

WHITEFLIES (HOMOPTERA: Aleyrodidae) FROM
CENTRAL AMERICA AND COLOMBIA INCLUDING
SLIDE-MOUNTED PUPAL AND FIELD KEYS FOR IDENTIFICATION,
FIELD CHARACTERISTICS, HOSTS, DISTRIBUTION,
NATURAL ENEMIES, AND ECONOMIC IMPORTANCE

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INTRODUCTION

Since the beginning of entomological history, the taxonomy of whiteflies (HOMOPTERA: Aleyrodidae) has been neglected by most taxonomists (Mound and Halsey 1978). Currently, there is no professional systematist employed full time anywhere in the world studying this group (Bink-Moenen and Mound 1990). One common fact concerning whiteflies is the lack of available organized information on their biology, such as habits, ecology, and systematics (Gerling 1990).

There have been 1,156 species described in 126 genera (Mound and Halsey 1978), but the actual number is probably much higher. Whiteflies are found worldwide, 63% of the described species are tropical and 37% are from temperate regions (Strong et al. 1984). Most research has been done in temperate areas, while studies in tropical America are yet to be done (Bink-Moenen and Mound 1990; R. J. Gill personal communication; S. Nakahara personal communication). The only known comprehensive work on tropical America was done by Bondar (1923), who dealt with whiteflies from Brazil. However, his work is now old and often unpractical. Since Bondar's publication (1923), small management research projects, primarily based on chemical control, have been made available. No other major efforts have been made to gain knowledge on this group of tropical insects.

Correct identifications and systematically collected agroecological observations are the first essential building blocks for the improvement of neotropical insect pest management procedures (Andrews 1983). Until then, regional scientists and technicians have to depend on foreign literature. An obvious consequence of this is incorrect identifications for many species since the literature covers species not occurring in tropical areas.

The objectives of this study were (1) to provide an up-to-date identification guide including an illustrated key for slide-mounted immatures and field color picture keys to immatures and adults for the most economically important and common species of whitefly occurring in agricultural and natural systems in Central America and Colombia; (2) to determine host plants, geographical distribution, natural enemies, and economic importance of whiteflies; (3) to incorporate the material collected and the ecological information in the collection and database system of the Agroecological Inventory Center, Plant Protection Department, at the Escuela Agricola Panamericana, El Zamorano, Honduras, Central America.

LITERATURE REVIEW

A. Geographical distribution:

Whiteflies are distributed worldwide; 1,156 species have been described (Mound and Halsey 1978), 63% are from the tropics and 37% from temperate regions (Strong et al. 1984). Whiteflies are known from nine zoogeographical regions: Palaearctic, Ethiopian, Madagascan, Oriental, Austro-Oriental, Australasian, Pacific, Nearctic, and Neotropical (Mound and Halsey 1978). Aleuroplatus, Aleurotrachelus, and Tetraleurodes are reported from many parts of the world; the other groups have a more restricted distribution (Table 1).

B. Host plants:

Host specificity in Aleyrodidae does not seem to be highly developed. Most common species have been collected from two or more, often unrelated, host plants (Mound and Halsey 1978). The majority of species are collected on angiosperms, primarily on dicotyledons. Some species, however, are found in three families of monocotyledons: Gramineae, Palmae, and Smilacaceae. There is only one record on a gymnosperm, Trialeurodes vaporariorum, one of the most polyphagous whitefly species. In contrast, the ten species recorded from ferns have not been found on flowering plants (Mound and Halsey 1978).

Byrne et al. (1990) group the economically important whitefly species in annual cropping and woody perennial cropping agricultural systems (Tables 2-3).

Takahashi (1933), cited by Russell (1948), pointed out the correlation between the morphology of whiteflies and that of the leaves of the hosts. Evidence of such correlation was found by Russell (1948) in the genus Trialeurodes, based on differences in papillae and setae. There is a tendency for species in this genus to lack prominent dorsal papillae when living on smooth leaves and to have the submarginal ones directed somewhat laterally. In contrast, species living on hairy leaves tend to have conspicuous dorsal papillae, and the submarginal ones are directed diagonally or vertically. Although there are some exceptions, certain species of this genus normally living on hairy-leaved hosts have long setae, whereas other species occurring on smooth leaves have relatively short ones.

Another well documented case of host-correlated variation was demonstrated by Mound (1963) from controlled breeding experiments with Bemisia tabaci on different host plants. He found hairy specimens on hairy leaves and smooth specimens on smooth ones; they also differed significantly in shape as well as size. Mound (1963) concluded that these variants were induced phenotypically by morphological characters of the host

plant leaves such as cuticle irregularity and hairiness.

In a recent study, Bink-Moenen and Mound (1990) found that one of the species of Aleuroviggianus, from Quercus spp. in the Mediterranean area, is of particular interest because the pupal cases varied in structure depending on whether they developed on the hairy underside or the glabrous upperside of the leaves of the same host plant.

C. Morphology:

The eggs of whiteflies usually are elongate-oval, occasionally reniform, and have either a smooth or variously sculptured surface (Gill 1990; Quaintance and Baker 1913). They usually have short stalks at or near their bases, but they are occasionally very long such as in Aleurodicus holmesii (Quaintance and Baker 1913). Newly oviposited eggs are white, pale yellow, or yellowish, turning pale pink, light brown to dark brown, or black before hatching (Garman and Jewett 1922; Hamon et al. 1990; Nguyen and Hamon 1989). Eggs may be oviposited singly, in a semicircle, a complete circle, spirally, or scattered; usually on the undersides of leaves (Dowell et al. 1981; Hamon 1981).

The first nymphal instar is the only mobile immature stage. It is usually transparent to opaque, ranging from light green (due to transparency) to yellow, light brown through dark

brown, and black. Segmentation usually is faint. It appears to have three pairs of legs and two antennal segments (Gill 1990). Eichelkraut and Cardona (1989) stated that the first instar of Bemisia tabaci is elliptical, white greenish, with 16 pairs of marginal setae and 6 pairs of microsetae. The eyes are like cephalic, red spots. The antennae are three-segmented, ending in a large spine. The legs are well developed, having a coxa, trochanter, femur, and a non-subsegmented tarsus armed with a long seta and ending in a stalked arolium. The abdomen has eight segments.

