rec. zool. Surv. India, Occ. Paper No.*, **107** : 35.

Diagnosis : Head, antennae, pronotum, scutellum, legs piceous; corium pale with a small piceous spot at apical angle; head, pronotum, clavus and corium with capitate hairs; membrane pale greyish hyaline; mid and hind tibiae pale stramineous, bases and apices piceous; subcostal region with single prominent row of puncture; clavus with three rows of punctures, middle one imcomplete. The adults 4-5 mm in length, dark brown and with dirty white transparent wings. The young nymphs with a rotund abdomen and, as they grow older, they resemble the adults, except for being smaller and having prominent wing pads instead of wings. tarsi stramineous with apex piceous; anterior femora distinctly spined beneath.

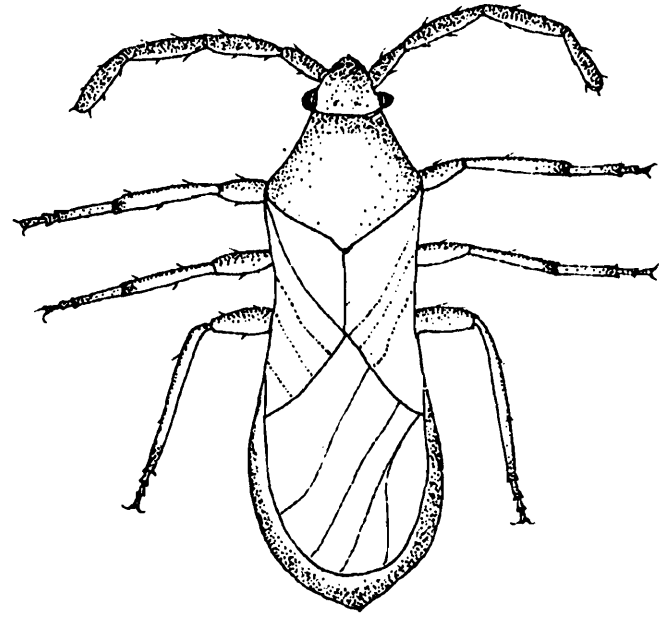


Fig. 374. General view of *oxycarenus laetus* Kirby

Host plants : *Gossypium stocksii, Sida rhombifolia, Hibiscus abelmoschus, H. vitifolius, H. sabdarifa, H. cannabinus, Althaea rosea, Abutilon indicum, Thespesia populnea, Abelmoschus esculentus,* okra, hollyhock and other malvaceous weeds.

Distribution : India : Southern part, Orissa, West Bengal.

Elsewhere : Myanmar; Mandalay; Pakistan; Sri Lanka.

Natural enemy complex : *Tripleps tantilus* Motsch. (Fam. Anthocoridae : Heteroptera) feeds on the nymphs of the lygaeid bug.

Symptom and Damage : Both the nymphs and adults suck the sap from immature seeds, whereupon these seeds may not ripen, may loose colour and may remain light in weight.

Biology : The female lays cigar-shaped eggs in the spring on *Hibiscus* and then on okra and finally on cotton during the monsoon. The eggs are usually laid in the lint of half-opened bolls, either singly or in small clusters of 3-18 each. The egg stage lasts for 5-10 days and the nymphs, on emerging, pass through 7 stages, completing the development in 31-40 days. The life cycle lasts for 36-50 days and a number of generations are completed in a year. The nymphs and adults are found feeding inside the open bolls, where quite a large number of them is seen at a time. Incidence : November-January.

Remarks : This lygaeid occurs in fruits and capsules of *Sida rhombifolia* and *Hibiscus abelmoschus*, mainly feeding on seeds. Infestation is mostly recorded in winter and early spring. This is a minor pest of cotton in India and its chief importance lies in the fact that the adults and nymphs get crushed at the time of ginning, thus staining the lint and lowering the market value of cotton. The insect is small and uniform dusky greyish brown in colour. A severe infestation of sunflower by the pest is observed in North India. It appears at bud formation during April and its population reaches a peak in May (full bloom and seed formation stages), with infestation ranging between 20 and 100% and an average population of nymphs and adults of 50-300/-head (Vijay-Singh 1999). This is also known an Egyptian "Cotton stainer" In India, it is found in all cotton growing areas including Punjab where it is known to occur on Cotton in considerable numbers during September-October. A few lygaeid bugs are predaceous on other insects. In India, *Geocoris tricolor* is predaceous on the mirid bugs *viz. Calocoris angustatus* Lethiery and *Ragmus importunitus* Distant, the painted bug *Coptosoma cribraria* (Fabr.), the aphids *Aphis gossypii* Glover and *A. nerii* B.d.F. and the coccids *Pseudococcus* sp. and *Dactylopius* sp.

Management : Any one of the following insecticides can be used in 250 litres of water per ha : 200 ml of phosphamidon 85 WSC, 750 ml. of formothion 25EC oxydemeton methyl 25EC, 625 ml of dimethoate 30 EC, 100 ml of imidacloprid 2000 SL. (Atwal and Dhaliwal, 1997).

Subfamily III ORSILLINAE

Genus 3 *Nysius* Dallas

1852. *Nysius* Dallas, *List Hem. B. M.*, **2** : 551-562.

Type-species : *Lygaeus thymi* Wolff.

Diagnosis : Head broad, eyes prominent, projecting beyond the anterior angles of the pronotum; basal joint of antenna a little shorter than the head, 2nd usually longer than the 3rd; body oblong; membrane with 5 veins, anterior femora unarmed.

4. *Nysius inconspicuus* Distant

1904. *Nysius inconspicuus* Distant, *Faun. Brit. Ind. Rhyn.*, **2** : 18.

1988. *Nysius inconspicuus* : Mukhopadhyay, *Rec. zool. Surv. India, Occ. Paper No.*, **107** : 19.

1994. *Nysius inconspicuus* : Chakraborty and Ghosh, Insecta : Hemiptera : Lygaeidae, *Fauna of West Bengal, State Fauna Series,* 3(Pt. 5) : 424. Zoological Survey of India.

Diagnosis : Head antennae and pronotum reddish ochraceous; head coarsely punctate, somewhat infuscate; body beneath ochraceous except blackish base of abdomen, pronotum with a transverse fascia near anterior margin and the lateral angles piceous; scutellum with punctures; corium pale creamy white; with some spots on veins and apical margins pale fuscous; membrane pale shining hyaline; sternum abdominal base much suffused with piceous; legs ochraceous; femora with coarse punctures, tarsi piceous apically; pronotum with a central anterior carination, scutellum also with a central carination and usually blackish.

Length : 3 mm.

Distribution : India : West Bengal.

Remarks : The species shows much variation specially in the pronotal and antennal colouration. The fuscous spots on corial veins and membranal sutures variable in number and extent. Abdomen ventrally some time variegated. This bug feeds on gingelly.

Subfamily IV BLISSINAE

Genus 4 *Cavelerius* Distant

1903. *Cavelerius* Distant, *Ann. Soc. Ent. Belg.*, : 44.

Type species : *Cavelerius illustris* Distant.

Diagnosis : Pronotum with posterior margin excavated, the posterior pronotal angles produced over the bases of the corium and clavus, their apices broadly oblique and extending beyond margins of corium; basal and apical segments of antennae thickened.

5. *Cavelerius excavatus* (Distant)
Sugarcane Black Bug

1901. *Macropes excavatus* Distant, *A. M. N. H.* (7)viii : 467.

1910. *Macropes excavatus* : Distant, *Fauna Brit. India*, **5** : 25.

Diagnosis : The adults are black with white patches on the wings extending slightly beyond the abdomen. The shape and colour of nymphs is similar to those of the adults but are smaller in size. Head, pronotum, scutellum, abdomen above, and body beneath

black; legs and antennae ochraceous; corium pale ochraceous, with the claval margins and venation somewhat darker; membrane piceous, basal angle, a spot on each lateral margin, and the apex creamy-white. Membrane just passing the fourth abdominal segment.

Length : 6-7 mm.

Distribution : India : all over.

Elsewhere : Pakistan; Sri Lanka.

Symptom and Damage : The nymphs and adults suck cell-sap from the central whorl of the young plants. In case of grown up plants they prefer to feed within the leaf-sheaths and varieties having broad and loosely attached sheaths are preferred by this pest. As a result of feeding of both the nymphs and adult bugs the leaves show pale appearence and holes appear on the infested leaves.

Biology : The pest actively breeds throughout the year during winter. In summer, the female lygaeid lays 55-478 creamy white eggs in clusters of 14-67 on the inner side of the leaf sheaths. The eggs hatch in 9-17 days. The nymphs grow through five stages and complete their development in 4-6 weeks. The adults live long. Males die earlier than the females. The insects complete approximately three generations in a year. In winter, the bugs lay eggs in the soil at a depth of 5-7 cm. Hatching takes place during next spring. The nymphs mature by June. Thus, overlapping generations occur in the field.

Natural enemy complex : Parasite : *Nardo camaeus* Nixon and *N. phaeax* Nixon. The eggs are parasitised by these species.

Remarks : This pest is widely distributed throughout India and Pakistan. It has been found feeding on rice, maize and a number of grasses. Both the adults and nymphs cause damage by sucking cell sap from the plants. They are seen congregated under the leaf sheaths or in the top whorl.

Management : Spray 875 ml. of endosulfan 35EC or 565 ml of fenitrothion 50 EC or 875 ml. of chlorpyriphos 20 EC in 1000 litres of water per ha. Direct the spray material into the leaf whorl (Atwal and Dhaliwal, 1997).

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Vijay Singh 1999. Infestation of dusky cotton bug, *Oxycarenus laetus* Kirby (Hemiptera : Lygaeidae) on sunflower in Uttar Pradesh. *Insect-Environment,* **5** : 2, 82.

HETEROPTERA : MIRIDAE (CAPSIDAE)

These insects are known as leaf bugs or plant bugs. The Miridae (Fig. 375a,b) comprise insects with a more or less soft integument but with most variable structural characters. These are small to medium-sized elongate delicate insects. Antennae four-segmented, the first segment usually stoutest, third and fourth segment most slender; rostrum 4-segmented; ocelli absent; tarsi 3-segmented; presence of distinct cuneus and indistinct embolium; female with well developed oviposition. These insects are variously coloured. Characteristic of the family is the wonderful simulation by many species of insects of other orders, especially of ants. Mirids are primarily plant sap feeders. Some are predaceous in nature while some are plant pests. In India, following are the important pests : *Calocoris angustatus* and *Megacoelum stramineum* on sorghum ears; *Pachypeltis politus* on betelvine; *Helopeltis antonii* and *H. theivora* on tea, cashew, guava; *Azadirachta indica* on tea, grapevine etc.; *Prodomus subviridis* on banana; *Cryptopeltis crassicornis* on tobacco and tomato; *Carvalhoia arecae* on arecaunt and *Ragmus importunitus* on *Crotalaria juncea.* Among the predaceous Mirid, a species of *Psallus* is important. It predates on Thrips-*Taeniothrips distalis* which infests flowers of *Cajanus cajan* (N.O. Fabaceae).

It is a very large family of over 6000 species all over the world. Some important workers are knight 1941; Carvalho 1952-60, Wagner and Weber, 1964, Leston 1961.

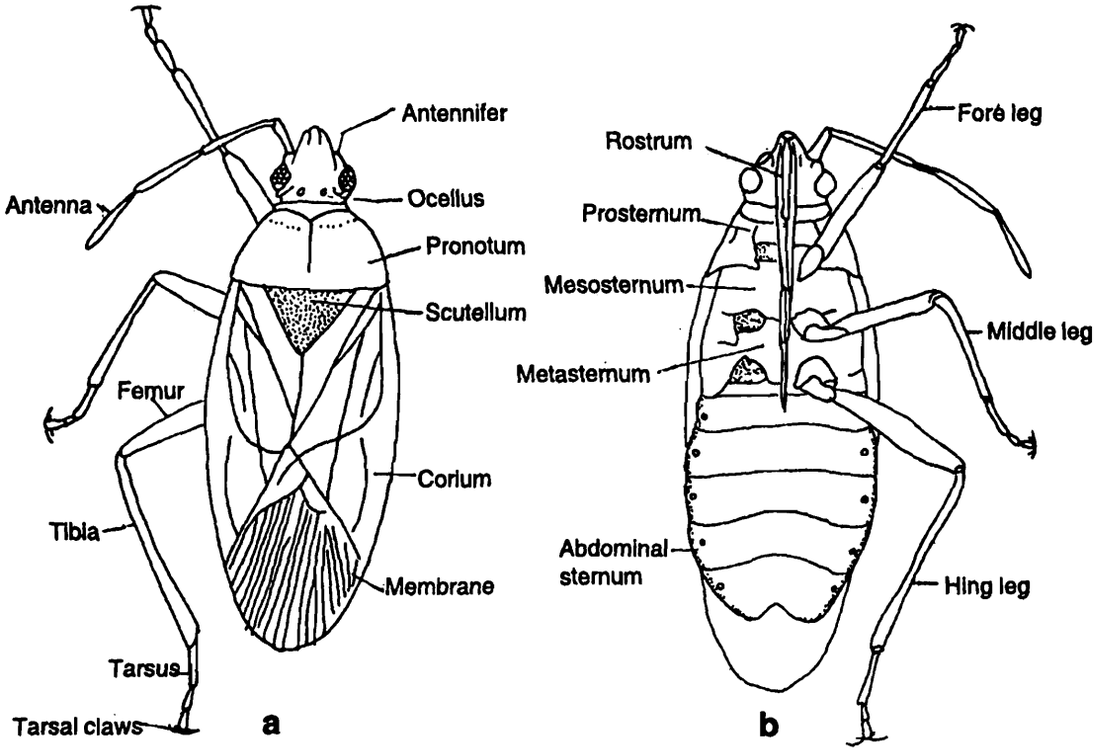


Fig. 375. Major morphological features of a Mirid Bug. a. dorsal view; b. ventral view.

It constitutes the largest Palaearctic family of Heteroptera, with more than 1000 species from that region. Not much work has been done on this group from India except the contribution of mainly Distant 1902, 1904, 1910 who dealt nearly 181 species from the Indian subcontinent.

SYSTEMATIC ACCOUNT

Family MIRIDAE (CAPSIDAE)

Genus 1 ***Calocoris*** Fieber

1. *Calocoris angustatus* Lethiery

Genus 2 ***Carvalhoia***

2. *Carvalhoia arecae* Miller and China

Genus 3 ***Helopeltis*** Signoret

3. *Helopeltis antonii* Signoret
4. *Helopellis theivora* Waterhouse

Genus 4 ***Ragmus*** Distant

5. *Ragmus importunitas* Distant

Key to the genera of the Family MIRIDAE

1(2) Body oval and much hairy ..... ***Carvalhoia***

2(1) Body elongate 3

3(4) Pronotum strongly constricted before middle ..... ***Helopeltis***

4(3) Pronotum deflected anteriorly 5

5(6) Smaller in size (about 3 mm); rostrum reaches 2nd coxae; posterior femora much more distinctly spinutose; tibiae distinctly longly spinulose ..... ***Ragmus***

6(5) Larger in size (5-8 mm); rostrum extends beyond 2nd coxae; posterior femora not as above; tibiae very feebly spinulose ..... ***Calocoris***

Genus 1 ***Calocoris*** Fieber

1858. *Calocoris* Fieb., *Wien. ent. monatsb, Bd.,* 11 : 305.

Type species : *Calocoris lincotus* Goeze

Diagnosis : Body elongate, head inserted to the eyes; rostrum extending beyond the mid coxae but not passing the hind coxae; antennae with the basal joint shorter than the pronotum or about the same length; pronotum convexly deflected anteriorly, with a narrow raised collar; scutellum moderately tumid; hemelytra with the margins parallel.

1. *Calocoris angustatus* Lethiery
Sorghum Earhead Bug
(Fig. 376)

1893. *Calocoris angustatus* Lethiery, *Indian Mus. Notes,* **3**(2) : 90.

1904. *Calocoris angustatus* : Distant, *Fauna Brit. India,* **2** : 452.

1976. *Calocoris angustatus* : Nayar, Ananthakrishnan and David, General and applied Entomology : 171.

Diagnosis : Body elongate; antennae fulvous, 1st segment robust, as long as head, 2nd segment very long, slender, 4 times as long as 1st antennal segment, 3rd, 4th and 5th segments equal in length, slender; pronotum trapeziform, punctulate, posterior angles prominent, little obtusely acute, anterior angles obtuse, anteriorly with a distinct collar, the apical area for about $^1/_3$ from anterior margin robustly callose; hemelytra punctate, sparingly fulvous-pubescent; clavus and sutural portion of corium roseate; tibiae armed with 10/11 black spinules, apices of tarsi fuscous.

Length : 5-8 mm.

Host plants : *Sorghum vulgare, Zea mays, Elucene coracana, Pennisetum typhoideum, Dinebra retroflexa, Decanthium annulatus, Eragrostis abyssinica, Panicum repens, Sporobolus coromandalianum, Saccharum officinarum, Setaria italica.*

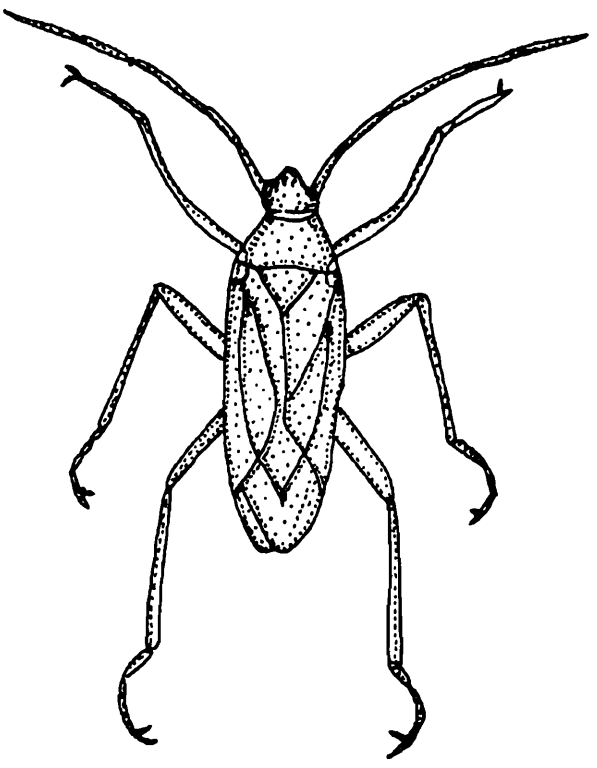


Fig. 376. *Calocoris angustatus* Lethiery

Symptom and Damage : Both adults and nymphs suck the sap from the developing grain which becomes tanned, shrivel, and result in both qualitative and quantitative loss grain yield. Hundreds of adults and nymphs can be observed on a single panicle under severe infestation, and as a result, the panicle become blasted and eventually dries up producing no grain. Head bug damage increases the severity of grain moulds, and deteriorates the grain quality. As a result, the rainy season grain is priced at half of the grain produced during the post rainy season in the absence of head bugs and grain moulds (Duale *et al.* 1999).

Biology : The pest species lays cigar-shaped eggs (150-200) under the glumes or in between anthers of florets, by inserting its ovipositor. The eggs hatch within a week. After emergence, the nymphs start feeding on developing grains in the milk stage. Through five instars the nymphs develop into adult stage in about 20 days. With the

ripening of the grains the pest stops multiplying on that crop. Life cycle is completed in a month or so. In a year, a number of generations are produced.

Natural enemy complex : *Geocoris tricolor* (Lygaeidae), *Reduviolus* sp. (Reduviidae)

Distribution : The pest enjoys wide distribution in southern and eastern parts of India. It is also known from Africa, Indonesia, Sri Lanka and Vietnam.

Remarks : *Calocoris angastatus* is one of the most destructive pests of sorghum particularly in southern parts of India. The adult is a small slender. greenish yellow insect feeding on a number of cereals, millets and grasses, lent sorghum is the main host on which it assumes the status of a pest posing a serious problem in good yield of sorghum. The adults appear on the crop as soon as the panicle emerges from the boot-leaf. Though it infests various cereal crops, its breeding is restricted to sorghum.

Management : Dusting carbaryl 10% dusts at an interval of 10 days synchronising with the milky stage proves effective. Also, spray 625 ml of malathion 50EC or one litre of endosulfan 34EC or 3 Kg. of Carbaryl 50 WP or 200 ml of phosphamidon 85 WSC in 500 litres of water per ha.

Efforts to develop, release, and popularize varieties that are resistant to key pests should be intensified. The possibility of using attractants, repellents and antifeedants should be explored. Insecticides of plant origin such as those obtained from *Azadirachta indica*, *Anona squamosa*, *Acorus calamus Catharanthus roseus* etc. may be explored to control the pest.

Genus 2 ***Carvalhoia***

2. ***Carvalhoia arecae*** Miller and China
Arecanut Mirid Bug

Diagnosis : The adult is a red and black bug measuring about 6 mm long and 2.5 mm wide. The nymphs are greenish with reddish brown patches. The adults and the nymphs suck sap from central spindles and the young fronds.

Host Plant : *Areca catechu, A. lutescens*

Length : 6 mm.

Symptom and Damage : The tender leaves of arecanut palms are usually attacked by both the adults and nymphs who suck the cell sap from the soft tissues with the help of their piercing and sucking type of mouth parts. The insects congregate within the top-most leaf axis. For feeding purpose they move out and later return to the axis again. As a result of feeding, damage symptom appears as longitudinal, narrow, decolourised zone rapidly on either side of the puncture, along the length of the blade of the leaf. The decolourised patch thus developed, gradually turns yellowish to brownish colour within a few days and ultimately the leaves get dried up and consequently holes develop on the leaves. As a result of severe infestation, stunted growth of the trees is noticed.

Biology : The female lays eggs singly into the tissues of the tender unopened leaves of the palm and rarely 2 or 3 eggs are found laid together. The operculum of the egg is visible with two silvery filaments projecting out. The eggs are oval. 13.6 × 0.34 mm with two-bristle-like structures arising from the operculum, one being straight and the other curved. The eggs hatch in nine days and the young nymphs suck cell sap from tender parts. The nymphs become adults in 2-3 weeks after undergoing 5 moultings. The pest is active during February.

Distribution : India : Southern part (South Kanara and Kerala).

Management : Sprays of 250 ml. of monocrotophos 40 EC or 375 ml. of quinalphos 25EC in 250 litres of water per ha at monthly intervals are effective.

Genus 3 ***Helopeltis*** Signoret

1858. *Helopeltis* Signoret., *Ann. Soc. Ent. Fr.* (3), **vi** : 502.

Type species : *Helopeltis antonii* Signoret

Diagnosis : Elongate body; head broad, deflected in front of eyes, discally and centrally longitudinally incised or sulcated; antennae inserted in front of but on a level with the inner margin of eyes, 1st antennal segment about as long head and pronotum together; pronotum strongly constricted before the middle; scutellum with a long more or less erect horn or spine, its apex clavate; legs slender and moderately long.

Key to the species of the genus *Helopeltis*

1. Scutellar horn more or less distinctly curved backwards; antennae dark brown, basal joint paler, yellowish at base ..... *theivora*

— Scutellar horn nearly straight and perpendicular; antennae peachy black, shining, ochraceous at base ..... *antonii*

3. ***Helopeltis antonii*** Signoret
(Fig. 377)

1858. *Helopeltis antonii* Signoret, *Ann. Soc. Ent. Fr.*, (3) **vi** : 502.

1910. *Helopellis antonii* Signoret : Distant, *Fauna Brit. India,* **5** : 440.

1976. *Helopeltis antonii* Signoret : Nayar *et al.*, General and Applied Entomology : 172.

Diagnosis : Body elongated; head black, anterior margin of pronotum narrowly obscurely ochraceous; rostrum ochraceous, more or less dark brown antennae shining peachy black ochraceous at base; scutellumdark, brownish-yellow at apex; scutellar horn nearly straight and perpendicular; hemelytra pale olivaceous-fuscous; legs brown, speckled with ochraceous; bases of femora distinctly brownish; abdomen beneath clay-coloured, with a basal spot and the apex black;

Length : 6-7½ mm.

Symptom and Damage : As soon as the young bugs hatch from the egg, vigorous feeding activity starts. They suck the plant sap voraciously. As a result, the affected shoots and leaves first turn brown and later on black.