Second and third nymphal instars are similar in shape and color to the fourth instar, or pupa. In the Aleurodicinae, there are conspicuous leg segments, but the antennal segments are not discernibly segmented. In the Aleyrodinae, in contrast, both legs and antennae appear to be reduced to only one segment. Pupae also differ from the former two instars in leg size and length of some dorsal setae (Gill 1990).

It is common to refer to the late fourth nymphal instar as the pupa. This implies that whiteflies undergo metamorphosis similar to holometabolous insects but this is not true. It is related to the fact that the pharate adult is formed inside the cuticular test of the fourth nymphal instar (Byrne 1990). The exuvium is referred to as the pupal case. Whitefly classification has been based on characters of the fourth

nymphal instar since these are useful in species identification (Gill 1990; Martin 1987; Mound and Halsey 1978; Quaintance and Baker 1913, 1914).

The vasiform orifice, operculum and lingula are located dorsally on the last abdominal segment. Their shape and construction offer useful specific and generic characters (Gill 1990). They allow sessile nymphs to discard honeydew. Honeydew exits the anus and fills the orifice. The lingula is locked down into the honeydew and when released, it catapults the honeydew away as a droplet (Byrne 1990).

Color of the pupa is dependent on the body color and the color of its wax secretions. The normal coloration ranges from transparent or translucent, greenish (reflecting the color of the host), to white, tan, brown, dark brown, or black. Gill (1990) describes two basic types of wax secretions by pupae. The first is transparent or translucent, reflecting the color of the nearby environment, or appearing white. The second, and most common, is a pure, opaque white, snowlike wax. Both types of wax are usually present. The first usually occurs as a very thin dorsal layer, marginally as a fringe, or dorsally as spine-like, wax rays. The second or opaque white may be produced dorsally as tufts or as flocculent or woolly mats.

Pupae typically are elliptical to elliptical-elongate, but

some vary from elongate to nearly circular. The margin and the general body outline may be distorted if a stiff leaf hair or other structure prevents normal outward or lateral growth (Gill 1990). Nymphs usually are flat in earlier instars, but at the pupal stage they become convex or elevated. Gill (1990) stated that the simple method of elevation is a lifting of the center of the dorsum, with the marginal areas remaining low in profile. In other forms, the entire dorsum becomes elevated, with the submarginal areas of the venter expanding upward to fill the area between the margin and the host surface.

The pupal case margin varies from smooth, crenulate to deeply toothed or even spinose. Each marginal type may be unique to a species or generic group (Gill 1990). There are usually a number of setae on whitefly pupae. These may include anterior and posterior marginal; cephalic; pro-, meso-, and metathoracic; first, eighth and ventral abdominal; and caudal ones. There may also be submarginal setae varying in number and size. The size and shape of individual setae and their placement may be extremely useful in classification (Gill 1990).

Slide-mounted nymphs have the anterior and posterior margins of legs subequal in length; they appear triangular with the apices usually directed laterally or marginally. In contrast, slide-mounted pupae have the anterior margins of legs larger;

the prothoracic legs directed anteromedially and the meso- and metathoracic ones directed caudomedially. In addition, in the pupal stage, segmentation of the legs and antennae is essentially lost; both of these structures appear as single unsegmented organs in most of the common species of the Aleyrodinae and Aleurodicinae (Gill 1990).

Russell (1948) found a structure in aleyrodids for distinguishing male from female pupae and described it as follows: "pupae containing males have a small, membranous, bifid invagination situated medially between the posterior abdominal spiracles, whereas pupae enclosing females lack this organ. Female pupae, in which adults are fully developed, sometimes show three small spots, one of them medial between the posterior abdominal spiracles and one somewhat anterior to each of these spiracles, which may be produced by the genitalia since they apparently are absent from recently emerged pupae. The bifid sac, on the other hand, is present when the pupae molt from the third instar".

Adult whiteflies usually appear white due to powdery wax secretions produced shortly after emergence from the pupa. These wax particles are extruded from wax plates found on the ventral lateral abdominal surface (Mound and Halsey 1978). The material is extruded as a continuous ribbon that is broken off as a curly particle when the hind tibia passes over these

plates. The particles are then distributed by the hind and forelegs to other parts of the body (Byrne 1990). Occasionally, wax secretions are gray, bluish-black or red. The actual body color of the integument is usually yellow; sometimes it ranges through tan, red, blue or black (Gill 1990). Some whiteflies have colored spots or bands on the wings. Usually the unwaxed wing is clear, with light brown or black pigmentation forming these patterns (Gill 1990).

In Aleurodicinae, the vertex of the head in dorsal view is rounded anteriorly and about as long as wide, except for one genus which has a triangular produced vertex (Gill 1990). In Aleyrodinae, it is broadly rounded, much broader than long. Compound eyes occur in two groups which may be divided or connected by one or more ommatidia, resulting in a reniform appearance. The presence or absence of a division between the upper and lower section of the compound eyes is of generic or specific importance (Gill 1990). One pair of ocelli is usually located just above each compound eye.

According to Gill (1990), the antennae are usually seven-segmented with the first segment short, about as wide as long, and relatively thick; the second is broader and longer. The third through the seventh segments are normally about half the diameter of the second but are variable. The third is usually the longest. In one genus, several terminal segments are

fused; males have the last five united, appearing three-segmented, and females have the last five united into two segments, appearing four-segmented.

Adult whiteflies have primary sensoria and sensorial cones. Primary sensoria have a central peg surrounded by a flower-like ring of inwardly directed or erect filaments or spinules (Gill 1990). In Aleyrodinae, the primary sensoria are restricted to the apical and subapical portions of the third antennal segment, the apex of the fifth one and the median or subapical areas of the seventh. In Aleurodicinae, there are numerous primary sensoria randomly scattered over the third antennal segment and sometimes the fourth and seventh ones.

In the Aleyrodinae, single sensorial cones are normally found on the third, fifth and seventh segments. In one tribe a single cone also occurs on the fourth segment. Sensorial cones may be modified on segments three through seven; in Aleurodicinae, they may be absent in some genera or may be numerous and randomly placed on antennal segment three to seven in others. Modifications take several forms and are often of specific significance (Gill 1990).