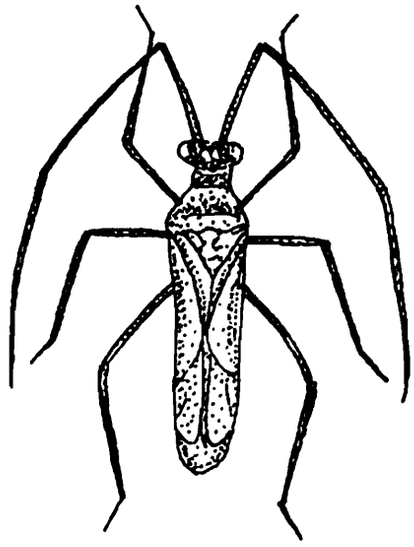


Fig. 377. *Helopeltis antonii* Signoret

Biology : The eggs are laid in groups of two or more in green shoots of the bush at the succulent stage. After emergence, the nymphs become hairy, look like spiders, amber-coloured. Later, they become smooth and orange-red in colour. In the warmer months they grow rapidly. Adults copulate. Within two days egg-laying may take place. A female may lay upto about 500 eggs. Life cycle is completed within a month. Several generations occur in a year. Multiplication takes place rather rapidly when early showers are followed by heavy and continuous rainfall. During colder months the pest species hibernates in the adult stage within the bushes of tea.

Management : Collecting the nymphs and adult by hand nets in early morning or late in the evening has been the practice for a long time. This operation should be done through as early in the season. With rising of day temperature the pest takes shelter in bushes. Spray the bushes with 500 ml. of malathion 50 EC in 500 litres of water per ha. (Atwal and Dhaliwal, 1997).

4. ***Helopeltis theivora*** Waterhouse
Tea mosquito Bug

1896. *Helopeltis theivora* Waterhouse, *Tr. E.S., t. xi. f. 3, moore ined* : 458.

1904. *Helopeltis theivora* : Distant, *Fauna Brit. India,* **2** : 440-441.

1976. *Helopeltis theivora* : Nayar *et al.* General and Applied Entomology : 172.

1997. *Helopeltis theivora* : Atwal and Dhaliwal, Agricultural pests of South Asia and their management : 345.

Diagnosis : Blackish insect with pronotum bright shining or ochraceous, having a subapical transverse fascia and the basal area shining black; head beneath with a lateral luteous fascia on each side, more obscurely seen above; scutellum ochraceous, more or less suffused with black, the horn long, more or less distinctly curved backwards, black, piceous at apex; antennae dark brown, basal joint paler, yellowish at base; femora dark brown, with a distinct pale annulation near base; tibiae concolourous with femora, abdomen pale creamy-ochraceous.

Length : 6-8 mm.

Host plants : Tea, Guava, Cashewnut and many medicinal plants.

Symptom and Damage : The Tea mosquito bug punctures the leaf frequently to suck the juice. While feeding, the saliva is injected and the tissues around the site of feeding are necrosed, becoming brownish or black. By the coalescence of a large number of such patches, the entire leaf may become black and shrivelled, and may fall off enentually. Due to severe attack of the pest, defoliation takes place and the shoots are killed. As a result, the plants look quite pale.

Biology : The female bug lays up to 500 eggs in the buds and axils of the leaves or often in the broken end of the plucked shoot. The eggs are elongate, sausage-shaped, having two long unequal protruding filaments. They hatch in 5-27 days, depending upon the prevailing temperature. A freshly emerged nymph is wingless and on account of its long appendages it looks like a spider. In summer, it completes its development in about two weeks after passing through five moults. In winter, the nymphal stage is prolonged to eight weeks or more. The adult is slender, agile and a good flier. It feeds at night on tea and several alternative host plants. During flight, the adults may be carried long distances by the wind and get dispersed over wide areas. Throughout the day, they are seen concealed on the underside of the leaves.

Natural enemy complex : *Agamennis paradecaudata* Steiner, a nematode, is known to parasitize the nymphs of the pest species.

Remarks : This bug bears no relation to mosquitoes and the name Tea mosquito bug is a misnomer. The female bug is orange across the shoulders and the male is almost black. Both nymphs and adults damage the plant by sucking sap from young leaves, buds and tender stems. The pest is more common in eastern India.

Management : Same as in *Helopeltis antonii.*

Genus 4 ***Ragmus*** Distant

1910. *Ragmus* Distant, *A.M.N.H.* (8) **V** : 18

Type species : *Ragmus importunitas* Distant.

Diagnosis : Head deflected anteriorly, eyes globular, placed at base of head, scarcely projecting beyond the anterior margins of the pronotum; antennae with the first joint shorter than head, slightly thickened and with two spinules, second joint more than three times as long as first and spinulose; rostrum reaches second coxae; pronotum at base more than twice as broad as long and less than twice as broad as anterior margin; posterior margin concave, with two transverse callosities before anterior margin, the lateral margins oblique; scutellum subtriangular; corium (including cuneus) only slightly longer than hind tibiae; cuneus as broad at base as outwardly long and distinctly longly sparsely pilose; membrane considerably passing the abdominal apex; anterior and mid femora slightly and posterior femora much more distinctly spinulose, tibiae distinctly, longly spinulose.

5. *Ragmus importunitas* Distant
Sunhemp Capsid
(Fig. 378)

1910. *Ragmus importunitas* Distant, *A.M.N.H.*, (8) **V** : 18.

1910. *Ragmus importunitus* Distant, *Fauna Brit. India*, **5** : 289.

1976. *Ragmus importunitas* Distant : Nayar, Ananthakrishnan and David, General and applied Entomology : 172.

1997. *Ragmus importunitas* Distant : Atwal and Dhaliwal, Agricultural pests of South Asia and their management : 238.

Diagnosis : Body pale ochraceous; globular eyes; third and fourth joints of antennae piceous; head with two transverse darker impressions in front of eyes and a more or less distinct central foveation near base; cuneus distinctly, darkly, sparsely pilose; membrane hyaline; body beneath and legs pale ochraceous, 1st and 2nd femora slightly, posterior femora more distinctly spotted with black, tibiae blackish the spinules black and placed near the black spots, apices of the tarsi black.

Length : 3½ mm.

Host plants : *Crotalaria juncea, Crotalaria anagyroides* and *Barleria cristata* (N.O. Fabaceae)

Symptom and Damage : The nymphs and adult green bugs suck plant sap from leaves with the help of piercing and sucking mouth pasts. When the population is high and severe attack takes place, the plants become pale and appear unhealthy. As a result of gregarious feeding, yellow spots appear first, later the spots become bigger. The leaves which are attacked, become distorted and undersized. Also, young plants get dried and older plants suffer stunted growth. Thus, appreciable damage is done to the plants due to severe attack of this mirid bug.

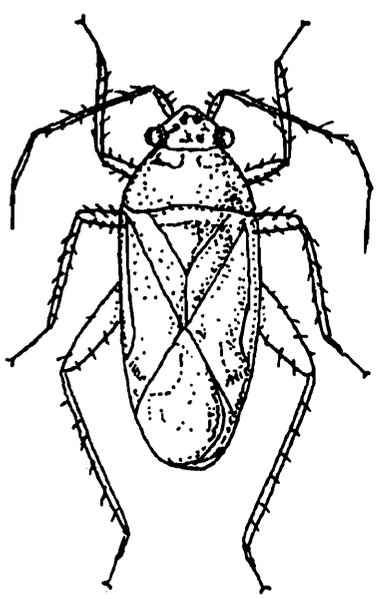


Fig. 378. *Ragmus importunitas* Distant

Biology : The adult female first makes holes by inserting the stylets into the plant tissue and then inserts the single cylindrical egg in each hole. Operculum of egg is without any filament which is applicable in most of the mirids. The incubation period is 7-8 days. There are 5 nymphal instars. The nymphal period ranges from 10-12 days. The longevity of adult female is 19-43 days and that female ranges from 13 to 33 days. The total life cycle from egg to adult varies from 35 to 62 days. There are two peak populations, one during November-December and

the other during July-August on *Crotalaria juncea* in South India. Whereas in Northeast India, on *C. anagyroides* the mirid bug completes its life cycle in 16-24 days. Here, the population is high during April-May. Afterwards it declines gradually till January. Thereafter, the population increases again.

Natural enemy complex : *Geocoris tricolor* (Fam. Lygaeidae) is predaceous on this mirid bug.

Distribution : The pest species is more common in Southern India than.

Elsewhere in India. It is also known from Sri Lanka, Java and Celebes.

Remarks : The species is considered to be one of the important pests of sunhemp *(Crotalaria juncea)* a green manure crop in South India. It is a serious pest on *Crotalaria anagyroides* grown for soil rehabilitation in the tea estates of North-east India.

Other important plant pests species in India :

Azadirachta indica on tea, grapevine

Cryptopeltis (Nesidiocoris) crassicornis on tobacco and tomato

Megacoelum stramineum on Sorghum ears

Pachypeltis politus on betel vine

Prodomus subviridis on banana

Management : Sprays of dieldrin 0.018%, endrin 0.02% and thiometon 0.025% prove useful.

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INSECTA : HEMIPTERA : HETEROPTERA : PENTATOMOIDEA

INTRODUCTION

The pentatomids or "Shield bugs" are heteropteran insects which are terrestrial and phytophagous. Some are carnivorous in habit. These insects are mostly solitary in nature. However, a few species may be seen in clusters. They are generally pests of vegetable crops. They can be recognised by a pungent odour emitted by them. The group is remarkable for its beautiful coloration. They are abundant in tropical regions and also spread over temperate zones. A persual of literature reveals that a little over 550 species (against about 5,000 spp. in the world) of Pentatomoidea are known from the Indian region. (Distant 1902, 1904, 1908, 1910, 1918; Paiva 1919; Ahmad and Afzal 1989; Dutta *et al.* 1985, Ahmad and Maizuddin 1990; Chakraborty and Dutta, 1977; Chakraborty *et al.* 1993, 1994; Ghosh *et al.* 1996; Chakraborty and Ghosh 1998; Hegde 1986, 1995; Mathew 1968; Ghosh *et al.* 1989). The classification is basically followed *sensu* (Distant *op. cit.* and Linnavouri 1975).

Superfamily PENTATOMOIDEA

Diagnosis (Fig. 379) : Body broad, shield-like in shape, moderate to large-sized, often brightly coloured insects with a triangular scutellum. Antennae usually 5-segmented; tarsi 2 or 3 segmented; scutellum usually covering only about half the abdomen; hemelytra well developed; membrane with 5-12 veins, spiracles of 2nd abdominal segment completely or almost completely concealed beneath metaflux. Some are minor pests of vegetables, cotton and other crops, but members of the subfamily Asopinae are chiefly predaceous, particularly on lepidopterous larvae.

MATERIAL AND METHODS

The Pentatomids can be collected by sweeping net. Beating branches with a stick over a sheet of cloth (white) is helpful for collection. Picking up of individual specimen is done from leaves, stems and twigs with the help of forceps. After collection, the specimens are killed in a killing jar using benzene or chloroform vapour. Then the insects are transferred to the insect envelopes and a separate data label mentioning collection locality, name of collector, date of collection, altitude etc. are provided to each envelope. The insects are usually preserved dry with paradichlorobenzene and nathalene. In Laboratory, the specimens are set, pinned and mounted to display properly for easy handling under the binocular microscope for examination and identification. The clasper or paramere, an important component of the male genitalia, structurally varies conspicuously from one species to other and even from one variety

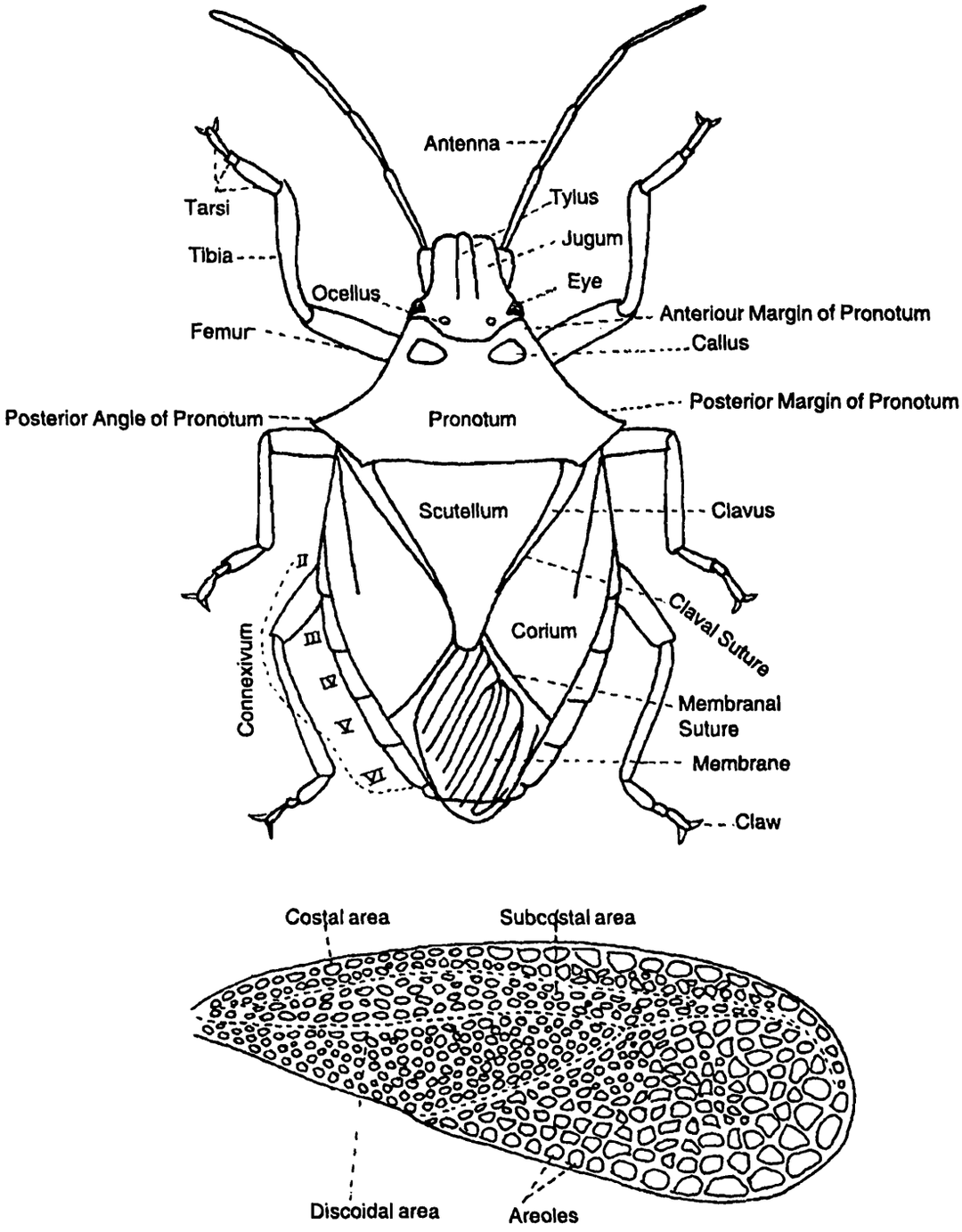


Fig. 379. Morphological features of a Pentatomid Bug

to other of the same species. Due to obvious reason, together with the morphological characters of male and female specimens, wherever possible, the shape of the clasper is also taken into consideration for determining the identity of a particular species.

For the preparation of slide of Genitalia, the tip of the abdomen of male specimen is cut, put in 10%–15% KOH, stained in acid fuchsin and mounted in canada balsom or DPX to prepare permanent slides of male genitalia.

SYSTEMATIC ACCOUNT

Superfamily PENTATOMOIDEA

Family I PENTATOMIDAE

Genus 1 ***Agonoscelis*** Spinola

1. *Agonoscelis nubila* (Fabricius)

Genus 2 ***Antestia*** Stal

2. *Antestia cruciata* (Fabricius)

Genus 3 ***Bagrada*** Stal

3. *Bagrada picta* (Fabricius)
4. *Bagrada hilaris* Kirkaldy

Genus 4 ***Canthecona*** Amyat & Serville

5. *Canthecona furcellata* Wolff.

Genus 5 ***Cappaea*** Ellener

5. *Cappaea taprobanensis* (Dallas)

Genus 6 ***Cinxia*** Stal

7. *Cinxia limbata* (Fabricius)

Genus 7 ***Dolycoris*** Mulsant & Rey

8. *Dolycoris indicus* Stal

Genus 8 ***Halys*** Fabricius

9. *Halys dentatus* (Fabricius)

Genus 9 ***Menida*** Motschulsky

10. *Menida histrio* (Fabricius)

Genus 10 ***Nezara*** Amyot & Serville

11. *Nezara viridula* (Linnaeus)

Genus 11 ***Piezodorus*** Fieber

12. *Piezodorus rubrofasciatus* (Fabricius)

Genus 12 ***Stenozygum*** Fieber

13. *Stenozygum speciosum* (Dallas)

Family II PLATASPIDAE

Genus 13 ***Coptosoma*** Dallas

14. *Coptosoma cribrarium* (Fabricius)

Family III SCUTELLERIDAE

Genus 14 ***Chrysocoris*** Nahr

15. *Chrysocoris grandis* (Thunberg)
16. *Chrysocoris marginellus* (Westwood)

17. *Chrysocoris stollii* (Wolff.)

Genus 15 ***Poecilocoris*** Dallas

18. *Poecilocoris hardwickii* (Westwood)
19. *Poecilocoris latus* Dallas

Genus 16 ***Scutellera*** Lam

20. *Scutellera nobilis* Fabricius

Family IV TESSARATOMIDAE

Genus 17 ***Tessaratoma*** Lep. & Serv.

21. *Tessaratoma javanica* (Thunberg)

Family V DINIDORIDAE

Genus 18 ***Aspongopus*** Laporte

22. *Aspongopus janus* (Fabricius)

Genus 19 ***Cyclopelta*** Amy. & Serv.

23. *Cyclopelta siccifolia* Westwood

Family VI UROSTYLIDAE

Genus 20 ***Urostylus*** Westwood

24. *Urostylus punctigera* Westwood

Key to the families of PENTATOMOIDEA

1(2) Head always clypeated; hemelytra longer than the body, folded in at the base of membrane ..... PLATASPIDAE

2(1) Head normal; hemelytra straight, not folded as above 3

3(4) Hamus present; scutellum covering the whole of the hemelytra, excepting extreme base of outer margin ..... SCUTELLERIDAE

4(3) Hamus absent 5

5(6) Spiracles of basal ventral segment not hidden by metasternum ..... TESSARATOMIDAE

6(5) Spiracles at basal ventral segment hidden by metasternum 7

7(8) Rostrum short, not usually passing anterior coxae ..... UROSTYLIDAE

8(7) Rostrum long, always passing anterior coxae 9

9(10) Membrane very large ..... DINIDORIDAE

10(9) Membrane small; antennae usually 5-segmented; hemelytra well developed .. .. PENTATOMIDAE

Family I PENTATOMIDAE

Key to genera of the family PENTATOMIDAE

1(2) Basal abdominal spine present 3

2(1) Basal abdominal spine absent 9

3(4) Basal abdomen acute and moderately long ..... ***Piezodorus***

4(3) Basal abdomen usually tuberculate 5

5(6) Pronotum with lateral margin normal; lateral margins of head scarcely sinuate ..... ***Menida***

6(5) Pronotum with lateral margin not normal 7

7(8) Pronotum with lateral margins truncate behind eyes, margins of head laterally sinuate ..... ***Nezara***

8(7) Pronotum with lateral margins sinuate; lateral margins of head concavely sinuate, not as above ..... ***Canthecona***

9(10) Lateral margins of pronotum serrate or dentate; head elongatged, tapering in front ..... ***Halys***

10(9) Lateral margins of pronotum normal 11

11(12) Scutellum apically distinctly narrowed, shorter than corium .... ***Stenozygum***

12(11)Scutellum a little narrowed at posterior half, almost as long as or a little longer than corium 13

13(14) Body distinctly oval; abdomen with a short basal furrow ..... ***Dolycoris***

14(13) Body rather elongately oval; abdomen apparently without such furrow ... 15

15(16) Body obovate; head subtriangular ..... ***Antestia***

16(15) Body elongate; head obovate 17

17(18)Anterior lateral margin of pronotum entire, straight, somewhat acute, anterior margin somewhat callous centrally; body remotely pilose, body beneath luteous; yellowish brown or bluish green body ..... ***Agonoscelis***

18(17)Anterior lateral margin of pronotum somewhat truncate and not callous; body not pilose; body beneath ochraceous; body rather blackish ..... ***Bagrada***

Family I PENTATOMIDAE

Antennae usually 5-segmented; tarsi 2 or 3-segmented; scutellum usually covering only about half the abdomen; hemelytra well developed; membrane with 5-12 veins, spiracles of 2nd abdominal segment completely or almost completely concealed beneath metaflux.

Genus 1 *Agonoscelis* Spinola

1878. *Agonoscelis* Spinola, *Essaisur les Hem.* : 327.

Type species : *Cimex nubilus* Fabricius, 1775. Selected by Distant, 1903.

Diagnosis : Body elongate-oval, coarsely and sparsely punctate. Head with apex rounded, lateral margins of juga concave. Anterior margin of pronotum oblique behind eyes; anterolateral margins thin and vaguely sinuate, posterior margin straight. Scutellum long, with apex shortly rounded, disc in anterior half raised. Exterior margin of corium much longer than scutellum, posterior margin straight, interior angle broadly rounded, clavus comparatively small. Rostrum passes hind coxae. Posterior exterior angles of laterotergites not produced.

1. *Agonoscelis nubila* (Fabricius)
Sapsucking Bug
(Fig. 380-381)

1775. *Cimex nubila* Fabricius, *Syst. Ent.*, : 712.

1851. *Agonoscelis nubila* Dallas, *List. Hem.* **1** : 179.

1989. *Agonoscelis nubila* (Fabricius) : Ghosh, L.K., Biswas, Chakraborty and Sen, *Fauna of Orissa, State Fauna series*, **1** : 203.

1994. *Agonoscelis nubila* (Fabr.) : Chakraborty, Ghosh, L.K. and Basu, *Fauna of West Bengal, State Fauna Series*, **3** : 477.

1995. *Agonoscelis nubila* (Fabr.) : Hegde, *Rec. zool. Surv. India, Occ. Paper No.*, **163** : 29.

1998. *Agonoscelis nubila* (Fabr.) : Chakraborty and Ghosh, L.K., *Fauna of Meghalaya, State Fauna Series*, **4** : 399.

1986. *Agonoscelis nubila* (Fabr.) : Hegde, *East. Ghats Ins.*, **1** : 27.

2000. *Agonoscelis nubila* (Fabr.) : Chakraborty and Ghosh, L.K., *Fauna of Tripura, State Fauna Series*, **7**(2) : 420.

Diagnosis : Yellow-brown, remotely pilose, body covered with blackish punctures excepting the lateral margins and central fascia to head, an irregular central fascia to pronotum; scutellum extending beyond the middle of abdomen, with apex levigate, luteous rugosities on the anterior lateral areas of scutellum; body beneath and legs luteous; apex of rostrum, antennae, tibiae, tarsi and apices of femora black; membrane fuliginous with vein piceous. On head, pronotum and scutellum coarsely and sparsely punctate, coriaceous parts of hemelytra densely and rugulosely punctate; connexivum orange-yellow; abdomen unarmed at base.

Length : 10-11 mm.

Host plants : Rice, wheat, sugarcane, millets, pulses, tobacco; sorghum and aniseed (*Pimpinella anisum*). The species also occurs on coriander and cumin plants. On cumin it feeds on flowers.