The thorax, except the insertion point for appendages and the rostrum, does not have taxonomic characters. The abdomen is unique because of the presence of the vasiform orifice,

operculum and lingula (Gill 1990). Most of Aleurodicinae are greater than 2 mm from vertex to wing tip; Aleyrodinae and two genera of Aleurodicinae are smaller.

Some leg setae are of tribal and generic significance in adult wheateflies because they are smaller, less heavily sclerotized, and more closely set than other setae on the same leg segment (Gill 1990). These setae, the metatibial comb, occur transversely along the dorsal or dorsolateral surface of the metatibia. The metatibial brush, in contrast, is found on the ventral or ventrolateral surface of the metatibia, formed by a closely appressed linear group of two to five setae set at an oblique angle across the length of the segment. A double set of mesotibial brushes occur on the inner and outer lateral edges of the mesotibia just distad of its midlength (Gill 1990). In most Aleyrodinae, there are two, rarely three, setae in each brush and the number of setae is constant for all brushes in each species. In Aleurodicinae, the brushes may have two to four setae; the number varies in some species depending on the location of the brush. It is assumed that the function of the combs and brushes is for wax grooming (Gill 1990).

The female ovipositor has few taxonomic features but the male genitalia are extremely useful taxonomically including the apex of the aedeagus, the claspers (parameres), and the

overall shape, length, thickness, setation and armature (Gill 1990).

D. Taxonomy:

The first species of Aleyrodidae was Phalaena (Tinea) proletella described by Linneaus in 1758 (Systema Naturae, 10th edition, p. 537). In 1836 a Frenchman mistakenly placed this species in Lepidoptera. Prior to this century, many errors were made (Byrne 1990). According to Mound and Halsey (1978) several whitefly species were placed in Dictyoptera, Neuroptera, Lepidoptera, and Homoptera (Aphididae and more often Psyllidae). The most important species, Bemisia tabaci was described by Gennadius (1889) on tobacco. The genus Bemisia was named by Quaintance and Baker (1913) in honor to Miss Bemis E. Florence, a whitefly taxonomist (Mound and Halsey 1978; Quaintance and Baker 1913).

The family Aleyrodidae is divided into two subfamilies, the Aleurodicinae and the Aleyrodinae (Gill 1990). A third subfamily, the Udamoselinae, was described by Enderlein (1909) based on only one specimen, Udamoselis pigmentaria, occurring probably in South America (Bondar 1923; Quaintance and Baker 1913). The type specimen apparently has been destroyed and a similar whitefly has never been recollected; the name is therefore considered a nomen dubium (Mound and Halsey 1978).

Subfamily classification is based on adult wing characteristics. The subfamily Aleurodicinae is considered more primitive. The members of this subfamily are characterized by the development of the costal-subcostal, radial sector, R_1 , and medial veins. The cubitus is also usually present. They have three ventral abdominal wax plates in males and four in females. The tarsal paronychium is thin and spine-like (Gill 1990). The Aleurodicinae comprise fewer than 100 of the described species, mainly from the Neotropics (Bink-Moenen and Mound 1990).

The subfamily Aleyrodinae is considered more highly evolved. Wing venation is reduced primarily in the costal-subcostal veins, radius (R_s only, R_1 is usually very short or absent), and occasionally the cubital veins. There are usually four ventral abdominal wax plates in males and two in females. The tarsal paronychium is usually thickened and clothed with spinules (microsetae) on the plantar surface (Gill 1990). The Aleyrodinae comprise more than 1,000 of the described species (Bink-Moenen and Mound 1990).

The basic morphological differences between Aleurodicinae and Aleyrodinae pupae is the presence of compound wax pores on the dorsal disk, two or more pairs of lingular setae, and one claw at the apices of the rudimentary legs in Aleurodicinae. In Aleyrodinae, there are no compound pores and leg claws, only

one pair of lingular setae, and adhesive or circular discs at the apices of the legs (Gill 1990).

Quaintance and Baker (1913) classified the family Aleyrodidae. They treated the subfamily Aleurodicinae, including four genera, Aleurodicus, Dialeurodicus, Leonardius, and Paraleyrodes. At this time, Aleurodicus included the subgenera, Aleurodicus, Lecanoideus, and Metaleurodicus. Twenty-eight species were treated in this subfamily. They included, in the same paper, the subfamily Udamoselinae with the genus Udamoselis. However, this is considered a nomen dubium (Mound and Halsey 1978).

Quaintance and Baker (1914) dealt with the subfamily Aleyrodinae at the generic level, listing the names of the described species in each genus. Seventeen genera were treated, Aleurocanthus, Aleurocybotus, Aleurolobus, Aleuroparadoxus, Aleuroplatus, Aleurothrixus, Aleurotithius, Aleurotrachelus, Aleurotulus, Aleyrodes, Asterochiton, Bemisia, Dialeurodes, Dialeurodoides, Neomaskellia, Pealius, and Tetraleurodes.

Six tribes have been named in the Aleyrodinae. Five were named by Sampson (1943): Neomaskellini, Aleurochitonini, Siphonini, Dialeurodini, and Aleyrodini. Russell (1947) added Trialeurodini.

Russell (1947) mentioned ten species in the genus Aleuoparadoxus and two in Aleurotithius. Russell (1948) studied the North American species of the genus Trialeurodes, including 34 nearctic species. Russell (1986) reviewed the neotropical genus Aleurocerus, adding new species for a total of 18 occurring from Mexico to Brazil. Previously, Russell (1965) described a new species of Aleurodicus (Aleurodicinae), and discussed two close related species.

Bondar (1923) published on Aleyrodids from Brazil, in Portuguese. He included 80 species in 23 genera; 35 species in 10 genera of Aleurodicinae and 44 species in 12 genera of Aleyrodinae. He considered Udamoselinae as a subfamily with the species Udamoselis pigmentaria. He described several new genera and 56 new species. Bondar (1928) added 17 new species and two previously described ones, from Brazil.

Martin (1987) provided an identification guide to common whitefly species of the world. He treated 46 species in 24 genera including four species in two genera of Aleurodinae.

Many species of whiteflies are undoubtedly unknown. The Aleyrodidae, therefore, have not been well studied yet. Their life histories and taxonomic relationships are still poorly understood (Byrne 1990). Bink-Moenen and Mound (1990) concluded that future taxonomic studies must involve field

biology of species, host range and structure of adults; such comparative studies have been greatly neglected.

E. Evolutionary patterns:

Quaintance and Baker (1913) interpreted the position of the family and the relationships of the genera of Aleyrodidae (Fig. A). Aleyrodidae is most closely related to the Psyllidae. In both groups the adult legs have two tarsomeres and pulvilli that are almost equal in size; Aphididae and Coccidae have the first tarsomere reduced or even absent, including the pulvillus. Wings in whiteflies are also closer to psyllids, it is clear that the ancestor of Aleyrodidae was winged with venation very similar to the psyllid type. Genitalia of these two groups are also similar, while the Aphididae are very different in structure. In addition, their mouthparts are identical, except for a slight variation in form and size.

Below the family level, there are two different lines of descent in Aleyrodidae (Fig. A). In Aleurodicinae the media is retained, the cubitus lost, and large compound wax pores are often developed in the pupa. In Aleyrodinae, the media is lost, the cubitus retained, and no pupal compound pores wax pores are present (Quaintance and Baker 1913).

At that time, they included three genera in Aleyrodinae,

Aleurochiton, Aleyrodes, and Neomaskellia. The first is the most primitive; from it Aleyrodes arose, represented by the reduction of radius,. Neomaskellia seems to have separated earlier than Aleyrodes because it retains very hairy psyllid-like claspers and much reduced wing venation (Fig. A). Since the genus Aleyrodes included many diversified forms, recent studies have split the genus.

In Aleurodicinae (Quaintance and Baker 1913), the most primitive form seems to be Dialeurodicus. This species has wing venation resembling Aleurodicus, but still retains head characters which resemble Udamoselis (Udamoselinae) and its pupa does not have compound pores. The genus Leonardius shows intermediate characters between Dialeurodicus and Aleurodicus, indicating a development toward Aleurodicus based on compound wax pores; it is also similar to Dialeurodicus in wing form, vertex of head, and vasiform orifice. The genus Aleurodicus is separated by wing venation, the definite development of compound pores, and the long exerted lingula. Paraleyrodes is plainly derived from near Aleurodicus because of the reduction of the radius and part of the media and by the shortening of the spinnerets and the cup of the compound wax pores. Some antennal segments are also united (Fig. A).

Mound and Halsey (1978) suggested that the additional wing veins in members of the Aleurodicinae might be a functional

necessity associated with large size. Schlee (1970), (cited by Mound and Halsey 1978 and by Bink-Moenen and Mound 1990), concluded that the larger number of veins is undoubtedly primitive (or plesiomorphic), and are of little value in defining a phylogenetic group; reduction is also related to large body size (small aleurodicines have reduced venation). Therefore, wing venation in Aleyrodidae does not give evidence for kinship relationships within the family.

F. Economic importance:

The economic importance of whiteflies has been reported since the early 1900's (Quaintance 1910, 1916; Quaintance and Baker 1913). Direct damage can result from feeding by immatures and adults; when present in large numbers, they cause leaf drop and prohibit the maturation of fruits. They also produce a sticky honeydew which soils and damages crops and hampers the processing of products such as cotton. Honeydew also serves as a substrate on which sooty mold grows, reducing photosynthesis of leaves and rendering plants and fruits unmarketable. Indirect damage can occur by transmission of pathogenic viruses (Gerling 1990; Mound and Halsey 1978). There are more than 70 whitefly-borne pathogens reported in cultivated and weedy plants from the tropics and subtropics. From six or seven morphological classes of whitefly-borne viruses, only the gemini group is transmitted in a persistent-circulative way by whiteflies (Cohen 1990).

Whiteflies are increasing in importance as pests of ornamental and agricultural plants in greenhouses and out-of-doors. According to Gerling (1990) they have reached this climatic point by spreading into new geographic areas, attacking previously uninfested plant species, becoming acclimatized to new environments, developing biotypes that react differently to host plants, transmitting more plant diseases, and becoming resistant to insecticides. However, much of the current distribution of pest species and their ability to reach and occupy these varied habitats is the result of human intervention. Man has both transported them to new locales and altered existing environments in ways that allow their survival in areas which normally would not support these populations (Byrne et al. 1990).

Only a few of the described species are actually pests (Byrne et al. 1990). Two species, of any consequence, occur in protected agriculture, while several others are of concern in annual cropping systems (Table 2) and about a dozen of species are reported as regularly causing damage in perennial cropping systems (Table 3).

The sweetpotato whitefly, Bemisia tabaci, is a polyphagous species of cosmopolitan distribution and the most important whitefly vector of viruses in the world (Costa 1976; Mound and Halsey 1978). It attacks more than 500 plant species in 74

families in warm temperate and tropical areas of the world (Broadbent et al. 1989). Most of the whitefly-borne diseases are transmitted by Bemisia tabaci (Duffus 1987).

In the United States, Bemisia tabaci was not considered an economically important pest of cotton and other vegetables crops in California and Arizona until 1981 (Buttler et al. 1986; Duffus et al. 1986; Prabhaker et al. 1985). Flock and Mayhew (1981) and Duffus and Flock (1982) have shown this species to be the vector of three virus diseases affecting vegetables and field crops that caused losses in excess of \$100 million to growers and consumers in 1981.

In the past few years, this species devastated tomato crops in Florida, causing farmers' losses of many millions of dollars (Yokomi et al. 1990). In addition, at the end of the past year, a completely different strain of the same species ("poinsettia strain") showed up in California on melons, lettuce, cauliflower, and other winter crops. The expected losses are up to \$200 million (Anon. 1991).

In Latin America, Bemisia tabaci is also a key pest in crops such as cotton, tobacco, tomato, sweet pepper, potato, bean, soybean, melon, watermelon, ornamentals and other crops (Andrews and Caballero 1989; Barleta and Rueda 1991; C. Cardona, personal communication; Daxl 1989; Hallman and

Andrews 1989; King and Saunders 1984; Larios 1979; Passoa 1983; J. C. Rosas, personal communication; Rosset and Secaira 1989; P. Soto, personal communication). C. Cardona (personal communication) mentions losses of up to 300,000 ha of bean production due to damage caused by the Golden Mosaic Virus (BGMV) transmitted by this species in Brazil.