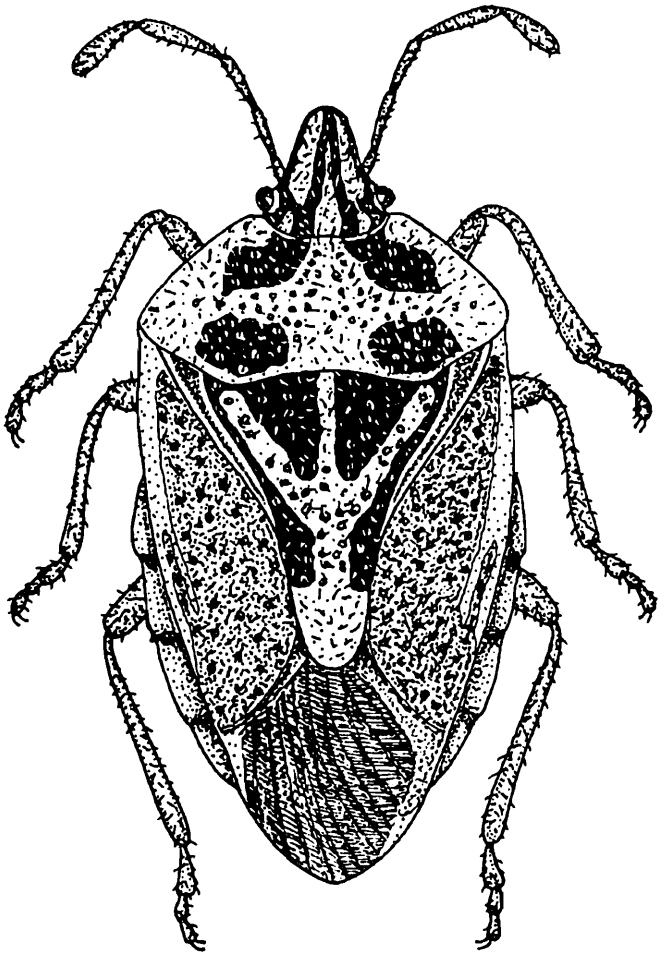


Fig. 380. *Agonoscelis nubila* (Fabricius)
(after G. F. Gross, 1975)

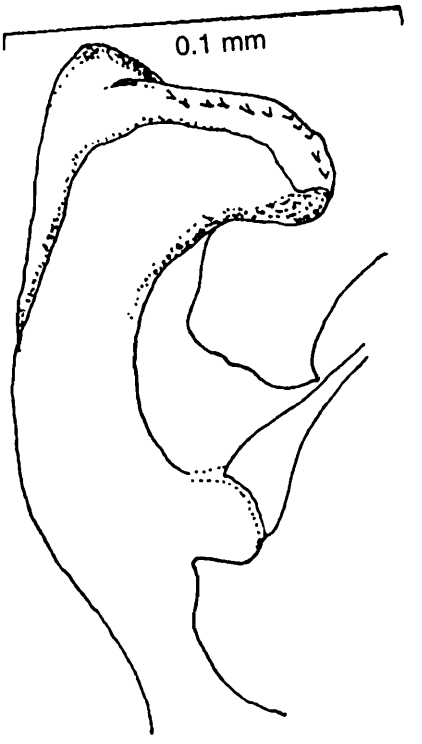


Fig. 381. *Agonoscelis nubila* (Fabricius)
Clasper

Symptom and Damage : Adults and nymphs suck the sap from leaves and stems of host plants. Heavily infested plants may show light defoliation, stunting.

Biology : Adults are yellowish in colour. Life cycle is completed in 40-60 days and extended to 50-70 days in winter (October to December). The species have five generations in a year under Indian conditions.

Distribution : India : widely distributed including Nilgiri Hills and Javadi Hills.

Elsewhere : Myanmar; China; Japan; Islands of Malayan Archipelago; Malaya Peninsula; Sri Lanka.

Remarks : The species closely resembles *Agonoscelis femoralis* Walker from which it differs in smaller size and in 2nd and 3rd antennal segments subequal (distinctly longer than 2nd in *femoralis*).

Management : Removal of the alternate hosts from the nearly paddy field bunds minimise bug incidence. Neem based products like achook or nimbecidine (1%) sprays are effective.

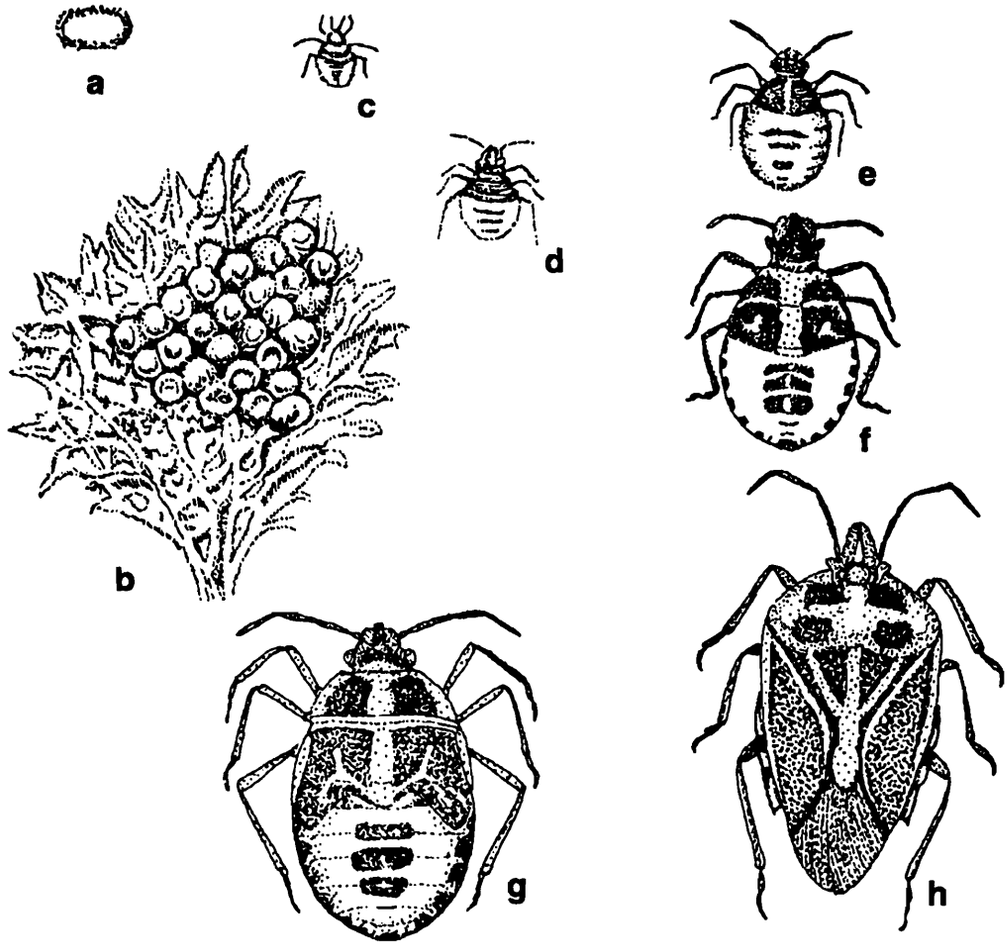


Fig. 382. Life history of a Pentalomid bug (*Agonoscelis* sp.) : a. egg; b. egg masses; c.–g. nymphal stages; h. adult.

Genus 2 ***Antestia*** Stal

1864. *Antestia* Stal, *Hem. Afr.*, **1** : 200.

Type species : *Antestia maculata* Dallas

Diagnosis : Broadly oval insect with head moderately deflected, lobes equal, rostrum passing the posterior coxae; first joint of antennae almost reaching apex of head; anterior lateral margins of pronotum distinctly elevated and callous, lateral angles rounded; scutellum subtriangular, broad, about as broad as long as base, narrowed towards apex, mesosternum centrally carinate; abdomen unarmed at base.

2. ***Antestia cruciata*** (Fabricius)
(Fig. 383)

1775. *Cimex cruciata* Fabricius, *Syst. Ent.*, : 714.

1851. *Agonoscelis nubila* Dallas, *List Hem.*, **1** : 179.

1902. *Antestia cruciata* : Distant, *Fauna Brit. India*, **1** : 185.

1985. *Antestia cruciata* (Fabricius) : Datta, Ghosh and Dhar, *Rec. zool. Surv. India, Occ. Paper No.,* **80** : 9.

1994. *Antestia cruciata* : Ghosh, M., Datta and Ghosh, L.K. In : *State Fauna Series, Fauna Series,* **3**(Pt. 5) : 497.

1902. *Antestia cruciata* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 28.

Diagnosis : Body orange-yellow; head with two central lines and a spot near each eye black; pronotum with ten black spots anterior lateral margins of pronotum elevated or callous margin; scutellum almost triangular with four black spots (two on basal margin, the other two elongate and angulate on disk), apex levigate; corium with three discal black spots and a costal black streak; membrane dark fuliginous, sternum and abdomen with two sublateral series of black spots, abdomen with additional central, submarginal and marginal series; clasper (Fig. 383) robust, arched along inner margin, infolded marginally.

Length : 7-9 mm.

Distribution : India : (Javadi Hills, Nilgiri Hills, Bombay, Calcutta, Sikkim, eastern ghats), widely distributed.

Elsewhere : Myanmar; Sri Lanka; and Islands of Malayan Archipelago.

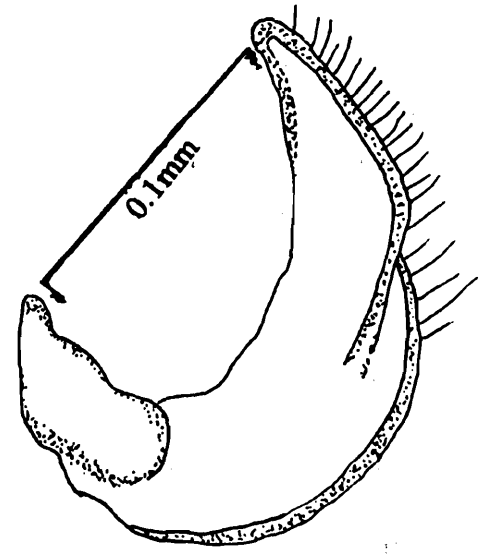


Fig. 383. *Antestia cruciata* (Fabricius) : Genital appendage (Clasper)

Remarks : The species is of great economic importance. It occurs in appreciable numbers usually during November and continues to stay till advent of rainy season. The incidence of the species is involved in the destruction of fruits, vegetables and cereal crops. It is common on coffee, fruits of *Citrus, Santalum* and also on *Zyzyphus.* It is destructive to Coffee trees both in Oriental and Ethiopian Regions. It usually feeds on the barries of the coffee plant.

Management : Chemical control using malathion dust or spray applications are effective.

Genus 3 ***Bagrada*** Stal

1862. *Bagrada* Stal, *Stett. ent. Zeit.* xxiii : 105.

Types species : *Bagrada picta* Fabricius

Diagnosis : Body rather ovate, head triangular, lateral lobes a little longer than the central; margins reflexed; eyes moderately stylate; pronotum obscurely sexangular, anterior margin of pronotum somewhat truncate not distinctly elevated and not callous; mesonotum with distinct carination; abdomen unarmed.

3. *Bagrada cruciferarum* [= *B. picta* (Fabricius)]
Painted Bug
(Figs. 384, 440)

1775. *Cimex picta* Fabricius, *Syst. Ent.;* 715.

1862. *Bagrada picta* : Stal, *Stett. ent. zeit.,* **23** : 105.

1995. *Bagrada picta* : Chakraborty & Ghosh, L.K., *Fauna of Meghalaya, State Fauna Series,* **4** : 399.

Diagnosis : Blackish body; antennae also blackish, connexivum ochraceous, spotted with black; membrane fuliginous; body beneath ochraceous; streaks to head, marginal lines to coxae, lateral marginal spots to sternum and abdomen, more or less distinct transverse discal segmented lines, segmental spots larger posteriorly black; legs brownish, spotted and streaked with black. The full grown nymphs are about 4 mm long and 2.6 mm broad. They are black with a number of brown marking.

Length : 5-7 mm.

Symptom and Damage : Severe damage is caused by both nymphs and adults. The adults and nymphs suck cell-sap from the leave and developing pods which in due course gradually wither and dry up. The insects do not spare even fruits in their attempt to satisfy their hunger. On plants chosen by them for food, they stay in cluster. They take shelter on leaves and stems. The affected plants are deprived of their vitality. The species prefers to cruciferous plants. The morphs also excrete a sort of resinous material spoiling the pods.

Biology : This bug is active from March to December. During this period, all the stages can be seen. It passes the winter months of January and February in the adult stage under heaps of dried oilseed plants lying in the fields. The female bugs lay eggs which are oval, pale-yellow, singly or in groups of 3-8 on leaves, stalks, pods and sometimes on soil. Eggs may be laid either in day or night. A female bug may lay 37-102 eggs in its life span of 3-4 weeks. The eggs are pale yellow when freshly laid but before hatching they turn pinkish. The eggs hatch in 3-5 days during summer and 20 during December. The nymphs develop fully in five stages and transform themselves into adults in 16-22 days during the summer and 25-34 days during the winter. The entire life cycle ends in 19-54 days and it passes though 9 generations in a year (Atwal and Dhaliwal, 1997).

Natural enemy complex : The eggs are parasitised by *Gryon* sp. [Scelionidae] while *Alophora* [Tachinidae] parasitise the adults.

Distribution : India : widely distributed.

Elsewhere : Arabia, East Africa; Egypt; Ethiopia; Malawi; Myanmar; Sri Lanka; Zimbabwe; Zaire; Senegal; Mozambique; South Africa; Italy; Iran; Iraq; Pakistan; Myanmar and USSR.

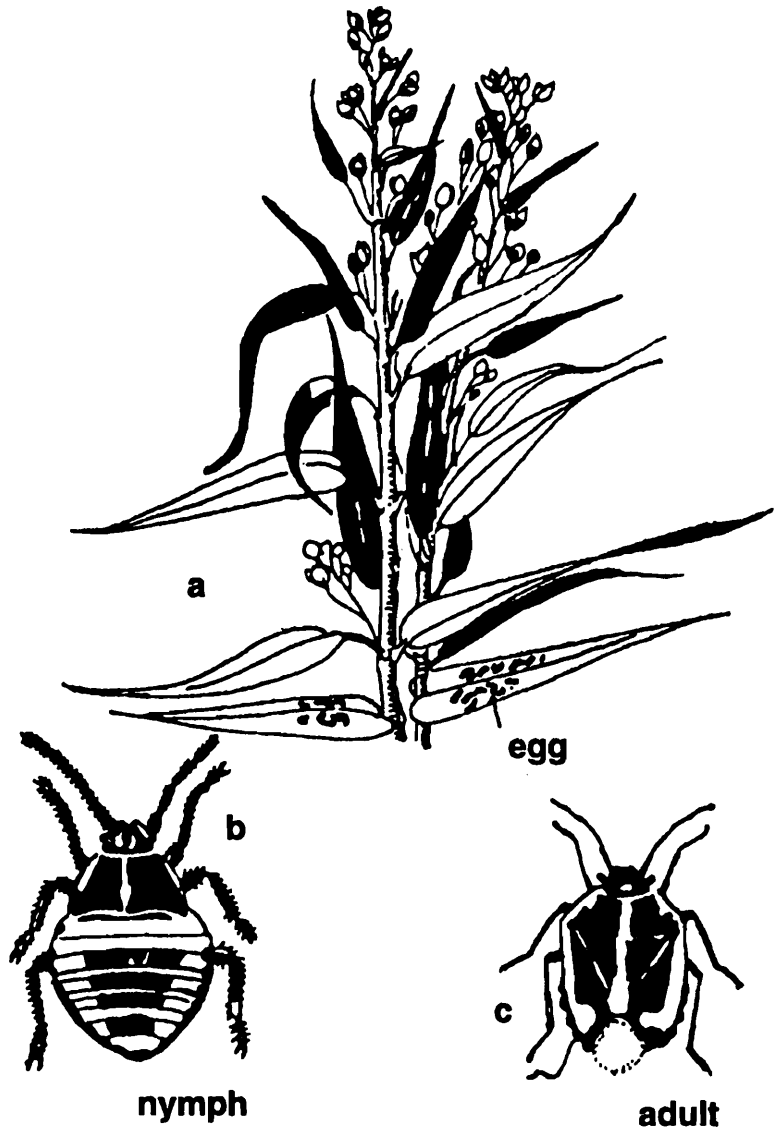


Fig. 384. *Bagrada picta* (Fabricius) : a. showing egg masses; b. nymph; c. adult.

Remarks : This painted plant bug is a serious pest of cruciferous crops. Apart from cruciferous crops, the pest also feeds on rice, sugarcane coffee, indigo etc.

Management : The first irrigation should be applied 3-4 weeks after sowing the crop. It will give an effective control of the painted bug. The nymphs and adults both should be collected by sweeping nets and killed. The stubbles of the old infested plants should be destroyed. If insecicidal treatments become necessary, following insecticides may be sprayed to control the bugs : 0.02% diazinon or 0.1% malathion or 0.03% dimethoate. Dusting of 2% folidol powder also gives satisfactory result.

4. ***Bagrada hilaris*** Kirkaldy
Painted bug/Harlequin bug

1997. Atwal, A. S. and Dhaliwal, G. S. Agricultural pests of South Asia and their management, Kalyani Publishers, Ludhiana : 211.

2000. Surender Kumar, D. K. Garg, Saroj Singh, Prem Kishore and Subhas Chander. Insect pests of Brassicas and their management. *In* : Insect pests of pulses and oil seeds and their management. Applied Entomology, Vol. 2, AZRA, Cuttack : 149.

Diagnosis : Body subovate, blackish and with a number of orange or brownish spots, shield-shaped. The fully grown nymphs are about 4 mm long and 2.6 mm broad, blackish in colour with a number of brown markings.

Length : 3.7 mm. with 3.3 mm width.

Host plants : Its main hosts are *Brassica* spp. and alterante host include other crucifera plants, beet, groundnut, potato and mallow etc.

Symptoms and Damage : Both nymphs and adults suck cell-sap from the leaves and developing pods, which gradually wilt and dry up. The nymph and adult bugs also excrete a sort of resinous material which spoil the pods. Severe incidence at seedling stage had necessitated the resowing of crops, while at harvesting stage it caused 3 to 4.5% reduction in oil content and 30% reduction in seed weight (Singh *et al.,* 1980). The yield losses due to painted bug were estimated to be 31% at the national level (Anonymous, 1993). It has also been reported to reduce oil content by 3 to 4.5 to (Batra. 1958).

Biology : Female bugs lay oval, pale-yellow eggs singly or groups of 3-8 on the leaves, stalks, pods and sometimes on soil. A female bug may lay 37-102 eggs in its life span of 3-4 weeks. The eggs hatch in 3-5 days during summer and in 20 days during December. The nymphs develop fully through five nymphal instars and transform themselves into adults in 16-22 days during summer and in 25-35 days during the winter. They are black with a number of brown marking. The adult bugs are shield-shaped, 3.71 mm long and 3.33 mm broad. They are sub-ovate, black and have a number of orange or brownish spot. The life cycle is completed in 19 to 54 days, the shortest being in May-June and longest in December-January and this bug has 9 generations in a year (Atwal. 1976). The pest species feeds on cruciferous oilseed and vegetable crops from September to February (Bhai and Singh 1961). This bug is active from March to December and passes the winter (January and Februry) in adult stage under heaps of dried oilseed plants lying in the fields.

Distribution : India : all over except high altitudes in the Himalayas.

Elsewhere : Africa, Egypt, Ethiopia, Malawi, Zimbabwe, Zaire, Senegal, Mozambique, S. Africa, Italy, Iran, Iraq, Pakistan, Sri Lanka, Myanmar and USSR.

Remarks : This is an occasional but important pest of cruciferous crops (Vora *et al.* 1985).

Management : Cultural Control : Destruction of all cruciferous weeds will help to prevent in population build up. Bug incidence is reduced in crop sown during mid November-December (Joshi *et al.,* 1989). Clean cultivation, balanced doses of nitrogen and quick threshing of harvested crops resulted in low infestation by this bug.

Increasing doses of nitrogen (0,20,40 and 60 kg/ha) also enhanced bug infestation (Makhmoor and Shinde, 1986).

Chemical Control : Phorate granules applied @ 1.15 g/m row in furrows, seed treatment with carbofuran 4g/100g seed and furrow treatment with disulfoton @ 1.95 g/m row were found effective (Nakat and Peswani, 1972). Application of phorate protected the crop upto 57 days. Sarup *et al.* (1971a) reported that fenitrothion proved the best insecticide. Gupta and Sharma (1971) reported that the application of dimethoate (0.05 kg/ha) offered best control of the painted bug. Jagdish and Dhingra (1990) found seed treatment with monocrotophos and phosphamidon (2.5%) and lindane (1.0%) effective against the pest species (After Kumar *et. al.* 2000).

Genus 4 ***Canthecona*** Amyot & Serville

1843. *Canthecona* Amy. & Serv., *Hem.*, : 81.

Type species : *Canthecona discolor* Palis

Diagnosis : Body elongately ovate; head flat, margins concavely sinuate in front of eyes; pronotum with the lateral margins sinuate, anterior portion with numerous fine scallops, anterior angles slightly spinous, posterior angles spinously produced; scutellum longer than broad; abdomen armed with a short central basal spine, anterior femora with a spine, anterior tibiae a little dilated.

5. ***Canthecona furcellata*** Wolff

1802. *Canthecona furcellata* : Wolff., *Icon. Cim.*, **5** : 182.

1902. *Canthecona furcellata* : Distant, *Fauna Brit. India,* **1** : 248.

1994. *Canthecona furcellata* : Ghosh, M., Datta, B. and Ghosh, L.K. Insecta : Hemiptera : Pentatomoidea-II, **In** : *Fauna of West Bengal, State Fauna Series,* **3**(Pt. 5) : 497.

1995. *Canthecona furcellata* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 33.

Diagnosis : Body clay-coloured, darkly punctate; head with the puncture somewhat confluent; antennae brownish; rostrum reddish apically; pronotum with a broken transverse fascia on anterior area, pronotal angles with their apices bifid, projected into short black spine; scutellum bronzyblack basally, with a somewhat large levigate spot at each basal angle; corium with bronzy-black suffusions; connexivum coarsely punctate, with large subquadrate bronzy-black spots; abdomen with short, central basal spine, abdominal margins with a series of green spots; legs ochraceous, femora annulated near apices, apices of tibiae blackish.

Length : 15-16 mm.

Distribution : India : Bihar, Maharashtra, Nagaland, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Myanmar; Sri Lanka.

Remarks : This is a predaceous species of pentatomid bug. It feeds on caterpillars of lepidopterous insects. Adult bugs paralyse the caterpillars by injecting saliva into the body of the caterpillar. It is much destructive to Tussar industry because the bug spoils the larval stages of Tussar silkworms. It is interesting to note that the first nymphal stage is sap-suckers and the second stages onward become predatory.

Genus 5 ***Cappaea*** Ellener

1862. *Cappaea* Ellener, *Nat. Tijdschr. Nederl. Ind.*, **24** : 146.

Type species : *Cappaea taprobanensis* (Dallas)

Diagnosis : Head normal, not deflected; pronotum with lateral angles subnormal, without lateral spines; ventral spines absent, anterior lateral margins of pronotum normal; scutellum a little narrower at posterior half, about as long as or a little longer than corium; abdomen with a short basal furrow.

Remarks : The genus is not accommodated in key because the material could not be examined.

6. ***Cappaea taprobanensis*** (Dallas)

1851. *Pentatoma taprobanensis* Dallas, *List. Hem.*, **1** : 244.

1944. *Cappaea taprobanensis,* Distant, *Fauna Brit. Ind. Rhyn.*, **1** : 149.

1994. *Cappaca taprobanensis,* Chakraborty, Ghosh & Basu *Rec. zool. Surv. India.* Occ. paper No. 161.

Diagnosis : Body above black except lateral margins and three longitudinal lines to head being slightly longer than pronotum; lineate reticulations on lateral areas of pronotum; a central fasciate line and two curved united lines on base of scutellum; margins and submarginal lines to corium, luteous body beneath the legs also luteous, also legs spotted with black; antennae fuscous with basal segments ochraceously spotted; membrane short, fuliginous with brown spots; abdomen with a short basal furrow (after Chakraborty and Ghosh, L. K., 2003).

Length : 10-11 mm.

Distribution : India : Sikkim (East Sikkim); Kerala, Meghalaya, Tamil Nadu.

Elsewhere : Java; Sumatra; Sri Lanka.

Remarks : This species is a pest on *Citrus* spp. and occurs on the bark of orange trees.

Genus 6 ***Cinxia*** Stal

1862. *Cinxia* Stal, *Stett. ent. Zeit,* xxiii : 105.

Type species : *Cinxia limbata* Fabricius.

Diagnosis : Body elongately ovate; head triangular, lobes equal; antennae with basal joint extending beyond the apex of head; pronotum sexangular, lateral margins reflected and elevated; basal segment of posterior tarsi about as long as other two segments taken together.

Remark : The genus is not included in the key as the material could not be examined.

7. ***Cinxia limbata*** (Fabricius)
(Fig. 385)

1803. *Cinex limbata* Fabricius, *Syst. Rhyng.*, : 176.