The second most important species worldwide, Trialeurodes vaporariorum, is also important in Latin America. It has been reported as a key pest, primarily on tomato and eggplant, in some regions of the Dominican Republic (Vennicio, personal communication); and in hillside cropping systems on green beans and several Solanaceae in Colombia (Cardona et al. 1991). In the same country, S. Saldarriaga et al. (personal communication) found that this species is responsible for transmission of an unidentified virus in potato.

Other species reported in the American neotropics on annual cropping systems are Aleuroglandulus malangae, Trialeurodes spp., and Aleurotrachelus spp. feeding on several crops and ornamentals (King and Saunders 1984). Three species of whiteflies are usually associated with cassava, Bemisia tuberculata, Aleurotrachelus sociales, and Trialeurodes variabilis (CIAT 1983, 1986; Vargas and Bellotti 1981). In South America, besides causing leaf yellowing deformation and sooty mold, these species transmit two different types of

viruses in cassava (Angel et al. 1989). Russell (1975) reported five species associated with beans and soybeans in America: Bemisia tabaci, B. tuberculata, Tetraleurodes acaciae, Trialeurodes abutiloneus, and T. vaporariorum. Only the first was considered injurious as a virus vector. The most important species reported in a woody perennial cropping system in Central America is Aleurocanthus woglumi on citrus (Andrews and Caballero 1989; Passoa 1983; Quezada 1976, 1989). Other occasional important species on citrus that may need to be controlled are Aleurothrixus floccosus and Dialeurodes spp. (Quezada 1989).

Table 1. General distribution of main groups of worldwide whiteflies (Mound and Halsey 1978).

<u>TAXA</u>	<u>DISTRIBUTION</u>
<u>Aleurodicinae</u>	Neotropics
<u>Aleurocerus</u>	"
<u>Aleurothrixus</u>	"
<u>Bellitudo</u>	"
<u>Crenidorsum</u>	"
<u>Trialeurodes</u>	New World
<u>Aleuoparadoxus</u>	"
<u>Africaleurodes</u>	Africa, Madagascar
<u>Aleurolonga</u>	" "
<u>Aleuropteridis</u>	" "
<u>Corbettia</u>	" "
<u>Dialeurolonga</u>	" "
<u>Acaudaleyrodes</u>	Ethiopian, Oriental Regions
<u>Aleurocanthus</u>	" " "
<u>Aleurolobus</u>	" " "
<u>Aleurotuberculatus</u>	" " "
<u>Dialeuropora</u>	" " "
<u>Dialeurodes</u>	" " "
<u>Pealius</u>	Oriental, Austro-Oriental regions
<u>Odontaleyrodes</u>	" " " "
<u>Rhachispora</u>	" " " "
<u>Orchamoplatus</u>	Pacific

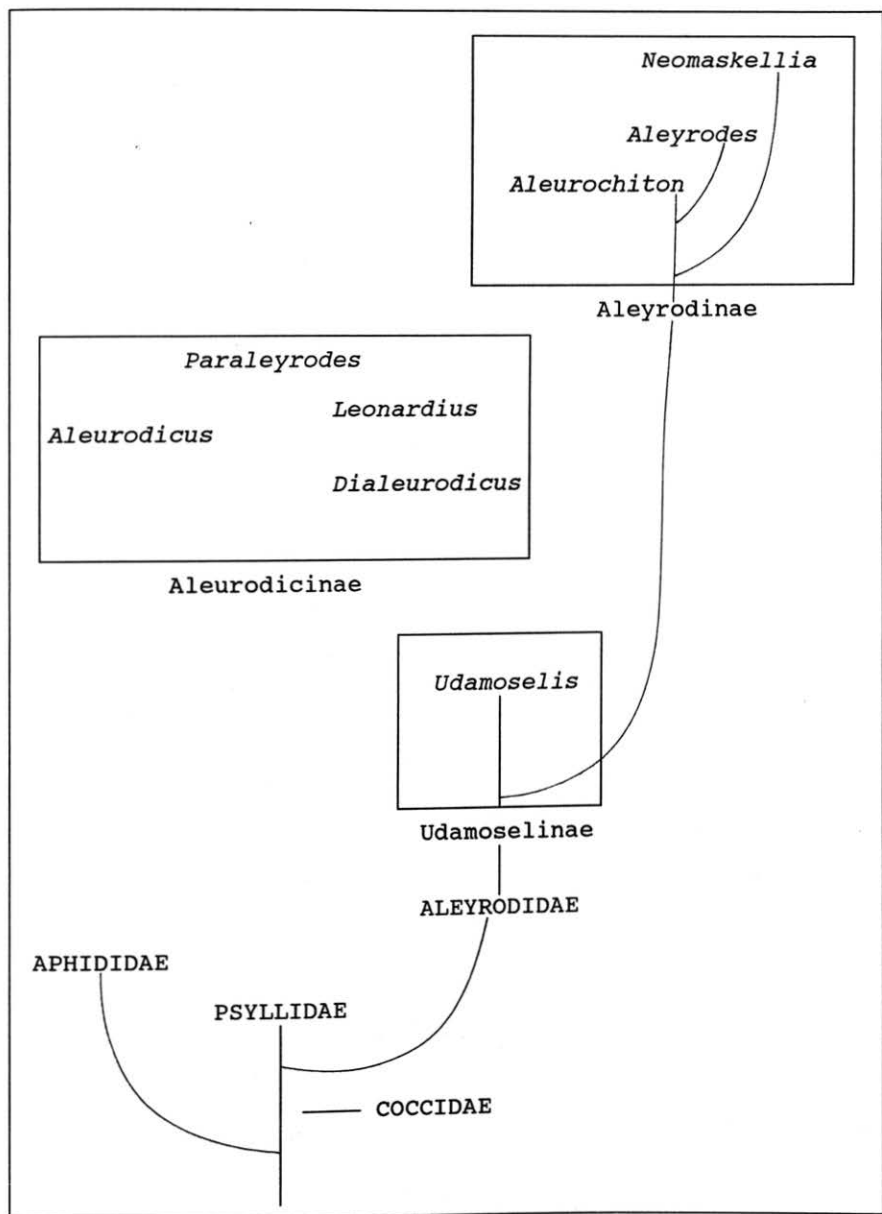
Table 2. Economically important whiteflies species associated with annual cropping agricultural systems (Byrne et al. 1990)

SPECIES	HOST
<u>Aleurocybotus indicus</u>	Rice
<u>Aleuroplatus malayanus</u>	<u>Pueraria</u> spp.
<u>Aleyrodes proletella</u>	<u>Brassica</u> spp.
<u>Aleyrodes lonicerae</u>	Strawberry
<u>Aleyrodes spiraeoides</u>	Potato
<u>Bemisia tabaci</u>	Various crops mostly in the families: Convolvulaceae, Cucurbitaceae, Leguminosae, Malvaceae and Solanaceae.
<u>Trialeurodes abutiloneus</u>	Cotton
<u>Trialeurodes packardi</u>	Strawberries
<u>Trialeurodes vaporariorum</u>	Various crops mostly in the families Cruciferae, Leguminosae, Malvaceae and Solanaceae.

Table 3. Economically important whiteflies species associated with woody perennial cropping agricultural systems (Byrne et al. 1990)

<u>SPECIES</u>	<u>HOST</u>
<u>Aleurocanthus spiniferus</u>	Citrus
<u>Aleurocanthus woglumi</u>	Citrus
<u>Aleurothrixus floccosus</u>	Citrus, coffee
<u>Aleurodicus cocois</u>	Coconut
<u>Aleurodicus destructor</u>	Coconut
<u>Aleurodicus dispersus</u>	Coconut
<u>Aleurolobus barodensis</u>	Sugarcane
<u>Aleurotrachelus jelinekii</u>	<u>Viburnum</u> spp.
<u>Dialeurodes chittendeni</u>	Citrus
<u>Siphoninus phyllyreae</u>	Apple, pear, pomegranate
<u>Tetraleurodes acaciae</u>	<u>Acacia</u> spp.
<u>Tetraleurodes mori</u>	Mulberry
<u>Trialeurodes floridensis</u>	Avocado
<u>Trialeurodes lauri</u>	Laurel

Fig. A. Phylogeny of the Aleyrodidae, showing position of the family and relationships of genera (after Quaintance and Baker 1913).



MATERIALS AND METHODS

Collected material: Whiteflies from economically important crops and wild hosts from Central America and Colombia were collected. This material was processed in the laboratory as follows:

- Pictures were taken of live immatures and adults on their live natural hosts.
- Part of the material was preserved for slide mounting to produce the pupal key. Adults were also preserved to insure identification of immatures and for future studies.
- Some immatures were reared to obtain adults, when the latter were not collected in the field, or to insure that adults and immatures belonged to the same species.
- Parasitoids were reared from some of the immatures.

Immatures were collected in plastic bags or preferably in plastic boxes (12x6x7, 15x10x7, 30x12x10 cms). Boxes prevented damage to the material. In some cases, immatures were placed directly into 70% alcohol. Adults, on the other hand, were carried on fresh leaves in big vials. When collecting near the laboratory, adults and a fresh host sample were kept in plastic bags. Adults were also collected with an aspirator and placed in vials with 70% alcohol.

When immatures where not found, adults were kept in small

cages on the leaves of living hosts. After oviposition and hatching, nymphs of different instars were obtained as well as adults of a second generation.

Slide-mounted pupal key: Martin's (1987) procedure, with some modifications, was used in preparing slide-mounts (Appendix II). A phase contrast microscope was used to identify the material.

For each species, drawings of the pupal case, and enlargements of the margin of the pupal case and vasiform orifice were made. Enlargements of compound pores were also included in the Aleurodicinae. In some Aleyrodinae, because of the morphological host-correlated variations, two opposite pupal case outlines were drawn. A scale in mm is presented for each drawing. Drawings were made from slide-mounted material using the phase contrast microscope with an incorporated camera lucida. The Leonardius lahillei material was lost during travel from Colombia to Central America, so Quaintance and Baker's (1913) drawings are used in the key for this species.

Species were determined using available literature. A reference collection of 24 species was provided by R. J. Gill, California Department of Food and Agriculture, Sacramento, California. Finally, species determinations were verified by whitefly experts, R. J. Gill, and A. B. Hamon, Florida

Department of Agricultural and Consumer Services, Gainesville, Florida.

Terms used in the key are those of Maskell (1895), some added by Quaintance and Baker (1913, 1914), additional ones by Russell (1943, 1947), including Torre-Bueno (1985). Figure B shows the general morphology of an Aleyrodidae, and explanations of each term are included in the glossary (Appendix V).

Color-photo field keys: Photographs were taken in Colombia using the services of the Photometry Section at the Centro Internacional de Agricultura Tropical (CIAT). A camera adapted to a stereoscope with automatic regulators was used in photography. Pictures were taken of live immatures and adults on their natural live hosts. When adults were not collected in the field, adults emerging from pupae reared in the laboratory were used for pictures. Care was always taken during this process to show in the photographs diagnostic characters for the recognition of the species. Magnifications ranged from 2 to 14x. In Honduras, the facilities of the Diagnostic Center at Panamerican Agricultural School, was used. An Olympus camera and stereoscope, with an attached photometer, were used in photography.

While collecting, field observations were made in order to

determine the appearance of live immatures and adults. Those observations helped in the preparation of the field keys, since sometimes the material taken to the laboratory was damaged.

Hosts and distribution: A temporary label was included with each collected sample giving basic information. Once in the laboratory, a formal data sheet was filled in for each sample. This sheet also included information about collecting, preserving and shipping material from persons cooperating from different countries (Appendix I).

Extensive collecting was done in Guatemala, Honduras, Nicaragua, and Colombia. Material was also received from cooperators in Belize, El Salvador, Costa Rica, the Dominican Republic, Ecuador, and Bolivia (Fig. 31-36).

Natural enemies: Field observations were made to determine the presence of predators. Predators apparently feeding on immature whiteflies in the field were reared on the same prey to verify their predatory activity. Part of the collected live whitefly material was kept in the laboratory to check for the emergence of parasitoids.

Economic importance: The determination of economic importance was based on frequency of control by farmers, population

density, host plant range, and geographical distribution of each species. Based on those parameters, whiteflies were classified into five categories from A to F.