1904. *Cinxia limbata* (Fabricius) : Distant, *Fauna Brit. India,* **1** : 195.

Diagnosis : Body blackish; head ochraceous, with a broad central fascia; antennae black; pronotum with all the margins ochraceous; scutellum with the apex, central and lateral fasciae ochraceous; body beneath ochraceous, with a double central and submarginal series of black spots; legs black, femora streaked with ochraceous.

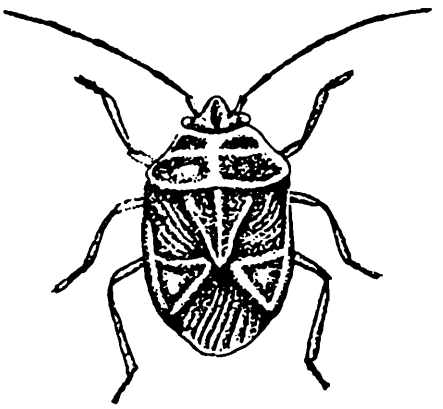


Fig. 385. *Cinxia limbata* (Fabricius)

Length : 13-16 mm.

Distribution : Oriental Region; India : Northeastern part.

Elsewhere : Myanmar; Java; Malay Peninsula; Sumatra.

Genus 7 ***Dolycoris*** Mulsant & Rey

1872. *Dolycoris* Stal, *Ofv. Vet.-AK. Forh,* **3** : 38.

1876. *Dolycoris* Stal, *Ent. Hem.,* **V** : 57.

Type species : *Dolycoris baccarum* Linnaeus (Fig. 441)

Diagnosis : Head somewhat elongate, lateral lobes a little longer than the central, apex somewhat truncate; first antennal joint not reaching head; lateral margins of pronotum oblique, lateral angles obtusely subprominent, the anterior lateral margins acutely reflexed; frena extends beyond the middle of scutellum.

8. ***Dolycoris indicus*** Stal
(Fig. 442)

1876. *Dolycoris indicus* Stal : *Ent. Hem.,* **5** : 76.

1904. *Dolycoris indicus* Stal : Distant, *Fauna Brit. India, Rhyn.,* **4** : 160.

1977. *Dolycoris indicus* Stal : Datta and Chakraborty, *Newsl. zool. Surv. India,* **3**(4) : 212.

1994. *Dolycoris indicus* Stal : Chakraborty, Ghosh, L.K. and Basu, R.C., *Fauna of West Bengal, State Fauna Series*, **3** : 480.

1998. *Dolycoris indicus* Stal : Chakraborty and Ghosh, L.K., *Fauna of Meghalaya, State Fauna Series*, **4** : 398.

2000. *Dolycoris indicus* Stal : Chakraborty and Ghosh, L.K., *Fauna of Tripura, State Fauna Series* **7**(2) : 419.

Diagnosis : Head narrowed, not deflected; body normal; scutellum not hump-shaped, a little narrowed at posterior half, almost as long as or a little longer than corium, anterior lateral margin of pronotum normal but sparingly punctured with dark base; membrane longer; head, pronotum and scutellum less densely punctate, lateral lobes of head longer than central lobe; odoriferous orifices on metasternum obruptly abbreviated; abdomen apparently with a short basal furrow closely allied with *D. baccarum* Linn. but differs in narrower form; head, pronotum as scutellum less densely punctate, membrane longer.

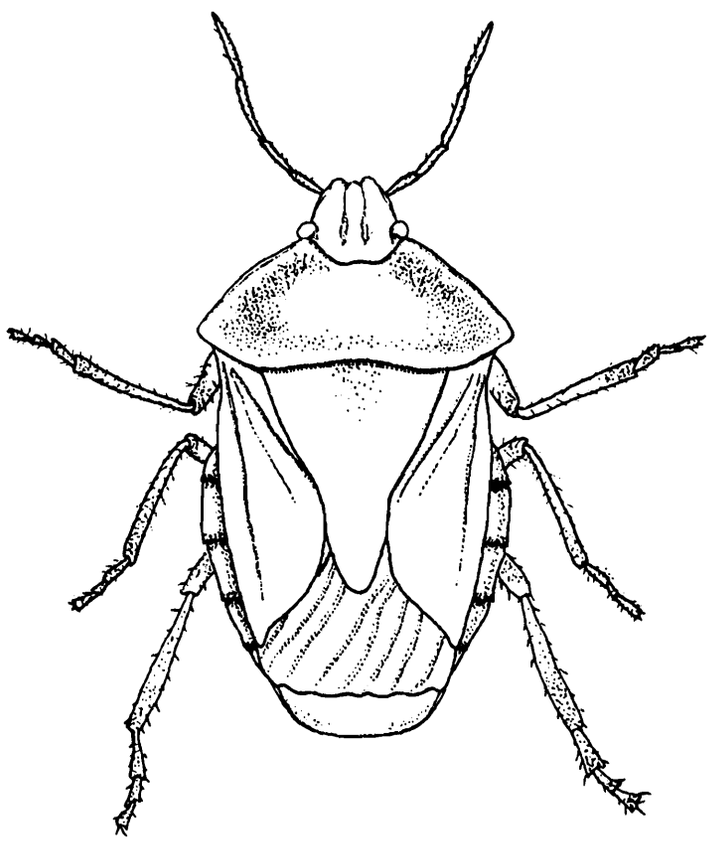


Fig. 386. *Dolycoris indicus* Stal

Length : About 10 mm.

Distribution : In India the species is rather widely distributed.

Remarks : This is commonly known as yellow plant bug which acts as pest occurring on Millets in India. Though the species attacks a large number of host plants, it prefers *Eleusine* spp. (N.O. Poaceae).

Management : As in case of *Agonoscelis nubila* (Fabr.)

Genus 8 ***Halys*** Fabricius

1803. *Halys* Fabricius, *Syst. Rhyng.* : 180.

Type species : *Halys dentatus* Fabricius

Diagnosis : Head long, distinctly tapering in front, the central lobe as long as the lateral lobes; 1st joint of rostrum reaches near bucculae; veins of the membrane irregularly ramulose; abdomen sulcated.

9. ***Halys dentatus*** (Fabricius)
(Figs. 387, 443)

1775. *Cimex dentatus* Fabricius, *Syst. Ent.*, : 702.

1803. *Halys dentatus* : Fabricius, *Syst. Rhyn.*, : 180.

1904. *Halys dentatus* (Fabricius) : Distant, *Fauna Brit. India,* **1** : 119.

1918. *Halys dentatus* : Distant, *Ibid.*, **7** : 121.

1986. *Halys dentatus* : Hegde, *East Ghats, Ins.*, **1** : 28, **2** : 27.

1995. *Halys dentatus* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.*, **168** : 21.

1997. *Halys dentatus* : L.K. Ghosh, Biswas, M. Ghosh and Chakraborty, Hemiptera, *Fauna of Delhi, State Fauna Series,* **6** : 254.

1999. *Halys dentatus* : Chakraborty and L.K. Ghosh, Insecta : Hemiptera : Pantalomoidea, In : *Fauna of Meghalaya, State Fauna Series,* **4** : 404. Zool. Surv. India.

Diagnosis : Body elongated oval, dull ochraceous; head long tapering in front; pronotum with indistinct oblique fasciae; scutellum with two marginal spots before apex black, pale at apex; rostrum extends beyond 5th abdominal segment; abdomen sulcated; 2nd and 3rd, also 4th and 5th antennal segments subequal; body beneath and legs ochraceous; head beneath and sternum coarsely and darkly punctate; abdomen finely and darkly punctate, its lateral margins spotted with piceous.

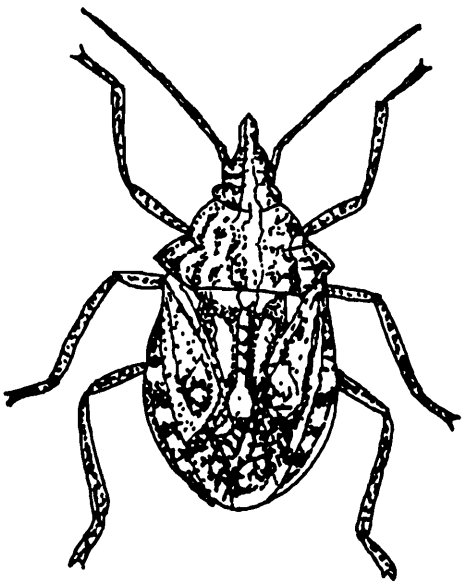


Fig. 387. *Halys dentatus* (Fabricius)

Length : 17-23 mm.

Distribution : Oriental, Ethiopian and Palearctic Regions; India : Meghalaya, Karnataka, Maharashtra, Orissa, Sikkim, Tamil Nadu, West Bengal.

Elsewhere : Africa; China; Japan; Pakistan and Sri Lanka.

Remarks : The species is usually found on *Acacia arabica* and also infests *Casuarina equisetifolia.*

Genus 9 ***Menida*** Motschulsky

1861. *Menida* Motsch., *Ent.*, **X** : 23.

1876, *Menida* Stal, *En. Hem.*, **V** : 97.

Type species : *Menida violacea* Motsch.

Diagnosis : Head broad, a little narrowed anteriorly, lateral margins a little sinuate; basal joint of antennae hardly reaches apex of head; rostrum reaching beyond posterior coxae; pronotum with the lateral margins very slightly sinuate; scutellum broad, sub triangular, abdominal base with a well developed spine or tubercle originating from the 2nd abdominal segment.

10. ***Menida histrio*** (Fabricius)
(Figs., 388, 444)

1787. *Cimex histrio* Fabricius, *Mant. Inst.*, **2** : 296.

1868. *Menida histrio* Fabricius : *Hem. Afr.* : 34.

1902. *Menida histrio* Fabricius : Distant, *Fauna Brit. India,* **1** : 228.

1989. *Menida histrio* Fabricius : Ghosh, L.K., Biswas, Chakraborty and Sen, *Fauna of Orissa, State Fauna Series*, **1** : 204.

1994. *Menida histrio* Fabricius : Chakraborty, Ghosh, L.K. and Basu, R.C., *Fauna of West Bengal, State Fauna Series*, **3** : 482.

1995. *Menida histrio* Fabricius : Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 32.

2000. *Menida histrio* Fabricius : Chakraborty and Ghosh, L.K., *Fauna of Tripura, State Fauna Series,* **7**(2) : 421.

Diagnosis : Body, beneath rostrum and legs ochraceous, sparingly blackly punctate; antennae ochraceous, head with the margins of 4 longitudinal lines blackly punctate; pronotum with an anterior submarginal black line and two transverse annulate black markings on anterior area; scutellum with a spot in each basal angle and the apex reddish ochraceous, an anterior discal spot and one on each lateral margin a little before apex black; corium with disk more or less greyish olivaceous, the apical area reddish ochraceous, containing a black spot; connexivum ochraceous spotted with black; membrane colourless; a broad sublateral margin to sternum and abdomen and a central abdominal series of spots black basal abdominal spine reaching the middle coxae; clasper stalked basally, abruptly broader on apical half and densely wrinkled.

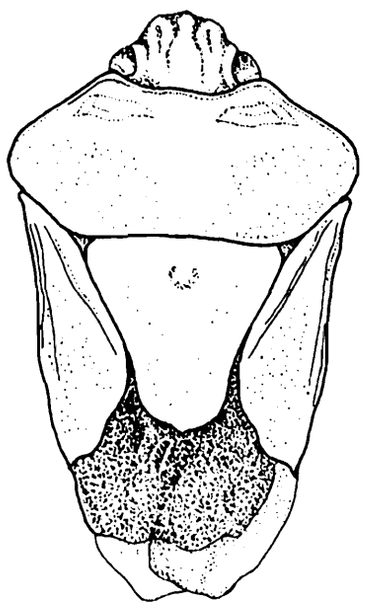


Fig. 388. *Menida histrio* (Fabricius)

Length : 6-8 mm.

Symptoms and Damage : Both nymphs and adults suck the sap/milk of developing rice grain, causing pecky rice. As a result of sucking, the bug causes small dot-like discolourations on the grains. The damage caused by this bug

along with *Eysarcoris ventralis* and *Nezara viridula* was recorded to be 3.2-14.9% (Gupta, 1991).

Biology : The female bug lays eggs in masses of 2-6 upto 40-60 eggs in a period of 11-20 days. There are 5 nymphal stages involving 28-31 days. It takes total 40-60 days to complete its life cycle, depending upon the availability of food grains and the weather conditions.

Host plants : Millets, rice, *Cynodon dactylon, Digitaria ciliaris* and *sphenochlox zeylanica* etc.

Distribution : India : Northeastern states including West Bengal and Orissa, also recorded from Southern India.

Elsewhere : Bhamo; Myanmar; China; Formosa; Sri Lanka; Taiwan.

Remarks : It is one of the minor pests occurring on wheat and sugarcane in India. As an occasional pest of rice, this bug is reported from eastern India.

Management : Removal of the alternate hosts from the nearby paddy field bunds minimise bug incidence. Chemical control by using malathion dust or spray applications 15 days after flowering only when its population is more than 5 bugs/m^2 are effective (Gupta, 1991). Achook or nimbecidine (1%) sprays also can control the populations of the bugs effectively (Rao and Prakash, 1995).

Genus 10 ***Nezara*** Amyot & Serville

1843. *Nezara* Amyot & Serville, *Histoire naturelle clees Insectes* : 143.

Type species : *Cimex smaragdulus* Fabricius, 1775 : *Cimex viridulus* Linnaeus, 1758 fixed by Kirkaldy, 1903.

Diagnosis : Body obovate; head rather quadrate, juga not surpassing apex of anteclypeus; antennae slender; rostrum reaching to about hind coxae; anterolateral margins of pronotum narrowly reflexed, lateral angles broadly rounded; hemelytra leaving most of laterotergites exposed, latter with posterior exterior angles produced into a minute backwardly directed spine; pronotum truncate behind eyes; mesosternum moderately carinate; abdomen tuberculately spinous basally.

11. ***Nezara viridula*** (Linnaeus)
Green Rice Bug
(Figs. 389, 390, 445)

1758. *Cimex viridulus* Linnaeus, *Syst. Nat. ed.* **10** : 444.

1976. *Nezara viridula* (Linn.) : Gross, Plant feeding and other bugs (Hemiptera) of South Australia, Hetereoptera, pt. 2 : 451.

1985. *Nezara viridula* : Dutta, Ghosh and Dhar, *Rec. zool. Surv. India, Occ. Paper No.*, **80** : 14.

1994. *Nezara viridula* : Chakraborty, Ghosh and Basu, *In* : *Fauna of West Bengal, State Fauna Series*, 3(Pt. 5) : 483. Zoological Survey of India, Calcutta.

1995. *Nezara viridula* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.*, **168** : 31.

2000. *Nezara viridula* : Chakraborty and Ghosh, Insecta : Hemiptera : Heteroptera : Pentatomoidae, *In* : *Fauna of Tripura, State Fauna Series*, (2) : 422. Zoological Survey of India, Calcutta.

Diagnosis : Body green or greenish-ochraceous, densely punctate; head binotate, thickly punctate, lobes equal; antennae green, apically brownish; abdomen punctate and tuberculously spinous at base black ventrolaterally; pronotum trinotate; corium with green spots. Basal antennal segments green, apex of most of 4th and 5th, except basally brown. Underside usually lighter than above, frequently yellow around blunt process at base of abdomen. Fovae in basal angles of scutellum black. Densely and finely punctate above. Scutellum somewhat swollen basally. Abdomen not furrowed; Clasper (Fig. 390) robust, foot-shaped strongly geniculate, densely rugulate, apex sharply bent.

Length : 12-17 mm.

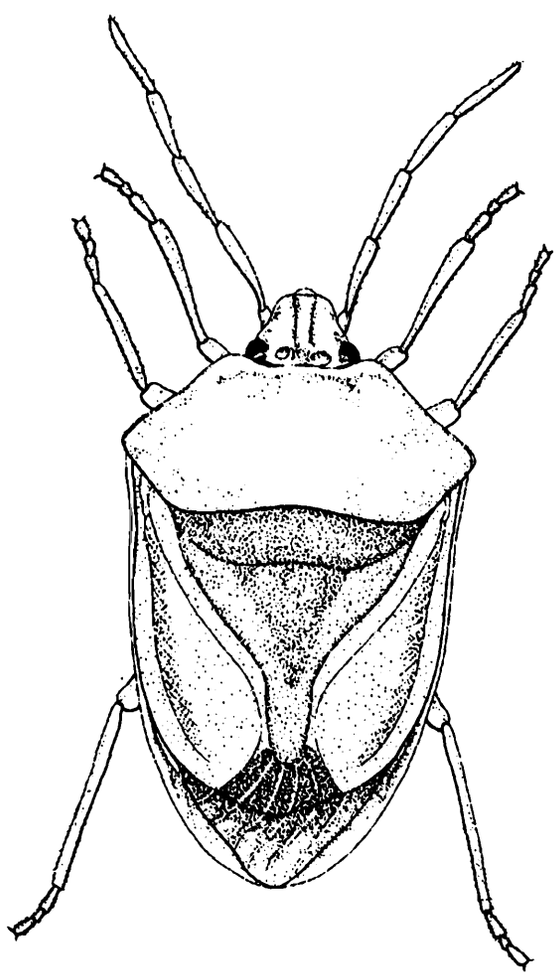


Fig. 389. *Nezara viridula* (Linnaeus)

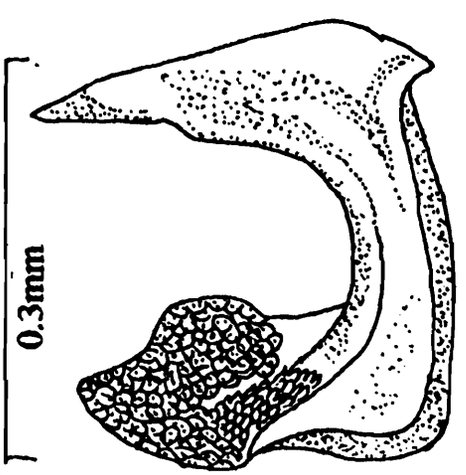


Fig. 390. *Nezara viridula* (Linnaeus) : Clasper

Symptom and Damage : Nymphs and adults suck the cell sap from tender leaves and stems and devitalise the host plants. Almost invariably the developing fruit is the part of the plant attacked, and the feeding punctures cause local necrosis with resulting fruit spotting, deformation, or if attacked at very young stage, fruit shedding.

Biology : The adults are shield bugs and light green in colour. A female lays on an average of 300 eggs in clusters on the surface of 8 to 12 leaves. Eggs are whitish or yellowish in colour when fresh but turns to pink before hatching. Eggs are barrel-shaped, 1.2 × 0.75 mm. Their incubation period takes about a week. Nymphs are 5 to 8 mm long with beautiful colour patterns. They are brownish red in colour with multicolour spots. Freshly hatched nymphs remain clustered around the egg-raft and it is only after the first moult that the nymphs disperse and start active feeding. The nymphs have five instars. The nymphal development takes about a month. There are 4 to 5 overlapping generations in a year.

Alternative Hosts : This is a highly polyphagous pest occurring on more than 200 host plants. Its main hosts are citrus, coffee, cotton, rice, millets, wheat, pulses, indigo, potato, tomato, castor etc.

Distribution : India : West Bengal. Maharashtra, Southern Peninsula, *Nezara viridula* (Linn.) is widely distributed in the tropical region of old world. It has been reported from South of Europe and Japan down to Australia and South Africa; almost universally cosmopolitan.

Remarks : This has acquired an enormous literature in entomological and agricultural journals from all over the world. It is known as green rice bug which occurs also on wheat, millets and fibre crops. It has been reported damaging a considerable range of economically important plants including tomatoes, beans, cauliflower, potato, turnip, oranges, tobacco, peanuts, squash, lucerne. The adults are active and bright green in the warmer months. During winter colour changes to brownish green or dark brown.

Management : As in the case of *Menida histrio* (Fabr.).

Genus 11 ***Piezodorus*** Fieber

1861. *Piezodorus* Fieber, *Eur. Hem.*, : 78 & 329.

Type species : *Piezodorus incarnatus* Germar

Diagnosis : Body ovate; head short, narrowed anteriorly, lateral margins moderately sinuate; antennae 5-segmented; rostrum reaches or just passes the 2nd coxae; abdomen with basal spine acute and moderately long; terminal end of clavus with a punctiform blackish spot.

12. ***Piezodorus rubrofasciatus*** (Fabricius)

1787. *Cimex rubrofasciatus* (Fabricius) : *Mant. Ins.*, 11 : 293.

1902. *Piezodorus rubrofasciatus* (Fabricius) : Distant, *Fauna Brit. India Rhyn.*, **1** : 224.

1989. *Piezodorus rubrofasciatus* (Fabricius) : Ghosh, L.K., Biswas, Chakraborty & Sen, *Fauna of Orissa, State Fauna Series*, **1** : 205. Zool. Surv. India.

1994. *Piezodorus rubrofasciatus* : Chakraborty, Ghosh, L.K. and Basu, R.C., *Fauna of West Bengal, State Fauna Series*, **3**(Pt. 5), : 483. ZSI.

1995. *Piezodorus rubrofasciatus* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.*, **168**, : 32.

1998. *Piezodorus rubrofasciatus* : Chakraborty and Ghosh, L.K., *Fauna of Meghalaya, State Fauna Series*, **4** : 405. Zool. Surv. India.

Diagnosis : Body pale greenish or luteous, thickly punctate; pronotum with lateral margins ochraceous with a transverse pale or purplish fascia between the pronotal angles; clavus with a small black apical spot; membrane hyaline; body beneath with legs pale luteous, fore tibiae not dilated; 4th and 5th antennal joints purplish; basal abdominal spine acute and moderately long;

Length : 8-10 mm.

Host plants : Millets.

Distribution : India : Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Australia; Myanmar; Malayan Peninsula; Archipelago; Sri Lanka; Indo-Malayan, Plaearctic, Australian regions.

Remarks : This is a minor best of millets in India.

Management : As in the case of *Menida histrio* (Fabricius).

Genus 12 ***Stenozygum*** Fieber

1861. *Stenozygum* Fieber, *Eur. Hem.*, : 345.

Type species : *Stenozygum variegatum* Fieber

Diagnosis : Body somewhat oval; head a little deflected; pronotum transversely impressed, with anterior margin rather concave, elevated and callous; scutellum longer than broad, narrowed at apex; abdomen unarmed.

13. ***Stenozygum speciosum*** (Dallas)
(Fig. 391)

1851. *Strachia speciosum* Dallas : *List Hem.*, **1** : 261.

1904. *Stenozygum speciosum* (Dallas) : Distant, *Fauna Brit. India*, **1** : 193.

1985. *Stenozygum speciosum* : Datta *et al.*, *Rec. zool. Surv. India, Occ. Paper No.*, **80** : 9.

1994. *Stenozygum speciosum* : Chakraborty *et al.*, Insecta : Hemiptera : Pentatomoidea-I, *Fauna of West Bengal, State Fauna Series*, **3** : 484. Zool. Surv. India

Diagnosis : Body brownish; head trinotate with a central fascia, with a spot on each side and two spots on anterior margin, median fascia extending from pronotum to scutellum; basal angle with spot, subapically with a triangular patch; connexivum black, spotted yellow; sternum with double series of spots.

Length : 7-9 mm.

Distribution : Palaearctic, Ethiopian, Oriental and Australasian Regions; India : West Bengal, Northwestern and Southern India.

Management : The use of light traps may deplete the numbers of adults.

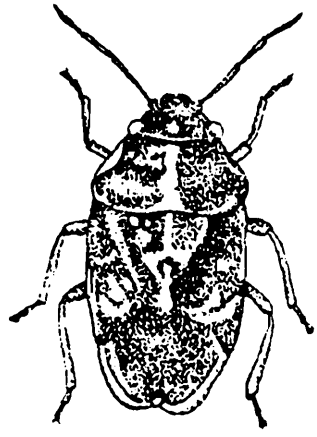


Fig. 391. *Stenozygum speciosum* (Dallas)

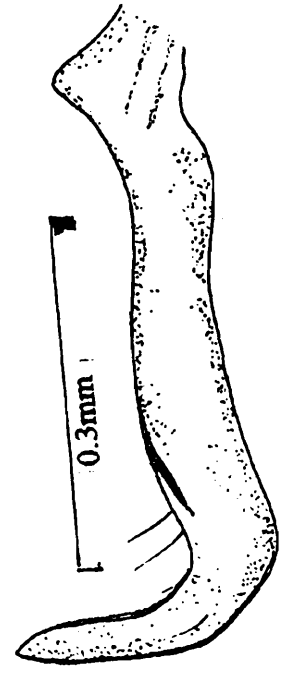


Fig. 392. *Coptosoma cribrarium* (Fabricius) : Clasper

Family II PLATASPIDAE

Genus 13 ***Coptosoma*** Dallas

1851. *Coptosoma* Dallas, *List Hem.*, **1** : 61.