Collected material: Two or three slide-mounts were made for each collected sample; the additional material was placed into 70% alcohol. Slide-mounted and alcohol material were deposited in the Agroecological Inventory collection, Plant Protection Department, at the Escuela Agricola Panamericana (EAP), El Zamorano, Honduras. Duplicates of all the collected species will be deposited at the Identification Branch, California Department of Food and Agriculture, Sacramento, California, U. S. A.

Gathered information: Information concerning each collected sample was included in the database system in the Agroecological Inventory of the Plant Protection Department at the EAP, El Zamorano, Honduras, C. A.

RESULTS AND DISCUSSION

Thirty species of whiteflies were collected (Table 4), 14 in the subfamily Aleurodicinae and 16 in the Aleyrodinae. Twenty-six were determined and four are probably undescribed; 23 of the 26 taxa were determined to species and three only to genus.

The key to slide-mounted pupae splits the family into two well known and differentiated groups: Aleurodicinae and Aleyrodinae. The arrangement of Aleurodicinae was based on the number, location and type of compound pores. Submarginal setae, shape of lingula, length of lingular setae, and dorsal setae were also used. However, this classification is arbitrary and might not show a true phylogeny for the group. Not much information is available for this mostly tropical and poorly known group. Aleurodicus linguosus is considered a synonym of A. maritimus by Mound and Halsey (1978); however, S. Nakahara considers it a different species based on morphological differences. The four undescribed species are included in this subfamily. Undescribed species #4 has similarities with Aleuronudus induratus Hempel. The species placed in Ceraleurodicus might belong to a different genus. The other species identified only to genus was Paraleyrodes which has some similarities to P. perseae (R. J. Gill, personal communication). Information regarding host plants,

geographical distribution, and economic importance for each species is included in the key.

The Aleyrodinae is a much better known group. The genera were separated based upon the presence or absence of large, simple pores, sclerotized dorsal spines, submarginal papillae, submarginal area separated from dorsal disk, thoracic tracheal folds, marginal and submarginal teeth, middorsal trachea-like elevation, shape and size of vasiform orifice, operculum, and caudal furrow. Other features used were shape, color, and size of pupae. For each species in the key, host plants, geographical distribution, and economic importance is included. The only species in this group identified only to genus was Aleuroplatus sp.

Species of the genus Bemisia were separated based on characters presented by Russell (1975). Differences listed by L. M. Russell (personal communication) were used to differentiate species of Dialeurodes. Diagnostic characters listed by Russell (1948) were used to separate species of Trialeurodes.

The field keys are based on characters observable in the field with a 10x hand lens. For the pupal field key, the color, shape, and dorsal patterns of pupae were very useful characters. Color, length and arrangement of wax secretions

were also important. Host plants, geographical distribution, and economic importance data is included for each species. The field key for imatures includes 26 species. To best use this key, many specimens should be used. Care must be taken in keying parasited nymphs. Characters, such as shape, wax secretions, thickness, hosts, etc., should be carefully considered during identification. The only species that can be erroneously identified is T. vaporariorum parasited by Amitus sp. which resembles T. abutiloneus.

The adult key was based on color and patterns on the body and wings. The length of the body was important. The position of wings at rest was a diagnostic character. The shape and length of wings, characteristics of antennae, color of eyes, and living habits were also used. Twenty-three species were included in the field key for adults with their hosts, distribution, and data on economic importance. Newly emerged adults have very pale wings, it would be ideal to have several mature adults when using the field key.

Thirty-seven records of Hymenoptera parasitoids of whiteflies belonging to the Aphelinidae, Eulophidae, and Platygasteridae are reported (Table 5-6). All the parasitoids emerged from immature whiteflies kept in petri-dishes in the laboratory. Sixteen records of predators in the orders Hemiptera, Neuroptera, Coleoptera, and Diptera are reported (Table 7).

All predators were reared feeding on whitefly nymphs, except the Mantispidae. Lygaeidae was feeding on an adult whitefly in the field. Miridae were reported feeding on whiteflies by farmers from the Dominican Republic.

Whitefly records include the countries of Belize, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, the Dominican Republic, Colombia, Ecuador, and Bolivia (Fig. 31-36, Table 8). The Dominican Republic is situated in the Caribbean islands and is not shown on the included maps.

Two or three slide-mounts from each collected sample were made; 862 slides were mounted corresponding to 331 of the 425 collected samples (Table 8). Eighty-four host plant species belonging to 29 families are recorded in the 331 mounted samples (Appendices III and IV).

According to their economic importance, whiteflies were classified into five categories (Table 9). The 14 species reported in Aleurodicinae were placed in categories C to F (Table 10); the 16 species of Aleyrodinae ranged from A to D (Table 11), indicating that at present the Aleurodicinae are less economically important than the Aleyrodinae.

General features of the family and the two subfamilies are given. In each subfamily, the characteristics for each genus

are discussed. From the literature, all the species occurring in America are listed per genus. In each genus, species descriptions are given. For each species, slide-mounted characters for immature are described, as well as field appearance of immatures and adults. Information regarding hosts, natural enemies, distribution, and economic importance is included for each species.

KEY TO SLIDE-MOUNTED PUPAE

1. Pupal case large, usually over 1.2 mm in length. Lingula large with two pairs of subterminal setae. Subdorsum with compound or agglomerate pores present (except Dialeurodicus). Thoracic legs with distinctive claws (Subfamily ALEURODICINAE)..... 2
- 1a. Pupal case usually less than 1.0 mm in length (except Aleuroglandulus, Aleurocanthus, and Dialeurodes). Lingula short with one pair of subterminal setae or none. Subdorsum without compound or agglomerate pores. Thoracic legs without claws (Subfamily ALEYRODINAE)..... 15
2. Pupal case without compound or agglomerate pores, with groups of simple pores on median region of thorax and abdomen. Pupal case elliptical with 20 radial ridges around margin. Pupal case 2.35 mm long and 1.40 mm wide (avg). Feeding on Persea in Honduras (Fig. 1)..... Dialeurodicus sp.
- 2a. Pupal case with compound or compound and agglomerate pores on subdorsum. Pupal case variable in shape. Hosts and distribution variable..... 3
3. Pupal case with agglomerate and compound pores. Operculum with two laterocaudal spines. Pupal case 1.44 mm long and 0.88 mm wide (avg). Feeding on the parasitic plant Oryctanthus occidentalis (Lauranthaceae). Found in Colombia (Fig. 2)..... Leonardius lahillei (Leonardi)
- 3a. Pupal case with compound pores only. If spines are present on operculum, they are located between the median and laterocaudal corners..... 4
4. Less than six pairs of compound pores present on abdomen..... 5
- 4a. Six pairs of compound pores present on abdomen..... 9
5. Four pairs of abdominal compound pores..... 6
- 5a. Five pairs of abdominal compound pores..... 7
6. Vasoform orifice transversely elliptical. Submarginal setae not reaching margin of pupa. Submedian area covered with minute pores. Dorsal disk without pores. Pupal case 2.13 mm long and 1.56 mm wide (avg). Feeding on Eucalyptus and Ficus. Found in Honduras and Colombia (Fig.3).... Lecanoideus giganteus (Quaintance and Baker)