Type species : *Coptosoma globus* Fabricius

Diagnosis : Body oval-shaped; head small deflected, narrower than pronotum; eyes moderately distinct; antennae inserted at the eyes; lateral margins of pronotum posteriorly sinuate, generally distinctly ampliated; scutellum broadened at the posterion end.

14. ***Coptosoma cribrarium*** (Fabricius)
(Fig. 392)

1798. *Cimex caribrarium* Fabricius, *Ent. Syst. Suppl.*, : 531.

1904. *Coptosoma cribrarium* : Distant, *Fauna Brit. India,* **1** : 22.

1985. *Coptosoma cribrarium* : Datta, Ghosh and Dhar, *Rec. zool. Surv. India, Occ. Paper No.*, **80** : 16.

1995. *Coptosoma cribrarium* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.*, **108** : 14.

Diagnosis : Body oval, greenish yellow, thickly and darkly punctate, ventrally black; apices of lateral lobes of head completely meeting in front of central lobe pronotum with a series of punctures, anterior angle with angulated striae; ventrally black; scutellum punctate; last abdominal segment with a ray-like fascia intercepted by a dark line; clasper (Fig. 392) slender, attenuate distally, apical $^1/_3$ curved like a beak, point of curvature with minute setae.

Length : 4.5-5 mm.

Symptom and Damage : This pentatomid bug is a serious pest of field bean. Nymphs and adults cluster on the tender shoots and suck cell sap.

Biological notes : Eggs are laid in double rows in batches of 30-50 on tender pods.

Distribution : Oriental and Palaearctic Regions; India : Maharashtra, Nagaland, Orissa, Tamil Nadu, West Bengal.

Remarks : The species infests the plants mainly belonging to N.O. Fabaceae and Compositae.

Management : Recommended insecticides are Aldrin, Chlordane and Malathion. The use of light traps will deplete numbers of adults (Hill 1975).

Family III SCUTELLERIDAE
(Shield-backed Bugs)

Diagnosis : Scutellum covers the entire abdomen, antennae conspicuous, situated in front of head; hind wing with humus in basical cell; generally brownish; phytophagous and measuring 8-10 mm. The group includes i) *Cantao ocellatus.* The female of the species shows maternal care by brooding over he eggs in nature; ii) *Hotea curculionoides* and *H. nigrorufa* occurring on santal trees.

Key to genera of the family SCUTELLERIDAE

1(2) Abdomen distinctly sulcated beneath 3

2(1) Abdomen not sulcated beneath ..... ***Chnysocoris***

3(4) Body oblong, obscurely pilose; head long and triangular ..... ***Scutellera***

4(3) Body ovate; head large and broad ..... ***Poecilocoris***

Genus 14 *Chrysocoris* Nahr

1834. *Chrysocoris* Hahn, *Wanz. Ins.*, **11** : 38.

Type species : *Chrysocoris dilaticollis* (Guerin)

Diagnosis : Head somewhat large, lateral margins moderately sinuate; anterior lateral margins of the pronotum rather straight or almost so; base of scutellum indistinctly elevated, completely covers the abdomen except at base; tibiae sulcated.

Key to the species of the genus *Chrysocoris*

1(2) Body smaller in size (13-14.5 mm); pronotum with 8 spots of which 3 near anterior margin, 3 larger on posterior disc as one each on lateral angle; scutellum with 7 spots ..... *stollii*

2(1) Body rather larger in size (14-24 mm) 3

3(4) Length of body 14-17 mm; pronotum with 9 or 11 spots of which 3-5 near anterior margin and 6 posterior spots; scutellum usually with 8 spots .... *marginellus*

4(3) Length of body 18-24 mm; pronotum with much less number of spots (usually 3); scutellum with 3 spots on disk ..... *grandis*

15. ***Chrysocoris grandis*** (Thunberg)
(Figs. 393, 446)

1783. *Cimex grandis* Thunberg, *Nov. Ins. sp.*, **2** : 31.

1904. *Chrysocoris grandis* : Distant, *Fauna Brit. India,* **1** : 54.

1994. *Chrysocoris grandis* : Chakraborty, Ghosh and Basu, *Rec. zool. Surv. India, Occ. Paper No.,* **161** : 32.

Diagnosis : Body reddish-yellow; head with margins beneath also reddish yellow; pronotum with an anterior subquadrate spot and a spot near each posterior angle, scutellar base narrowly widened at lateral angles, 3 spots on disk, the central one largest, an irregular transverse fascia beyond these spots and an apical spot blackish. Abdomen ventrally violaceous with blackish fasciae. Head, antennae, rostrum, sternum and legs black.

Length : 18-24 mm.

Distribution : India : Arunachal, Assam, Meghalaya, Nagaland.

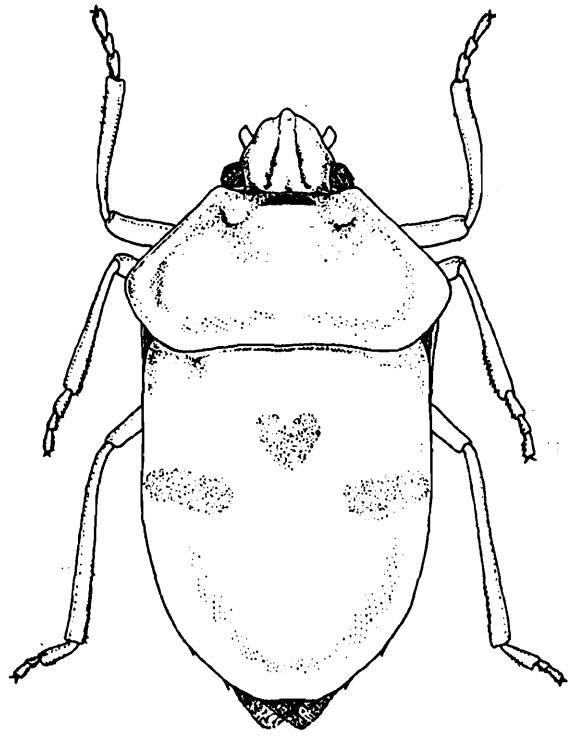


Fig. 393. *Chrysocoris grandis* (Thunberg)

Elsewhere : Myanmar; China; Japan; Java.

Remarks : Examination of a series of specimens reveals that in some specimens body above is pale yellow, pronotum with the basal spots often obsolete; the fascia and apical spot to scutellum is absent and there are two lateral yellow spots to prosternum and one to metasternum. Also, pronotal and central spot to the scutellum are wanting in some other cases.

16. ***Chrysocoris marginellus*** (Westwood)
(Figs. 394, 447)

1837. *Collida marginellus* Westwood, *Hope Cat.*, i : 15.

1868. *Chrysocoris marginellus* : Stal, *Ofv. Vet.-Akad. Forh* : 181.

1902. *Chrysocoris marginellus* : Distant, *Fauna Brit. India,* **1** : 59.

1995. *Chrysocoris marginellus* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 17.

Diagnosis : Body bluish green above; antennae, rostrum, apices of femora, the tibiae, tarsi and a large spot at base and apex of abdomen black. Pronotum with 3-5 anterior and 6 posterior spots; scutellum with 8 black spots; abdomen beneath, coxae, base of rostrum and a central line to sternum ochraceous or reddish ochraceous; lateral margins of abdomen reddish or violaceous; sternum and a submarginal abdominal series of broad transverse spots greenish or bluish green. The species is characterised by having the markings to the underside of the abdomen; spots above are in constant number.

Length : 14-17 mm.

Distribution : Oriental Region : India : commonly found in Maharashtra, Tamil Nadu and Andaman Is.

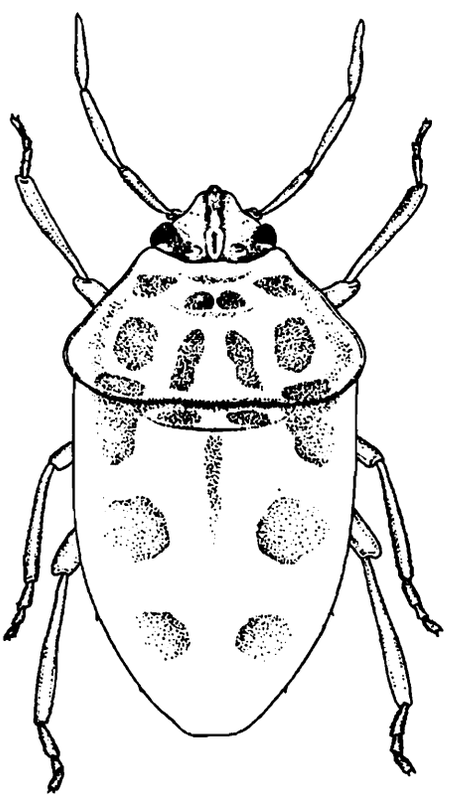


Fig. 394. *Chrysocoris marginellus* (Westwood)

17. ***Chrysocoris stollii*** (Wolff.)
Litchi Bug
(Fig. 448)

1901. *Cimex stollii* Wolff, *I.C.,* **2** : 48.

1904. *Chrysocoris stollii* Distant, *Fauna Brit. India,* **1** : 58.

1989. *Chrysocoris stollii* (Wolff.) : Ghosh Biswas, Chakraborty and Sen, *In* : *Fauna of Orissa, State Fauna Series*, **1** : 206. Zool. Surv. India.

1994. *Chrysocoris stollii* : Chakraborty, Ghosh and Basu, *In* : *Fauna of West Bengal, State Fauna Series*, **3**(Pt. 5) : 488. ZSI.

1998. *Chrysocoris stollii* : Chakraborty and Ghosh, L.K., *In* : *Fauna of Meghalaya, State Fauna Series*, **4**(Pt. 4) : 407.

2000. *Chrysocoris stolli* : Chakraborty and Ghosh, L.K., *In* : *Fauna of Tripura, State Fauna Series* **7**(2) : 424

Diagnosis : Body rather bluish green; pronotum with 8 spots, 3 near anterior margin, 3 larger on posterior disk, and one on each lateral angle; scutellum with 7 spots six arranged in pairs, one central, large, subovate on anterior chick and the apex either black or dark with the central spot being large, subovate.

Host plant : The species is common on the plants belonging to plant family Euphorbiaceae. It also feeds on *Litchi chinensis*.

Length : 13-14.5 mm.

Symptom and Damage : The vitality of the plants is reduced as a result of sucking plant sap both by nymphs and adult of the species. The insect also sucks sap from the fruits. Consequently, the fruits get dried up.

Biology: Mating takes place end to end and the copulation period is rather long. About 20 spherical and creamy white eggs are laid by the female either in single batch or in 2 or 3 batches. Emergence takes place within a week. The young nymphs (about 9 mm) are bright green in colour. The nymphs moult 5 times and the duration of successive nymphal instars in 2-3, 3-6, 3-6, 5-6, and 5-7 days. Nearly one month is taken by the pest species to complete its life cycle.

Distribution : The species enjoys rather wide distribution throughout India.

Elsewhere : Myanmar; China; Formosa; Sri Lanka.

Remarks : The litchi bug is also known from Myanmar, Formosa and South China. In India, it feeds on litchi, *Logan, Lantana,* banana and a number of berries, particularly in States of Uttar Pradesh, Bihar, Orissa and West Bengal. The one cm long adult bug, on emergence, is red but gradually acquires greenish colour. There are six distinct black spots arranged in rows on the thorax and seven on the seutellum, which covers the abdomen completely. The insect is prevalent throughout the year excepting the months of December and January.

Genus 15 ***Poecilocoris*** Dallas

1848. *Poecilocoris* Dallas, *Trans. Ent. Soc.*, **5** : 100

Type species : *Poecilocoris druroei* Linn.

Diagnosis : Body ovate, convex; head large, broad, the lateral margins sinuate. Antennae of five joints; basal joint short, robust; second shortest and most slender; third, fourth, and fifth joints each as long as the first and second joints together or longer, and longitudinally sulcate. Scutellum moderately truncate at apex. Abdomen distinctly sulcate beneath.

Key to the species of *Poecilocoris*

1(2) Anterior margin of pronotum reddish-ochraceous, not black; last abdominal segment with a spot; the base of scutellum transversely rugose ..... *latus*

2(1) Anterior margin of pronotum black; last abdominal segment usually without any spot; the base of scutellum hardly with rugosity..... *hardwickii*

18. *Poecilocoris hardwickii* Westwood

1837. *Poecilocoris hardwickii* Westwood, *in Hope cat.*, **1** : 13.

1904. *Poecilocoris hardwickii* : Distant, *Fauna Brit. India*, **1** : 45.

1994. *Poecilocoris hardwickii* : Chakraborty and Ghosh, *Fauna of Meghalaya, State Fauna Series*, **4** : 409. Zool. Surv. India.

Diagnosis : Body dark reddish-ochraceous; head, anterior margin, and two large basal spots to pronotum black; scutellum with usually eleven black spots three at base, of which the central one is longest and is closely followed by two smaller ones, four in transverse series beyond the middle, of which the two central are largest and two smaller subapical ones; body beneath (excluding lateral margins of pro- and mesosterna and the central area of abdomen), legs, rostrum, and antennae black or violet-black, *Genitalia* : Paramere hamate, ¾ part flattened.

Length : 19-22 mm.

Distribution : India : Northeastern, Southern part.

Elsewhere : Bhutan; Myanmar; China; Hong Kong.

Remarks : It is a minor pest of Tea plantation.

Management : Collecting the nymphs and adults by hand nets in early mornings or late in the evenings has been the practice for a long time. This operation should be done thoroughly and early in the season.

19. *Poecilocoris latus* Dallas
(Fig. 395)

1848. *Poecilocoris latus* Dallas, *Trans. Ent. Soc.*, **5** : 101

1985. *Poecilocoris latus* : Datta, Ghosh and Dhar, *Rec. zool. Surv. India, Occ. Paper No.*, **80** : 19.

Diagnosis : Body reddish yellow, thickly punctate; anterior angle of pronotum with a spot, also two spots near base; scutellar base with a patch, basal angle spotted, beyond middle with four spots, last abdominal segment with a spot; rostrum violet-black, antennal segments I and II reddish yellow, legs blackish; clasper (Fig. 395) with many setae just below the ventrolateral line robust, unciform and tapering subapically.

Length : 21 mm.

Distribution : India : Northern part.

Elsewhere : Myanmar.

Remark : This bug is a pest of tea seed. It also attacks flowers.

Management : As in the case of *P. hardwickii* Westwood.

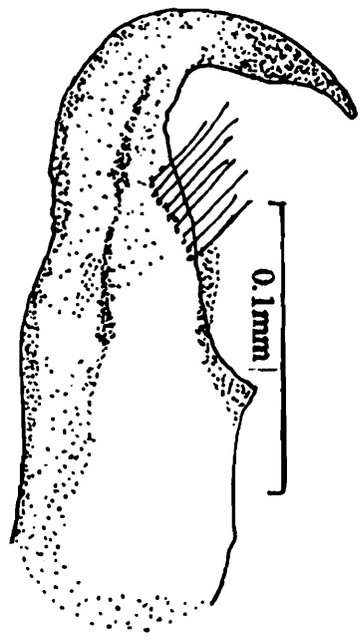


Fig. 395. *Poecilocoris latus* Dallas : Clasper

Genus 16 ***Scutellera*** Lamarck

1801. *Scutellera* Lamarck, *Syst.* : 293

Type species : *Scutellera nobilis* Fabricius.

Diagnosis : Body elongated, obscurely pilose; head long, triangular, convexly and obliquely directed downwards; mesosternum distinctly sulcated; abdomen very strongly and broadly sulcated, the sulcation narrowing towards apex

20. ***Scutellera nobilis*** Fabricius
(Figs. 396, 449)

1775. *Cinex nobilis* Fabricius, *Syst. Ent.*, : 697.

1904. *Scutellera nobilis* Fabricius : Distant, *Fauna Brit. India,* **1** : 51.

1985. *Scutellara nobilis* Fabricius : Datta, Ghosh and Dhar, *Rec. zool. Surv. India, Occ. Paper No.,* **80** : 21.

1995. *Scutellera nobilis* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 17.

Diagnosis : Body metallic green, without transverse fascia; scutellum with a median fascia, hexanotate on disc, spots placed in pairs; lateral margins of pronotum and the connexivum ochraceous; body beneath, rostrum, and legs reddish-ochraceous; basal joint of antennae ochraceous, its apex and remaining joints blackish. Clasper (Fig. 396) robust, cylindrate more than half, with bifid apex, chiliform apically.

Length : 19 mm.

Distribution : India : Southern part.

Elsewhere : Myanmar; China; Pakistan; Sri Lanka.

Remarks : The species is common on Sandalwood plantation *viz. Santalum album, Phyllanthus emblica.* The bug also acts as minor pest on agricultural crops in India.

The species is very close to *Scutellera fasciata* Panz. but can be distinguished by the absence of the transverse fasciae above; the scutellum with central fascia and bearing six small discal spots arranged in pairs and a lateral spot on each side near the centre.

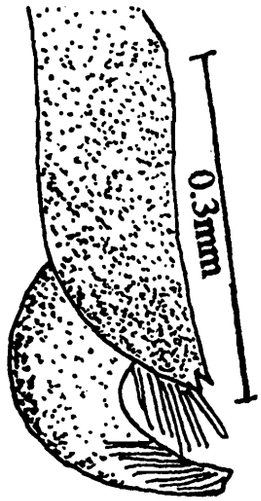


Fig. 396. *Scutellera nobilis* Fabricius : Clasper

Management : As in the case of *Menida histrio* (Fabr.)

Family IV TESSARATOMIDAE

Genus 17 ***Tessaratoma*** Lepell. & Serv.

1825. *Tessarotoma* Lepelelier & Serville, *Encycl. Meth.,* x : 590.

Type species : *Tessarotama papillosa* (Drury)

Diagnosis : Head rounded at apex, lateral lobes longer than central lobe; antennae 4-joined; rostrum short, extending to the middle of mesosternum; pronotum with posterior margin strongly produced over the base of scutellum; corium with the apical margin rounded towards the exterior apical angle; prosternum more or less anteriorly dilated; mesosternum with a robust ridge; metasternum considerably elevated; 2nd abdominal segment elevated in the middle into an obtuse tubercle; tibiae furrowed above; tersi 3-segmented.

21. ***Tessaratoma javanica*** (Thunberg)
Litchi Bug
(Figs. 397, 450)

1878. *Cimex javanica* Thunberg, *Nov. Ins. spec.,* **2** : 45.

1904. *Tessaratoma javanica* : Distant, *Fauna Brit. India,* **1** : 259.

1986. *Tessaratoma javanica* : Hegde, *East. Ghats Ins.,* **1** : 27.

1995. *Tessaratoma javanica* : Hegde, *Rec. zool. Surv. India, Occ. Paper No.,* **168** : 35.

Diagnosis : Body somewhat elongately ovate, brownish-ochraceous; head small, rounded at apex; antennae 4-segmented, black, pronotum with the lateral margins

moderately ampliated and reflexed; scutellum with apex more or less piceous; veins of the membrane forming cells at base; body beneath with white powdery matter; legs and tarsi dark castaneous; femora with apical spine; anal appendage truncate at its apex; body above very finely and obscurely punctate.

Length : 25-31 mm.

Distribution : Indo-Malayan Region; India : Andhra Pradesh, Assam, Kerala, Maharashtra, Sikkim, Tamil Nadu.

Elsewhere : Myanmar; Malaya Peninsula; Malaya Archipelago; Sri Lanka.

Management : Spray 1.25 litres of monocrotophos 40 EC or 2.5 litres of dimethoate 30 EC in 1250 litres of water per ha.

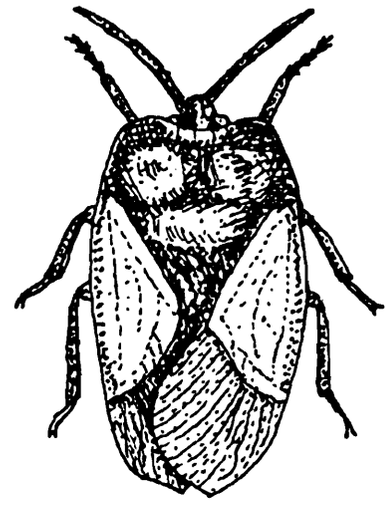


Fig. 397. *Tessaratoma javanica* (Thunberg)

Family V DINIDORIDAE

Scutellum medium-sized, with a blunt or rounded apex reaching about half the length of abdomen; Bacculae elevated and lobe-like; and hind wings with the primary and subtended veins widely spaced at base converging at apex, forming sometimes a reticular network on membrane of hemelytra. First segment of antennae is shortest while the other segments vary greatly in length, tarsi 3-segmented.

Key to the genera of the family DINIDORIDAE

1(2) Antennae 5-segmented; head with the margins laminately reflexed ..... ***Aspongopus***

2(1) Antennae 4-segmented; head with the margins ampliately reflexed ..... ***Cyclopelta***

Genus 18 *Aspongopus* Laporte

1832. *Aspongopus* Laporte, *Ess. Hem.*, : 58

Type species : *Aspongopus janns* Fabricius

Diagnosis : Body broadly oval; head narrow, small, margin laminately reflexed, lateral lobes a little longer than the central lobe; antennae 5-segmented; rostrum passing the first coxae; scutellum short, broad apically; membrane large, abdomen unarmed; femora spined towards apices.

22. ***Aspongopus janus*** (Fabricius)
(Fig. 451)

1775. *Cimex janus* Fabricius, *Syst. Ent.*, : 714.

1832. *Aspongopus janus* Laporte, *Ess. Hem.*, : 58.

1904. *Aspongopus janus* : Distant, *Fauna Brit. India,* **1** : 281.

1989. *Aspongopus janus* : Ghosh, L.K., Biswas, Chakraborty and Sen, *In* : *Fauna of Orissa, State Fauna Series,* **1** : 206.

Diagnosis : Body brown ochraceous; body beneath and legs black or greenish black, lateral margins of sternum and abdomen ochraceous; head, antennae, subanterior transverse fascia to pronotum, a little more than basal half of scutellum and membrane blackish; 3rd antennal segment a little longer than 1st segment but shorter than the remaining segments.

Length : 16-20 mm.

Distribution : India : Himachal Pradesh, Kerala, Maharashtra, Meghalaya, Tamil Nadu, Uttar Pradesh, West Bengal, rather widely distributed.

Elsewhere : Myanmar; Sri Lanka.

Remarks : The species acts as a sporadic pest of cucurbits in most parts of India.

Management : Application of dimethoate (0.05 kg/ha) is very effective (Gupta and Sharma 1971)

Genus 19 ***Cyclopelta*** Amy. & Serv.

1843. *Cyclopelta* Amyot & Serville, *Hem.*, : 172.

Type species : *Cyclopelta obscura* (Lepelelier and Serville)

Diagnosis : Body oval; head with the margins ampliately reflexed, lateral lobe a little longer than the central lobe, apex subtruncate; rostrum reaches 2nd coxae; antennae 4-segmented, pronotum with lateral angles rounded, not produced; scutellum short, apex broad; abdomen unarmed at base; mesonotum sulcated; membrane large, veins reticulated.

23. ***Cyclopelta siccifolia*** Westwood
(Fig. 398)

1837. *Aspongopus siccifolia* Westwood, *Hope Cat.,* **1** : 26.

1904. *Cyclopelta siccifolia* (Westwood) : Distant, *Fauna Brit. India,* **1** : 280.

1985. *Cyclopelta siccifolia* (Westwood) : Datta, Ghosh, L.K. and Dhar, *Rec. zool. Surv. India, Occ. Paper No.,* **80** : 5.

1994. *Cyclopelta siccifolia* (Westwood) : Ghosh, M., Datta, B. and Ghosh, L.K., Insecta : Hemiptera : Pentalomoidea-II, *In* : *Fauna of West Bengal, State Fauna Series,* **3**(Pt. 5) : 500. Zool. Surv. India.

1995. *Cyclopelta siccifolia* (Westwood) : Hegde, *Rec. zool. Surv. India, Occ. Paper No.*, **168** : 36.

1998. *Cyclopelta siccifolia* (Westwood) : Chakraborty and Ghosh, L.K., *In* : *Fauna of Meghalaya, State Fauna Series*, **4**(Pt. 4) : 410.

Diagnosis : Body blackish in colour; antennae 4-segmented; pronotum and scutellum absolutely transversely winkled; scutellar base with sanguineous spot; abdomen with red pigmentations; marginal spots and stigmata black; forewing membrane brownish yellow; connexivum concolourous without spots; membrane large, more or less brownish ochraceous; clasper oval-shaped, distally attenuate, shaft fissate, discal margin setose (Fig. 398).

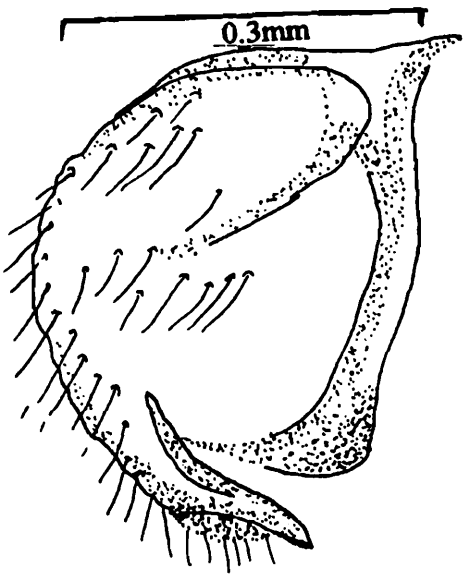


Fig. 398. *Cyclopelta siccifolia* Westwood : male genitalia : clasper

Length : 11-16 mm.

Host plants : *Cajanus cajan, Pongamia glabra, Sesbania aegyptica, Sesbania speciosa, Erythrina indica.*

Distribution : India : Maharashtra, Meghalaya, Sikkim, West Bengal.

Elsewhere : Myanmar; Sri Lanka.

Remarks : The species is known to infest *Erythrina* and other fabaceous plants. Varshney (1967) made some observations on this pest species attacking on *Butea monosperma*. The female adults lay eggs on the plants. The adults flock together and make punctures causing brown spots on epidermal tissues of the host plants.

Management : As in the case of *Aspongopus genus* (Fabr.) (P. 420).

Family VI UROSTYLIDAE

Genus 20 ***Urostylus*** Westwood

1837. *Urostylus* Westwood, *Hope Cat.*, **1** : 45

Type species : *Urostylis punctigera* Westwood

Diagnosis : Head with ocelli; antennae very long and slender, basal joint nearly as long as the head and pronotum taken together; pronotum about as broad as the abdomen, the posterior angle not prominent, membrane with seven longitudinal veins.

24. ***Urostylus punctigera*** Westwood
(Fig. 399)

1837. *Urostylus punctigera* Westwood, *Hope Cat.*, **1** : 45.

1904. *Urostylus punctigera* Westwood : Distant, *Fauna Brit. India* **1** : 306.

1985. *Urostylus punctigera* : Datta, Ghosh and Dhar, *Rec. zool. Surv. India, Occ. Paper No.*, **80** : 24.

Diagnosis : Body brownish-ochraceous with a greenish tinge, somewhat coarsely punctate, excepting discoidal area of corium, which is almost impunctate; pronotum binotate; corium with a black discal spot, its apical margin also narrowly black at centre and outer angle; scutellum with a small levigate ochraceous spot near each basal angle; membrane pale hyaline; antennae more or less fuscous, body beneath and legs pale brownish-ochraceous; prosternum punctate, remaining surface finely and sparsely brown-speckled; rostrum hardly reaching middle of mesosternum, with its apex black; clasper (Fig. 399) elongate, sagitally infolded, apex hamate.

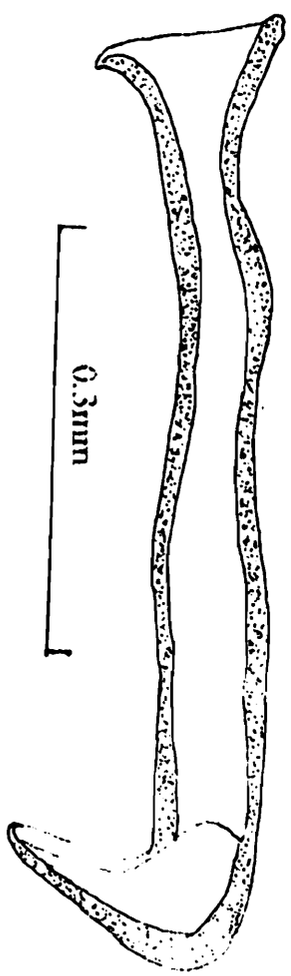


Fig. 399. *Urostylus punctigera* Westwood : male genitalia : clasper

Length : 11 mm.

Distribution : India : Northeast India.

Symptom and Damage : The nymphs and adults suck plant sap from the terminal foliage and uppermost branches of the plants. The adults penetrate stylets into the shoots, main stem of young plants and disintegrate the tissues and developing cells. As a result, withering of the plants takes place.

Remarks : The species infests the plants belonging to N.O. Magnoliaceae. Highest incidence has been recorded from the foot hills of Darjeeling and Kurseong in West Bengal.

Other Pentatomids of economic importance : *Tetroda histeroides* on Rice; and *A. bruneus* on cucurbitaceous crops; *Antestiopsis cruciata* on Jasmine and coffee.

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INSECTA : HETEROPTERA : PYRRHOCORIDAE

Family PYRRHOCORIDAE

Pyrrhocorid bugs are popularly known as "Cotton stainers." This is derived from their habit of piercing the cotton Bolls and staining the fibre. They usually inhabit the agrcultural fields, bushes, vegetable gardens etc. and are phytophagous in habit.

The family Pyrrhocridae is one of the smallest families of Hemiptera and ecnomically important because it includes one of the most serious pests of cotton known as *Dysdercus koenigii* (Fabricius). It resembles another heteropteran allied family Lygaeidae but is distinguished from it by the absence of ocelli.

The family is primarily tropical and subtropical in distribution. The world record of the family repesents about 360 species belonging to 43 genera. In India, the family is known by 45 species in 15 genera (Distant 1904, 1910, Mitra *et al.* 1977; Sen *et al.* 1994, 1998; Hegde 1995).

Diagnosis : Large and robust insects; usually bright-colour, with red and black with predominant tints. Ocelli absent; antennae inserted below a line drawn from the centre of the eye to the apex of the face; corium broader, without appendix; membrane generally with four but not with more than five veins; in a few genera hemelytra incomplete, membrane fully developed. The legs are with rotatory coxae, 3-jointed tarsi and pulvilli.

MATERIAL & METHODS

Pyrrhocorid insects are mostly phytophagons in nature, inhabiting in agricultural fields, vegetable gardens, crop fields, bushes etc. The specimens of the group can be collected either by the sweeping the crops or bushes with insect nets or by light trapping. The collected specimens are killed in a killing jar using benzene or chloroform vapour and preserved dry with Napthelene and Paradichlorobenze. The specimens are kept in insect envelope. Each envelope should contain proper data label mentioning locality, date of collection, name of the collector, possible site of infestation, nature of damage and other ecological notes. In the Laboratory, specimens are set and pinned properly before examining the material under binocular microscope for identification.

Genus 1 ***Dysdercus*** Amyot & Serville

1843. *Dysdercus* Amyot and Serville, *Hemip.*, : 272.

Diagnosis : Body elongate; head immersed to eyes, antennae with the 1st joint longer thant the 2nd; rostrum of variable length, 1st joit a little longer than the head; lateral margins of pronotum moderately ampliated and reflexed; hemelytra complete, membrane with two distinct basal cells; anterior femora spined beneath apically.

1. *Dysdercus koenigii* (Fabricius)
Red Cotton Bug
(Fig. 400, 452)

1775. *Cimex koenigii* Fabricius, *Synt. Ent.*, : 720

1902. *Dysidereus cingulatus* : Distant, *Fauna Brit. India,* II : 119.

1914. *Dysdercus koenigii* : Bergroth, *Ent. Mitt.,* **3** : 355.

1994. *Dysdercus koenigii* : Sen *et al.,* Insecta : Hemiptera : Heteroptera : Pyrrhocoridae. *In* : *Fauna of West Bengal, State Fauna Series,* **3** : 439. Zoological Survey of India.

1998. *Dysdercus koenigii* : Sen, M. Ghosh and L. K. Ghosh, Insecta : Hemiptera : Pyrrhocoridae, *In* : *Fauna of Meghalaya, State Fauna Series,* **4** : 337. Zoological Survey of India.

Diagnosis : Body ochraceous; head, pronotum, rostrum blood reddish; pronotum with lateral margin sanguineous; antennae, apex of rostrum, scutellum, membrane and legs blackish; corium punctate with a black discal spot; anterior margin to prosternum, anterior collar to pronotum creamy white; abdomen stripped with creamy white; with a transverse line connecting area of each eye. clasper (paramere) robust, flattened, apex deeply bifid, outer arm twice as long as inner arm, shorter one further bifurcate.

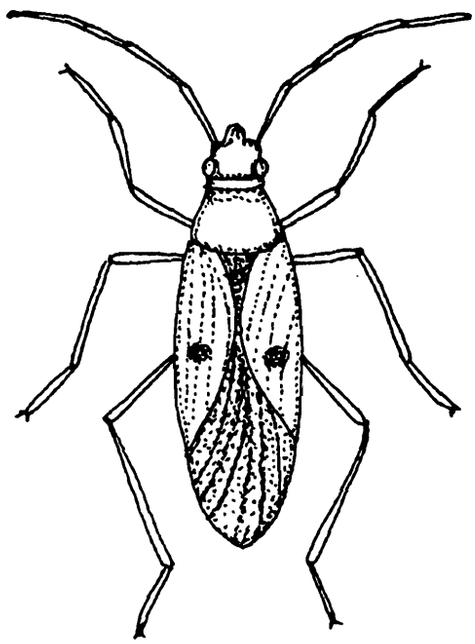


Fig. 400. *Dysdercus koenigii* (Fabricius)

Length : 12-15 mm.

Host plants : Cotton, Okra, Hollyhock, wheat, maize, pearl-millet, clovers, portia tree, *Abutilon indicum, Bombax ceiba, Brassica spp., Buddleja madagascarensis, Carissa carandas, Dombeya spectabilis, D. natalensis, Gossypium* spp., *Hibiscus cannabinus, H. esculentus, H. rosasinensis, Jasminum sambac, Malva parviflora.* Important alternate hosts : *Chrozophera rotleri, Tricodesma amplexicaule* (Jalamkar *et al.* 1975).

Symptom and Damage : The adults and nymphs suck cell-sap from leaves and green bolls of cotton. Heavily attacked bolls open badly and the lint is of poorer quality. They also suck the sap from the seeds and make them unfit for sowing or for oil extraction. Also at the site of injury caused by the insects on the bolls a bacterium *Nematospora gossypii* makes entry and thereby spoils the lint.

Biology : The red cotton bug is active throughout the year and passes winter in the adult stage. In spring, the bug becomes active and lays, on an average, 100-130

eggs in moist soil or in crevices in the ground. The eggs are spherical, bright yellow and are laid in clusters or in loose irregular masses of 70-80 eggs each. They hatch in 7-8 days and the young nymphs have flabby abdomens but as they grow older, they become more slender and develop black markings on the body. There are 5 nymphal stages (the nymphal period being 49-89 days). The egg stage and five instars last 4-6, 4-5, 4-9, 5-8, 18 and 19 days respectively. In summer, the life of an adult is very variable, but in winter, it may live up to three months.

Natural enemy complex : The predacious bugs like *Antilochus cocqueberti* Fabricius (Pyrrhocoridae) and *Harpactor costalis* (Stal) (Reduviidae) feed on nymphs and adults.

Fungus : *Rhizopus oryzae*

Distribution : Oriental, Ethiopian, Australasian, East Palaearctic, Nearctic and Neotropical Regions; India : widely distributed.

Elsewhere : Bhamo, Burma, Houngdaran, Kamorta, Minhla Metaja, Malaya Peninsula, Malayan Archipelago; Pakistan, Queensland (Australia), Sri Lanka.

Remarks : It is one of the most injurious pests of cotton. This insect is widely distributed in India. Apart from cotton, it also feeds on okra, maize, pearl millet, etc. The bugs are elongated slender insects, crimson red with white bands across the abdomen. The membraneous portion of their fore wings, antennae and scutellum are black; both adults and nymphs feed on the cell-sap of host plants mainly belonging to plant family Malvaceae. It may be conceded that the nymphs and adults almost squeeze the vital juice from the bolls. The insect is well known as cotton spoiler. Attacked seeds become worthless for sowing and oil extraction. The most diagnostic feature of this pest species is black marking on the wings and white bands on the abdomen.

Management : Sprsy against the red cotton bug should be done at economic threshold level of 1–2 nymphs per leaf or when second grade injury symptoms (bolls open badly) appear in 50% case. Any one of the following insecticides can be used in 250 litres of water per ha : 200 ml. of phosphamidon 85 WSC, 750 ml. of formothion 25EC or oxydemeton methyl 25EC, 625 ml. of dimethoate 30EC, 100 ml of imidacloprid 2000 SL. (Atwal and Dhaliwal, 1997).

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HETEROPTERA : TINGIDAE

The tingids are commonly known as lace bugs. These insects are pests of maize, sugarcane, cotton, fruit trees etc. These lace bugs measuring about 5-6 mm, infest leaves of shrubs and trees and suck sap. Due to infestation, yellowish spots appear on the leaves and in cases of severe attack they become brown, shrivel and dry up. The tingid bugs are characterised in having densely reticulate body as well as wings. The elevated ridges and sunken membranous oval areas constitute a lace-like appearance on the head, lateral expansions of thorax and the wings. The pronotum always covers the scutellum. Ocelli are absent. Though the adult tingid shows the lace-like appearance, the nymphs are usually spiny.

On a global basis nearly 1925 species of Tingidae belonging 236 genera are known. About 105 species belonging to 49 genera of tingids are so far known from India through the contributions of Distant 1910; Nagaraj 1955; Menon 1959; Menon and Hakk 1959a, 1959b, 1959c; Livingstone and his collabarators 1959-1990; Drake and Livingstone 1964; Chopra 1971; Mahansundaram 1973; Mahansundaram and Subba Rao 1973; Nayar *et al.* 1976; Hegde 1986a, 1986b, 1995.

Family TINGIDAE

Diagnosis : Characterised by densely reticulate body and wings. The pronotum covers the scutellum. Ocelli absent. The elevated ridges and sunken membranous oval areas present a lace-like appearence on the head, lateral expansions of the thorax and the wings. The nymphs are usually spiny.

SYSTEMATIC ACCOUNT

Family TINGIDAE

Genus 1 ***Cadmilos*** Distant

1. *Cadmilos retiarius* Distant

Genus 2 ***Dulinius*** Distant

2. *Dulinius conchatus* Distant

Genus 3 ***Monantha*** Lepell. and Serv.

3. *Monantha globulifera* Walker

Genus 4 ***Stephanitis*** Stal

4. *Stephanitis typicus* (Distant)

Genus 5 ***Tingis***

5. *Tingis buddleiae* Drake

Genus 6 ***Urentius*** Distant

6. *Urentius euonymus* Distant

7. *Urentius sentis* Distant

Key to genera of the family TINGIDAE

1(2). Head unarmed, a little pointed at apex 3

2(1) Head armed 7

3(4) Pronotum much dilated, reflexed, concave; hood large globular, covering the head ..... ***Dulinius***

4(3) Pronotum and head not as above 5

5(6) Disk of pronotum pale; lateral margins of abdomen reddish ochraceous ..... ***Stephanitis***

6(5) Disk of pronotum pitch coloured; lateral margins of abdomen dull brownish yellow ..... ***Monanthia***

7(8) Head with 3 long frontal spines, elytra obliquely narrowed posteriorly..... ***Urentius***

8(7) Head with 2 curved spines (one each near eye) and 2 porrect spines; elytra concavely truncate at base and widened posteriorly ..... ***Cadmilos***

Genus 1 ***Cadmilos*** Distant

1909. *Cadmilos* Distant, *Ann. Soc. Ent. Belg.*, Liii : 113.

Type species : *Cadmilos retiarius* Distant

Diagnosis : Pronotum with the lateral margins strongly and laminately produced, the areolets large, subquadrate, hood large, somewhat oblong, with large areolets, convexly raised and almost completely covering head, which has a curved spine on each side near eyes and two porrect spines in front; antennae with the first and second joints short, incrassate, first longer than second, third very long, slender, hirsute, fourth longer than first and second together, finely hirsute, its apex distinctly thickened; the disk of the pronotum flattened and subangularly dilated on each side, centrally acutely carinate, its posterior area areolate; elytra hyaline, the areolets large and transverse, the costal area dilated, abruptly concavely truncate at base, widened posteriorly, the subcostal area narrow, legs somewhat long and slender, the femora slightly thickened.

1. ***Cadmilos retiarius*** Distant
Sunflower Lacewing Bug

1909. *Cadmilos retiarius* Distant, *Ann. Soc. Ent. Belg.*, Liii : 114.

1910. *Cadmilos retiarius* Distant, *Fauna Brit. India,* **5** : 107.

1976. *Cadimilos retiarius* Nayar, Ananthakrishnan and David, General and Applied Entomology : 173.

Diagnosis : Body pale hyaline, beneath black; antennae with the third and the base of the fourth joint paler and more ochraceous in hue; disk of pronotum more fuscous, the margins and the central carinations greyish white, the disk and lateral marginal areas more or less coarsely punctate; subcostal area of elytra with a slight brownish suffusion near apex of discoidal area; apices of femora slightly infuscate.

Host plants : Sunflower (*Helianthus annuus), Gaillarida,* daisy, Chrysanhemums, marigold, *Vernonia, Launea, Argemone mexicana* (Weed).

Length : 4 mm

Symptom and Damage : The nymphs and adults suck plant sap and the infested leaves turn yellowish-brown and finally dry up.

Bionomics : The eggs are laid scattered mostly on the upper surface of the leaves of the host plants and in chrysanthemum laid on the involucre of bracts and in the stems of succulent herbs. The eggs are inserted slantingly into plant tissues leaving the operculum exposed as white or brownish dots. The operculum bears a spongy opercular crest. Its function has been suggested for controlling humidity. The eggs hatch within a week. The nymphs after emergence moult 5 times to become adult. The nymphal period lasts for 2-3 weeks.

Natural enemies : The eggs are parasitized by *Trichogramma* sp. (Trichogrammatidae). A mite, *Leptus* sp. (Erythraeidae) is parasitic both on nymphs and adults.

Distribution : India : Northern part and also other places having garden plants.

Management : Spray 500 ml of malathion 50 EC in 500 litres of water per ha.

Genus 2 ***Dulinius*** Distant

1903. *Dulinius* Distant, *Ann. Soc. Ent. Belg.,* **xlvii** : 48.

Type species : *D. conchatus* Distant.

Diagnosis : Head unarmed; rostrum reaches posterior coxae, antennae finely and longly pilose, 1st joint moderately incrassated and extends upto about apex of head; pronotum much dilated, reflexed, concave, membranous margins shell-like and rounded; hood large, globular, convex, covering the head; elytra entirely hyaline, about twice as long as the abdomen, areolae large.

2. ***Dulinius conchatus*** Distant

1903. *Dulinus conchatus* Distant, *Ann. Soc. Ent. Belg.,* **xlvii** : 48.

1904. *Dulinus conchatus* Distant : Distant, *Fauna Brit. India,* **2** : 133.

Diagnosis : Body hyaline, margins of the areolae pale ochraceous; hood, pronotum, extreme lateral margins of pronotum, antennae, body and legs pale ochraceous; elytra with opaline reflections; pronotum with lateral margins ochraceous and with transverse spots being darker.

Length : Body 2 mm; to apex of elytra 4 mm.

Host plant : *Morinda tinctoria.*

Distribution : India : Southern part.

Elsewhere : Sri Lanka.

Remarks : It is a minor pest.

Genus 3 ***Monanthia*** Lepell. and Serv.

1825. *Monanthia* Lepell. and Serv., *Encly. Meth.,* **10** : 653.

Type species : *Monanthia echii* Schrank

Diagnosis : Antennae slender, apical segment fusiform, its base slender; pronotum with lateral margins strongly reflexed; hemelytra with subcostal area distinctly forming an angle at apex of discoidal area, a transverse divisional vein present near middle of discoidal area; pronotum with lateral margins strongly reflexed, hemelytra with sub basal elevations.

3. ***Monantha globulifera*** Walker

1873. *Monanthia globulifera* Walker, *Cat. Het.,* vi : 182.

1902. *Monanthia globulifera* Walker : Distant, *A.M.N.H.* **(7)** : ix : 356.

1904. *Monanthia globulifera* Walker : Distant, *Fauna Brit. India,* **2** : 144.

Diagnosis : Body dull ochraceous; antennae pale ochraceous, apical segment a little darker; body beneath black, legs ochraceous, posterior margin of metasternum and lateral margins of abdomen dull brownish-yellow; pronotum with disk pitch-coloured, margins of discoidal sutural area piceous; the foveate disk to discoidal area also more or less piceous, costal area hyaline, uniseriate, transverse veins black.

Length : 2-3 mm.

Host plants : Safflower, *Ocimum sanctum, Coleus* sp.

Distribution : India : Common in South India : In Tamil Nadu the species attacks heliotrope.

Management : Sprays of parathion 0.025% or methyl demeton 0.025% are effective.

Genus 4 ***Stephanitis*** Stal

1873. *Stephanitis* Stal, *En. Hem.*, **3** : 119 & 123

1903. *Cadamustus* Distant, *Ann. Soc. Ent. Belg.*, **xLvii** : 47.

1904. *Moecenas* Kirkaldy, *Entomologist* : 280.

Diagnosis : Head unarmed, a little pointed at apex; antennae slender, two basal segments only slightly shorter than apical segment; rostrum passing anterior coxae; pronotum with lateral margins strongly laminately and upwardly produced, areolets rather large, outer ones somewhat subquadrate; hood convex compressed, covering head, truncately attenuated anteriorly, posteriorly with similar pronotal elevation; elytra twice as long as abdomen, broadened posteriorly, rounded at apices, the areolets of costal area longitudinally gibbous on discoidal area.

4. ***Stephanitis typicus*** (Distant)
The Banana Lace-wing
(Fig. 401, 453)

1903. *Cadamustus typicus* Distant, *Ann. Soc. Ent. Belg.*, **xlvii** : 47.

1904. *Cadamustus typicus* Distant, *Fauna Brit. India*, **2** : 132.

1976. *Stephanitis typicus* (Distant) : Nayar *et al.* General and applied Entomology : 174.

Diagnosis : Body pale, glassy; antennae and legs very pale greenish yellow, apical segment of antennae and tarsi pale ochraceous; disk of pronotum pale castaneous or pale brown; abdomen pitch coloured and more or less reflected above through elytra, lateral margins of abdomen reddish-ochraceous; the margins of the areolets piceous; elytra with opaline reflections, elytral areas ill defined.

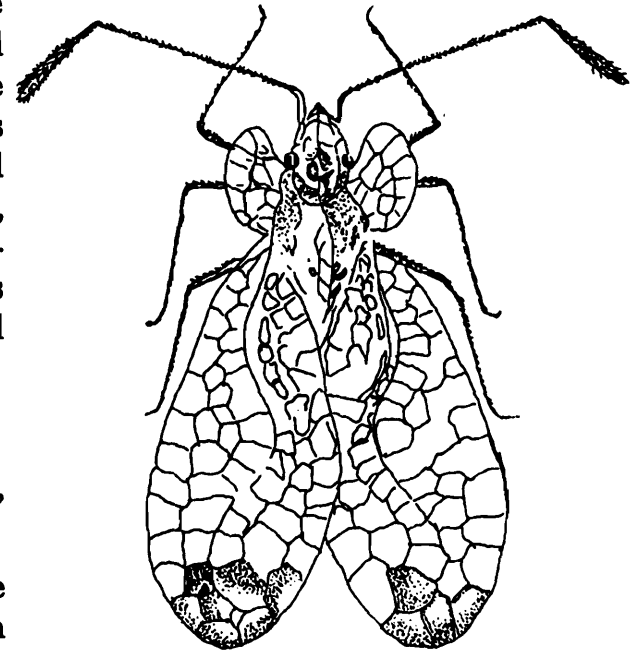


Fig. 401. *Stephanitis typicus* (Distant)

Length : 3.5-4.5 mm.

Alternative hosts : Banana, Cardamom, Coconut, *Colocasia,* Tumeric etc.

Symptom and Damage : Nymphs are gregarions in habit and are found along with adults on lower surface of leaves sucking the cell sap resulting in a greyish yellow patches on the leaves. In case of severe infestation the growth of the plants in retarded and ultimately the yield is adversely affected. Occasionally the insect assumes serious proportions on banana and coconut causing yellowish or whitish spots on the leaves. It also infests cardamom and tumeric plants.

The lacewing is suspected to be a vector of the coconut virus (coconut root wilt). The insect is found to be present in increasing numbers from the outer to the inner leaves and the middle leaflets are preferred to either end of each leaf.

Bionomics : Adults are small, dull coloured, very conspicuous bugs with transparent shiny lace-like reticulate wings. A female lays on an average of 30 eggs, singly inserted into leaf tissues. These hatch in about 12 days and nymphal period lasts for 13 days.

Distribution : India : widely distribution in Banana cultivated areas partcularly southern India.

Elsewhere : Sri Lanka; Manilla; Philippines.

Management : Sprays of parathion 0.025% or methyl demeton 0.025% prove useful.

Genus 5 ***Tingis***

5. ***Tingis buddleiae*** Drake
Buddleia Tingid

1976. *Tingis buddleiae* Drake : Nayar, Ananthakrishnan and David, General and applied Entomology, New Delhi : 173.

Length : 5-6 mm.

Host plants : *Buddleia asiatica; B. madagascarensis*

Symptom and Damage : As a result of infestation the leaves crinkle, dry and drop off. During November-March, the infestation attain its peak.

Biology : A female of this lace bug inserts about 12-50 eggs, generally scattered on the under surface of the leaf near the side veins and leaf tips. The incubation period ranges from 10 to 12 days. There are 5 nymphal instars, the 1st and the last instars moult after 3 days, the 2nd, 3rd and 4th instars moult after 2 days.

Natural enemy complex : *Apploldotus* sp. (Miridae: Heteroptera), larvae of *Chrysopa* sp. (Neuroptera) and *Coccinella* sp. (Coleoptera : Coccinellidae) predate on this tingid bug.

Distribution : This Buddleia Tingid is rather common in North India.

Remarks : Material could not be examined. So, the taxon is not included in the Key. The other details are reproduced from Nayar *et al.*, 1976.

Genus 6 ***Urentius*** Distant

1904. *Urentius* Distant, *Fauna Brit. India,* **2** : 134.

Type species : *Urentius echinus* Distant.

Diagnosis : Head with three long frontal spines; antennae setose, about as long as pronotum, apical joint subglobose; pronotum with anterior vesicle or hood almost covering head, disk carinate, enclosing two anterior and two lateral foveate areas,

lateral margins sinuate and strongly spined; elytra obliquely narrowed with discoidal and sutural areas finely granulate, costal area broad.

Key to the species of *Urentius*

Smaller in size; elytra distinctly obliquely narrowed, subcostal area opaque to give the appearence of the one instead of two lateral series of areolets..... ..... *euonymus*

— Larger in size; elytra a little obliquely narrowed posteriorly, subcostal area not opaque showing two lateral series of areolets ..... *sentis*

6. *Urentius euonymus* Distant
Hollyhock Tingid Bug

1909. *Urentius euonymous* Distant, *Ann. Soc. Ent. Belg.*, **Liii** : 116.

1910. *Urentius euonymous* Distant, *Fauna Brit. India,* **5** : 114.

1976. *Urentius euonymous* Distant : Nayar, Ananthakrishnan and David, General and applied Entomology, Mc Graw Hill Publ. Ltd., New Delhi : 174.

Diagnosis : Body pale ochraceous, beneath black; eyes red; antennae setose, apical segment of antennae darker than other antennal segments and prominently globose; head with three long frontal spines; pronotum with hood almost covering head, its disk heavily carinate, anterior foveation centrally carinately divided, posterior transverse foveation on each side of posterior lateral areas, the lateral margins sinuate and spinose; elytra obliquely narrowed to apex; tarsal claws black, subcostal area rather opaque.

Length : 5-6 mm.

Host plants : *Althaea rosea, Abulilon indicum, Sida cardifolia, Chrozophora rottleri.*

Symptom and Damage : As a result of sucking the plant sap by the crowded nymphs and adults from the under surface of leaves, the infested leaves become pale-yellow and turn brown. Subsequently the leaves shrivel and dry up.

Biology : The adult female lays the eggs on the upper surface of leaves and rarely on the under surface of leaves. The eggs are completely buried in the mesophyll, always at an angle to the leaf surface, leaving the operculum exposed. Faecal matter deposited in the vicinity of the eggs appear as minute spots. The incubation period of the eggs is 8-10 days. There are five nymphal instars and development is completed in 15-27 days. The full developmental cycle is completed on a single leaf. The pest overwinters in egg stage.

Distribution : Widely distributed in India particularly in the southern part.

Remarks : The species is characterised in the presence of opaque subcostal area and in the structure of pronotum. The bugs are easily recognised by their densely reticulate body and wings. The nymphs are spiny in appearence.

7. *Urentius sentis* Distant
Brinjal Lace-wing Bug
(Fig. 402)

1909. *Urentis sentis* Distant, *Ann. Soc. Ent. Belg.*, **Liii** : 115.

1910. *Urentis sentis* : Distant, *Fauna Brit. India,* **5** : 113.

1997. *Urentis sentis* : Atwal and Dhaliwal, Agricultural pests of south Asia and their management : 264

Diagnosis : Body and disk pale ochraceous, body beneath blackish, the areolets of the elytral costal areas hyaline; eyes carmine-red; head with three long frontal spines; pronotum with hood almost covering head, its disk strongly irregularly carinate, the lateral margins strongly spined; elytra a little obliquely narrowed posteriorly, with the discoidal and sutural areas finely granulate, their margins strongly spinous.

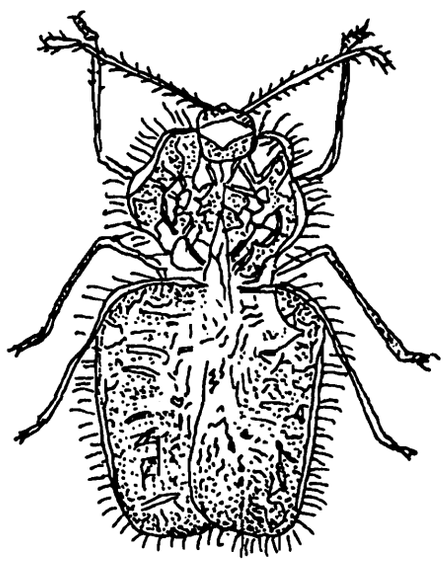


Fig. 402. *Urentius sentis* Distant

Length : 3 mm.

Host Plant : Except for brinjal, it has not been recorded feeding on any other plant.

Symptom and Damage : The adults and the nymphs suck the sap from leaves and cause yellowish spots (loss of chlorophyll) which, together with the black scale-like excreta deposited by them, impart a characteristic mottled appearance to the infested leaves.

Bionomics : The female lays 35-44 shining white nipple-shaped eggs singly on the under surface of the leaves. The hatching period is 3-12 days. After emergence the nymphs feed voraciously on the leaves. After five moults adult stage is attained in 10-23 days. 8 overlapping generations occur in a year. The pest is active from April to October and hibernates as an adult from November-March in cracks and crevices in the soil under the brinjal plants or other protected places. The pest is most abundant in August-Spetember. When the attack is severe, about 50 per cent of the crop may be destryoed.

Distribution : The pest species is distributed in the north-western parts of the Indian Sub-continent and is common in the plains.

Remarks : Both the nymphs and adults are destructive. The full-grwon nymphs are about 2 mm long and 1.35 mm broad. They are pale ochraceous and are stoutly built, with very prominent spines, straw coloured on the dorsal side and black on the ventral side. On the pronotum and wings, there is network of marking and veins.

Other tingids of Economic importance :

Name of the tingid	**Host plant**
Corythanma ayyari	Jasmine
Habrochila laeta	*Barlaria cristata*
Monosteria edeia	*Zizyphus jujuba*
Phenotropis cleopatra	*Indigofera* sp., *Tephrosia* sp.
* *Urentius hystricellus*	*Solanum melongena*

* It is allied to *Urentius euonymous* Distant and *U. sentis* Distant but differs in totally uncovered head, the disk of pronotum covered with two large vesicular processes and lateral margins not sinuate.

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Fig. 403. *Aphis craccivora* Koch : Apterous viviparous female

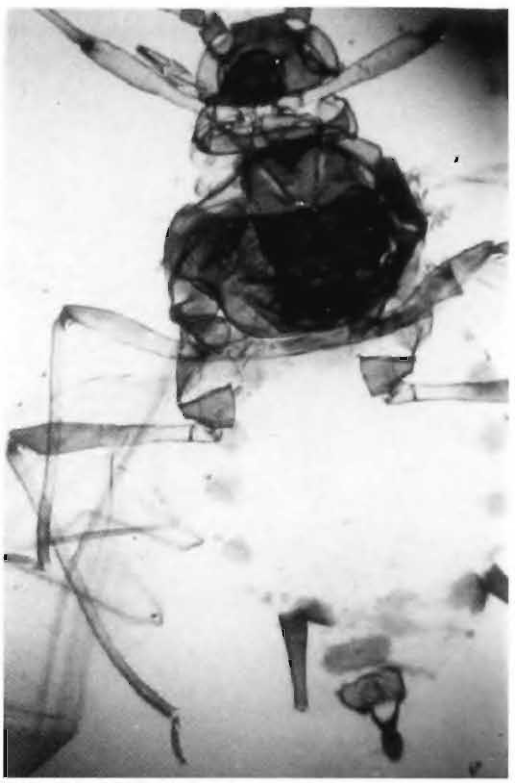


Fig. 404. *Aphis craccivora* Koch : Alate viviparous female

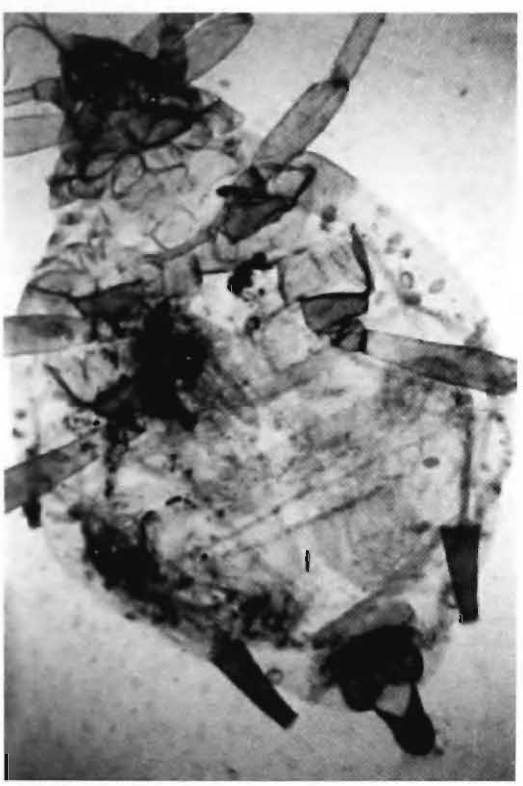


Fig. 405. *Aphis fabae* Complex : Apterous viviparous female



Fig. 406. *Aphis gossypii* Glover : Apterous viviparous female



Fig. 407. *Aphis gossypii* Glover : Alate viviparous female



Fig. 408. *Aphis nasturtii* Kaltenbach Apterous viviparous female



Fig. 409. *Aphis nasturtii* Kaltenbach : Alate viviparous female

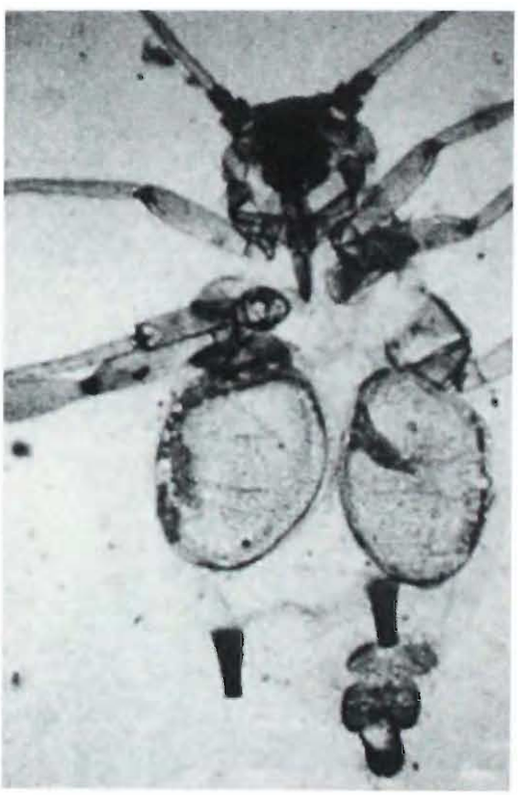


Fig. 410. *Aphis nasturtii* Kalt : Apterous oviparous female

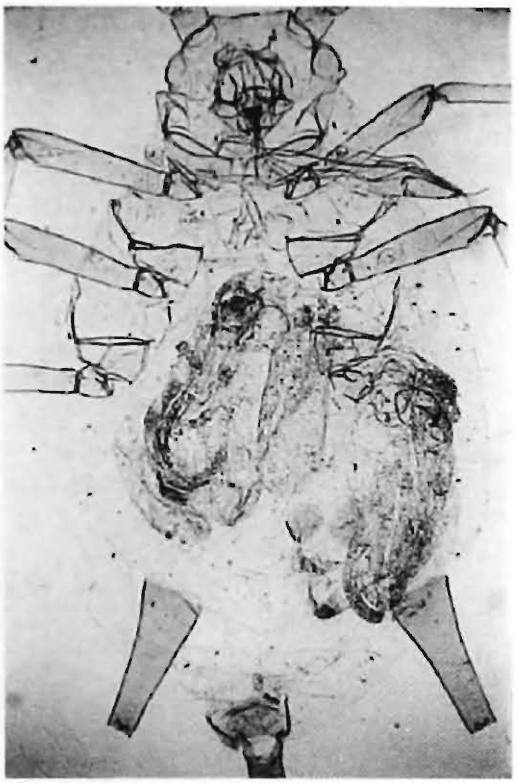


Fig. 411. *Aphis nerii* B.d.F : Apterous viviparous female

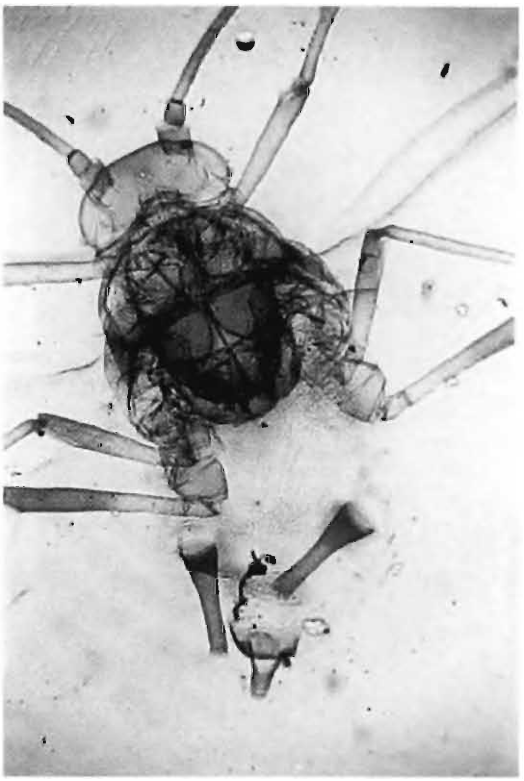


Fig. 412. *Aphis nerii* B.d.F : Alate viviparous female

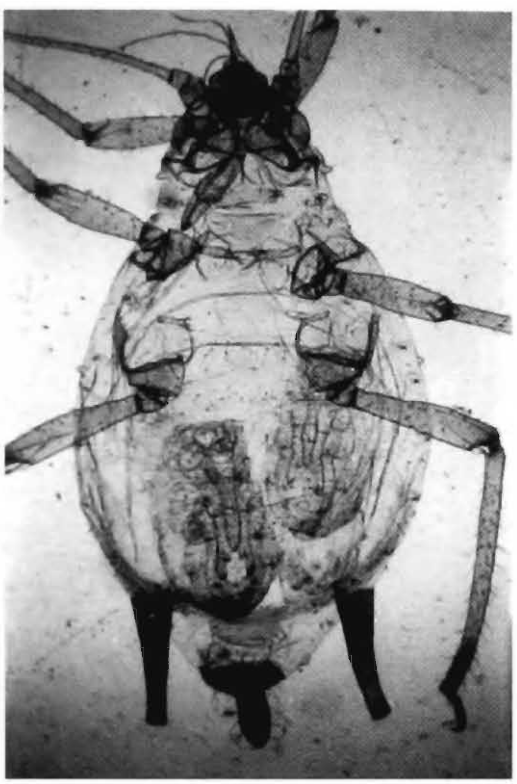


Fig. 413. *Aphis spiraecola* Patch : Apterous viviparous female



Fig. 414. *Aphis spiraecola* Patch : Alate viviparous female



Fig. 415. *Toxoptera aurantii* (B.d.F) : Apterous viviparous female showing stridulatory apparatus

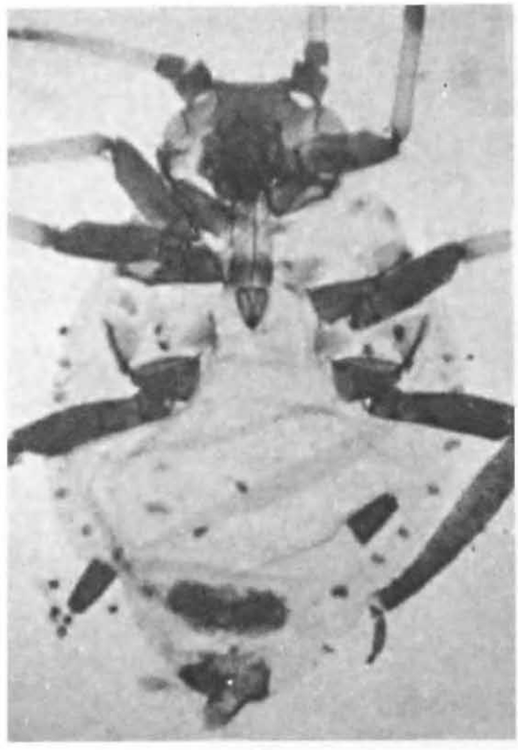


Fig. 416. *Hysteroneura setariae* (Thomas) : Apterous viviparous female

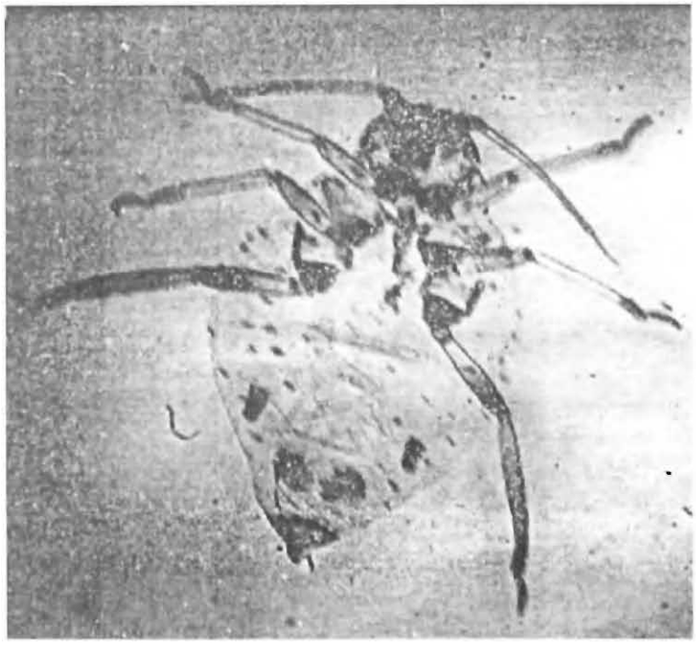


Fig. 417. *Rhopalosiphum maidis* (Fitch) : Apterous oviparous morph



Fig. 418. *Aphis craccivora* Koch infesting a plant *Lymantria disper*



Fig. 419. *Aphis craccivora* Koch infesting a plant of Fabaceae



Fig. 420. *Aphis gossypii* Glover on *Cajanus cajan*



Fig. 421. *Uroleucon (Uromelan) compositae* (Theobald) infesting *Sonchus* sp.



Fig. 422. Mummies of *Impatientinum* sp. on leaf of *Impatientinum sultaensis*



Fig. 423. *Aphis nerri* B.d.F. heavily infesting *Asclepias* sp.

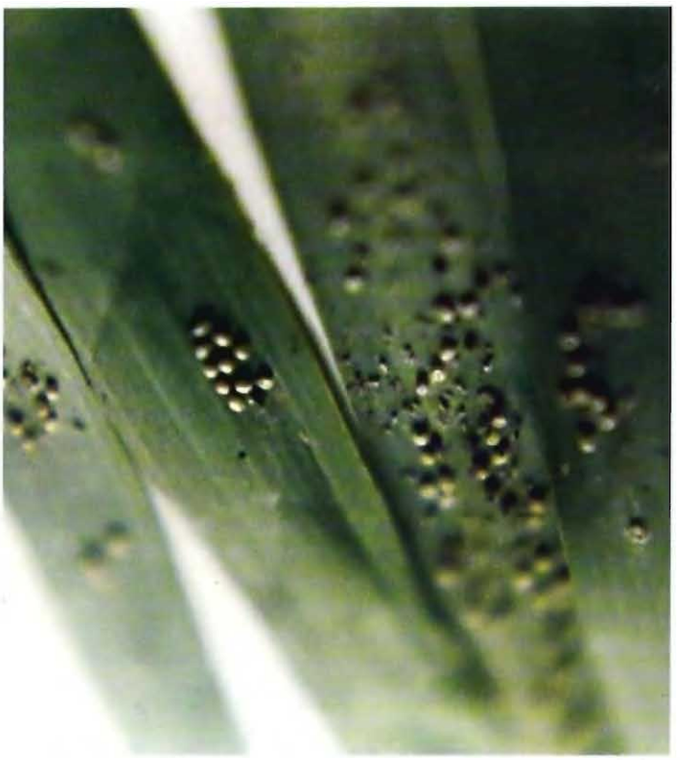


Fig. 424. Mummified aphid of *Melanaphis sacchari* (Zehntner) on *Arundo donax* (Poaceae)

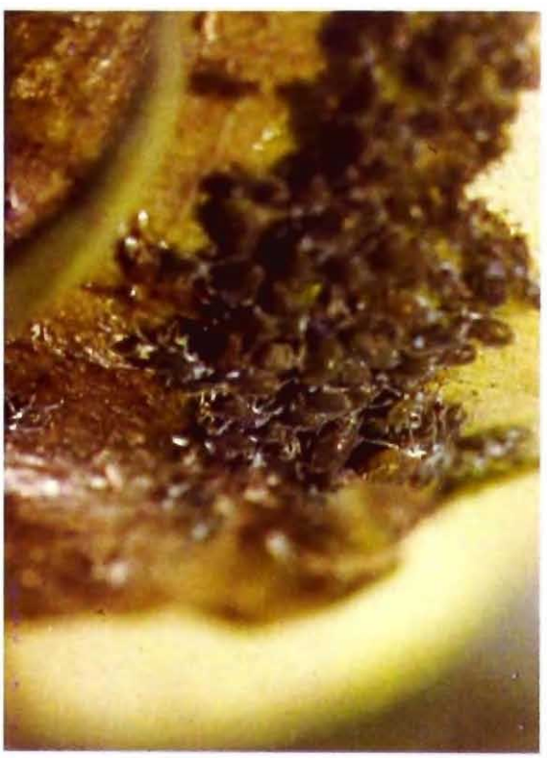


Fig. 425. *Brevicoryne brassicae* (Linnaeus) infesting Cabbage



Fig. 426. *Lipaphis erysimi* (Kaltenbach) colonising on leaf of Cabbage



Fig. 427. *Lipaphis erysimi* (Kaltenbach) heavily infesting inflorescence and seeds of *Brassica juncea ver rugosa*



Fig. 428. A composite leaf heavily infested by Aphids (*Macrosiphoniella sanbormi)*



Fig. 429. Pest of rice (Brown plant hopper)



Fig. 430. Damage–Hopper burn

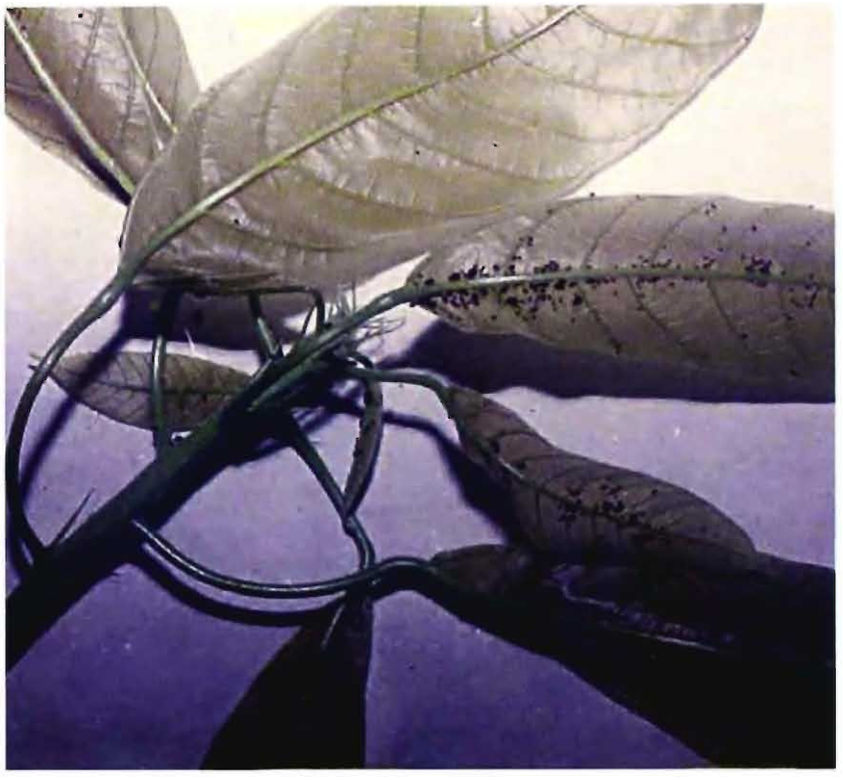


Fig. 431. Aphids—*Toxoptera aurantii* on Cocoa

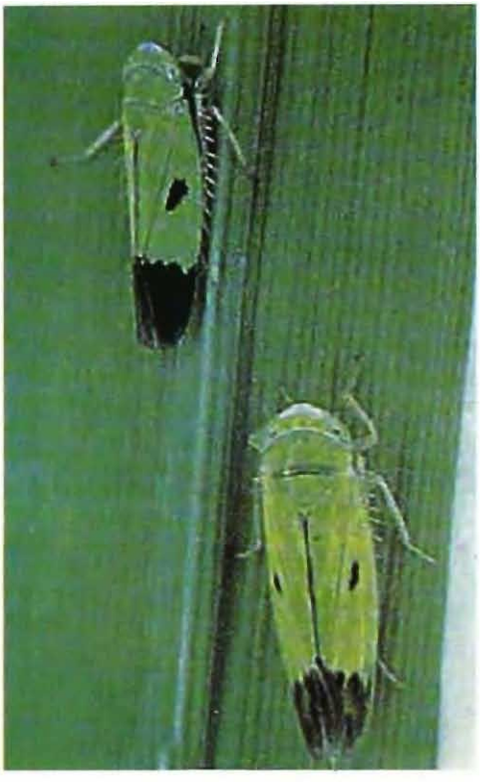


Fig. 432. Rice pest (*Nephotettix* sp.)



Fig. 433. Egg spirals of Mealy whitefly (spiralling Whitefly)



Fig. 434. Infestation of Mealy whitefly



Fig. 435. *Pyrilla perpusilla* (Walker)



Fig. 436. *Cosmoscarta naiteara* Distant

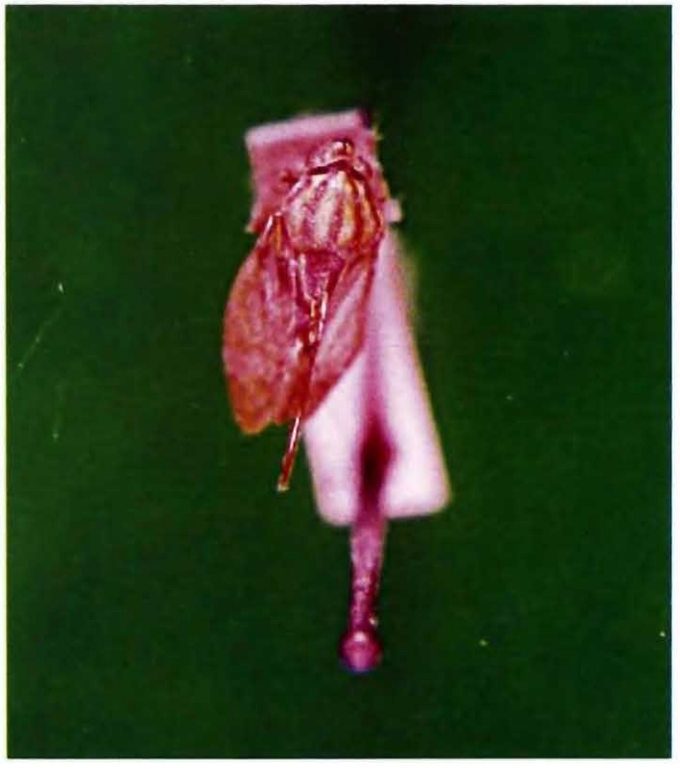


Fig. 437. *Machaerota ensifera* Burmeister



Fig. 438. *Riptortus linearis* (Fabricius)



Fig. 439. *Clavigralla gibbosa* Spinola



Fig. 440. *Bagrada picta* (Fabricius)



Fig. 441. *Dolycoris baccarum* Linnaeus



Fig. 442. *Dolycoris indicus* Stal



Fig. 443. *Halys dentatus* (Fabricius)



Fig. 444. *Menida histrio* (Fabricius)



Fig. 445. *Nezara viridula* (Linnaeus)



Fig. 446. *Chrysocoris grandis* (Thunberg)



Fig. 447. *Chrysocoris marginellus* (Westwood)



Fig. 448. *Crhysocoris stolii* (Wolf.)



Fig. 449. *Scutellera nobilis* Fabricius



Fig. 450. *Tessaratoma javanica* (Thunberg)

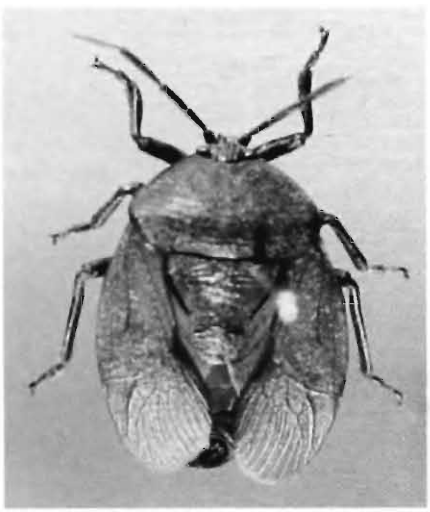


Fig. 451. *Aspongopus janus* Fab.



Fig. 452. *Dysdercus koenigii* (Fabricius)

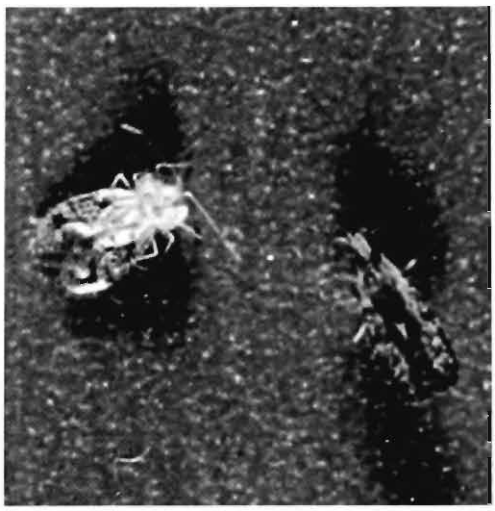


Fig. 453. *Stephanitis typicus* (Distant)

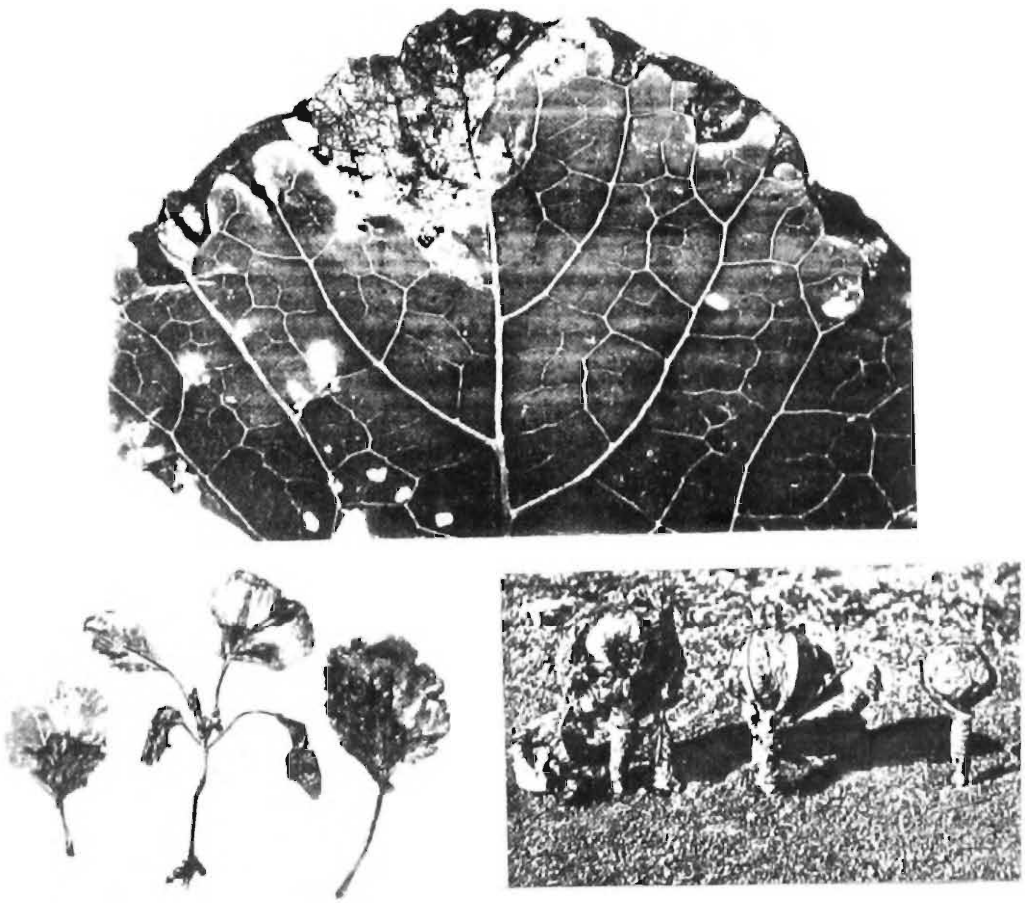


Fig. 454. Black rot. (Cabbage) : On margins of leaves V-shaped area turn yellow, wither, and the veins become black : spreads rapidly and leaves drop off often leaving a bare head : internal discoloration of vascular tissue. Can cause heavy losses, especially during hot, wet weather. Caused by a bacterium, *Xanthomonas campestris* (Pammel) Dowson, which can be carried on, or within the seed. New outbraks of disease often proved to have originated from use of infested seed.



Fig. 455. Damage caused by Potato virus Y or by combination of viruses like virus X+Y
Vector : *Myzus persicae* (Sulzer)

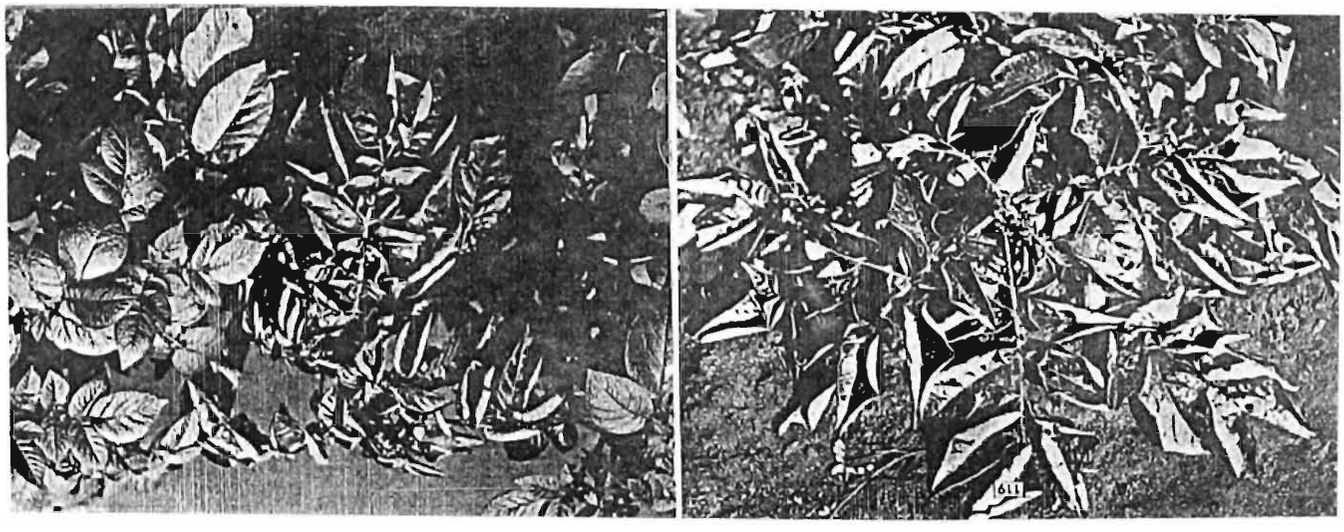


Fig. 456. Leaf Roll (Potato) : Leaves curl or roll inwards and have a leathery feeling. Plants become stunted and tubers are small. Caused by *Potato leaf Roll Virus* and is carried from infected to healthy plants by Aphids : it is also transmitted by seed.



Fig. 457. Mosaic (Cabbage and Cauliflower) : Plants are stunted and veins of leaves become prominent as a yellow network. Caused by the *Cauliflower mosaic virus* Tompkins : infected juice can be carried from diseased to healthy plants during transplanting or cultivation, or by insects such as aphids.



Fig. 458. Black Ring Spot. (Cabbage) : Small, light-brown dots on upper side, but dark grey to black on underside, appear on outer leaves causing them to turn borwn and dry out. Spots are often in patterns along veins or in broken rings. Caused by the *Cabbage black ring spot virus* Smith; it is spread by aphids feeding first on infected and then on healthy plants.

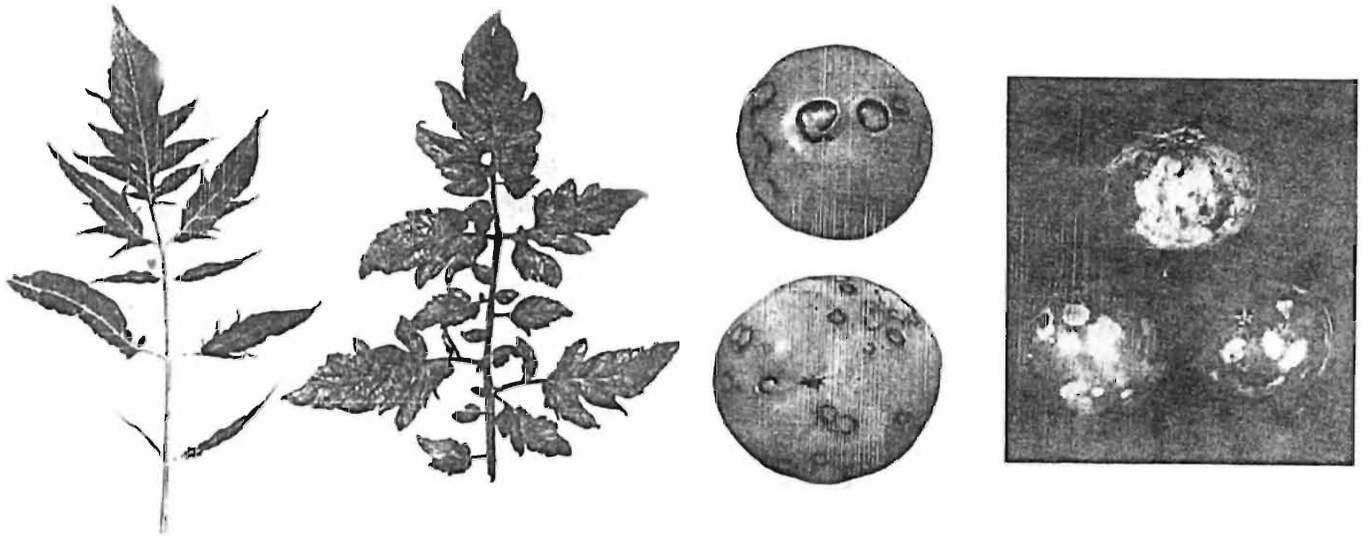


Fig. 459. Mosaic (Tobacco) : Light coloured, green or yellow mottled areas appear on the fruit and leaves : the leaves may also become distorted and in extreme cases thread-like, and occassionally black, sunken rings may form on the fruit. Caused by the *Tobacco Mosaic Virus* Clinton.

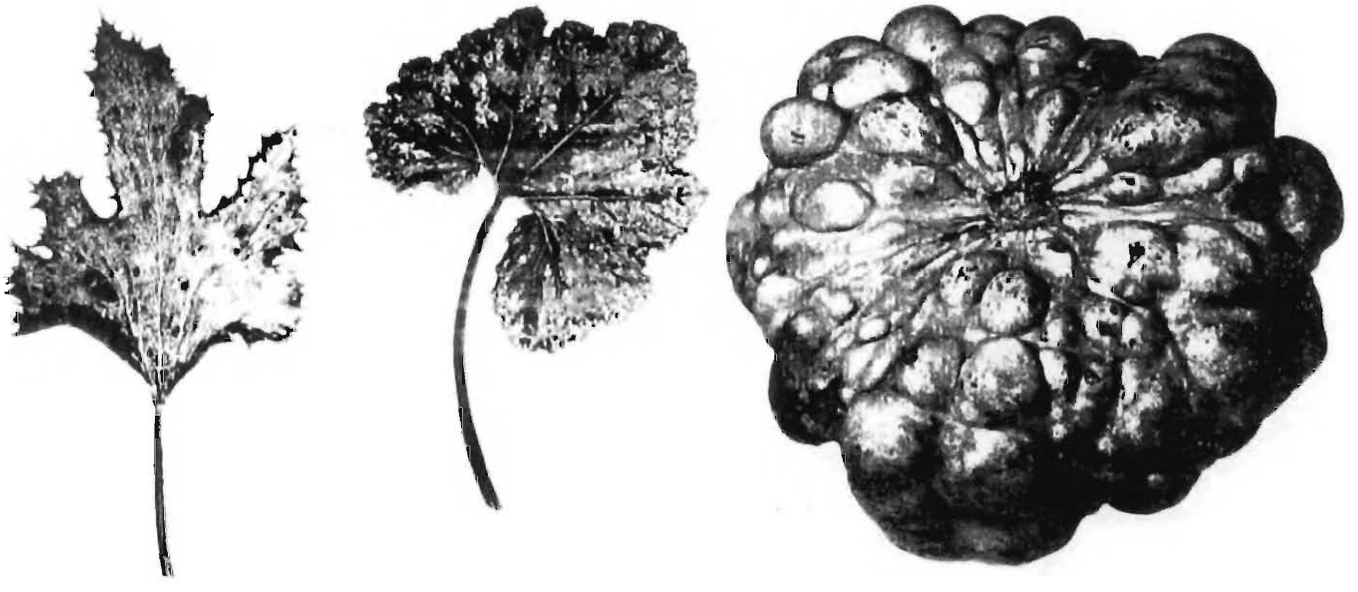


Fig. 460. Massow and Pumpkin : Cucumber green-mottle mosaic virus



Fig. 461. Cotton Boll infested by pyrrhocoreid bugs



Fig. 462. Pumkin Mosaic. Vector–*Aphis gossypii* Glover



Fig. 463. Pumpkin yellow vein mosaic vector : *Bemisia tabaci* (Genn.) [Hemiptera : Aleyrodidae]



Fig. 464. *Dysdercus koenigii* (Thunberg), Red cotton Bug [Hemiptera : Pyrrhocoridae]



Fig. 465. Nymphal colony of *Dysdercus koenigii* (Thunberg) on cotton



Fig. 466. Infestation of Cotton plant twig by coccids being attended by ants

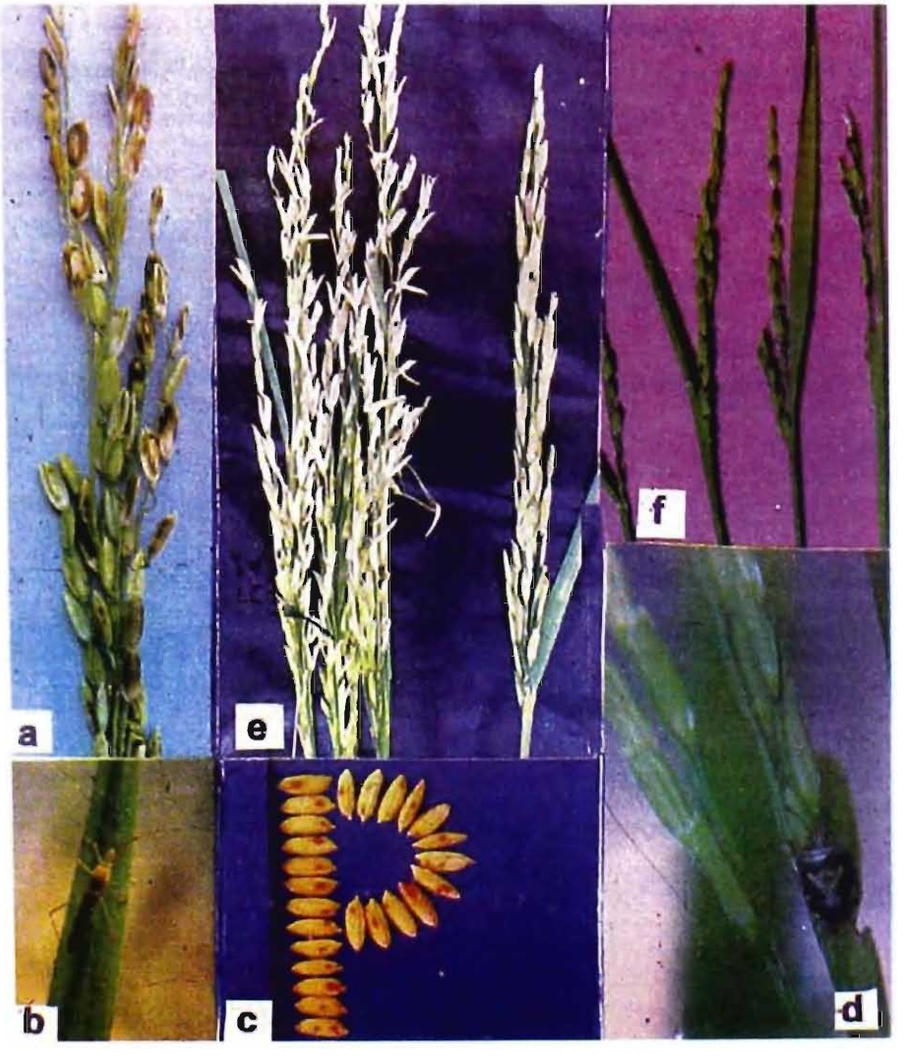


Fig. 467. a. Panicle infested by *Leptocorisa acuta;* b. Adult *L. acuta;* c. Grains infested by *Menida histrio;* d. Adult *M. histrio;* e. Panicle infested by bugs, f. Panicle infested by aphids



Fig. 468. Mealy whitefly, *Aleurodicus dispersus* infesting on coconut



Fig. 469. Tea mosquito bug, *Helopltis antonii* damaging cashew



Fig. 470. White flies (Aleurodid) colonising on the leaf of the host plant

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