- 6a. Vasiform orifice subcordate. Submarginal setae extending beyond margin of pupa. Dorsal disk with medium sized pores. Pupal case 1.32 mm long and 0.90 mm wide (avg). Feeding on undetermined Euphorbiaceae in Colombia, not common (Fig. 4)..... **Aleurodicus dispersus Russell**
7. Compound pores large. Lingula broadly spatulate. Submarginal setae short, not reaching margin of pupa. Pupal case elongate, 1.60 mm long and 0.83 mm wide (avg). Feeding on undetermined legume in Colombia, not common (Fig. 5)..... **Undescribed species #1**
- 7a. Compound pores small. Lingula tongue-shaped. Submarginal setae long, extending beyond margin of pupa. Pupal case variable..... 8
8. Stellate structures on cephalothorax and abdominal segment III surrounded by simple pores. Compound pores located on the submarginal area. Lingula protruded. Pupal case elliptical, 2.05 mm long and 1.34 mm wide (avg). Feeding on Phaseolus, Inga, another legume, and undetermined host. Found in Honduras and Colombia (Fig. 6)..... **Ceraleurodicus altissimus (Quaintance)**
- 8a. Stellate structure absent. Compound pores located on subdorsal area. Lingula included. Pupal case elongate, 3.04 mm long and 1.65 mm wide (avg). Feeding on Persea in Honduras (Fig. 7)..... **Ceraleurodicus ingae (Baker)**
9. Two pairs of abdominal compound pores smaller than other four. Submarginal setae present. Pupal case elliptical to ovoid..... 10
- 9a. Three pairs of abdominal compound pores smaller than other three. Submarginal setae absent. Pupal case broadly elliptical, 1.22 mm long and 0.69 mm wide (avg). Feeding on undetermined host in Colombia (Fig. 8)..... **Undescribed species #2**
10. First two pairs of abdominal compound pores smaller than others. Pupal case elliptical in shape..... 11
- 10a. Third and last or the last two pairs of abdominal compound pores smaller than others. Pupal case pear-shaped or ovoid..... 12
11. Distal side of operculum straight, with pair of short setae mesoanteriorly. Punctures absent on cephalothorax. Pupal case 0.89 mm long and 0.56 mm wide (avg). Very common on Citrus in Central America and Colombia, found in low densities. Also feeds on Cassia, Capsicum, Psidium and Theobroma (Fig. 9)..... **Paraleyrodes sp.**

- 11a. Distal side of operculum not completely straight and without setae. Punctures present on pro- and metathorax. Pupal case 1.22 mm long and 0.83 mm wide (avg). Feeding on undetermined host in Colombia, not common (Fig. 10)..... **Undescribed species #3**
12. The third and last pairs of abdominal compound pores smaller than others. Pupal case pear-shaped, 1.58 mm long and 0.97 mm wide (avg). Feeding on Heliconia in Guatemala (Fig. 11)..... **Undescribed species #4**
- 12a. The last two pairs of abdominal compound pores smaller than others. Pupal case ovoid (Genus Aleurodicus).... 13
13. Septate pores present on submargin and dorsal disk. Pupal case 1.17 mm long and 0.84 mm wide (avg). Feeding on Psidium in Belize and Nicaragua (Fig. 12)..... **Aleurodicus linguosus Bondar**
- 13a. Septate pores absent..... 14
14. Submarginal setae extending beyond margin of pupa. Setae of lingula much longer than its widest part. Pupal case 1.58 mm long and 1.26 mm wide (avg). Feeding on Citrus, Cocos, Psidium, Musa, Persea, Psidium, Terminalia and other hosts. The most common species of Aleurodicinae in Central America and Colombia (Fig. 13)..... **Aleurodicus cocois (Curtis)**
- 14a. Submarginal setae not reaching margin. Setae of lingula about the same length as its widest part. Pupal case 1.37 mm long and 0.98 mm wide (avg). Feeding on Psidium, Gossypium, Persea, and Musa. Found in Honduras and Nicaragua (Fig. 14)..... **Aleurodicus dugesii Cockerell**
15. Two large, subcircular, simple pores on prothorax and abdominal segment III. Margin at thoracic and caudal tracheal openings dentate. Pupa case broadly elliptical, 1.38 mm long and 1.06 mm wide (avg), wider cephalad than caudad. Feeding on Colocasia, Caladium, other hosts, mainly Araceae. Found in Honduras and Colombia (Fig. 15)..... **Aleuroglandulus malangae Russell**
- 15a. Glandular pores absent. Pupal case variable, usually elliptical. Margin of pupa rarely dentate at thoracic tracheal openings..... 16
16. Submarginal area and dorsal disk with prominent, sclerotized spines. Pupal case black with dentate margin, 1.48 mm long and 1.10 mm wide (avg). Pest on Citrus. Found in Central America and Colombia (Fig. 16)..... **Aleurocanthus woglumi Ashby**

- 16a. Prominent, sclerotized spines absent. Pupal case usually not black, margin of pupa variable, sometimes dentate, with smaller teeth..... 17
17. Pupal case with row of submarginal papilla-like pores. (Genus Trialeurodes)..... 18
- 17a. Pupal case without row of submarginal papilla-like pores. 21
18. Marginal crenulations narrow, about 30 in 0.1 mm. Submarginal papillae broadly conical with blunt apex. Anterior marginal setae absent. Vasiform orifice usually elongate cordate with peg-like tooth at caudal end. Pupal case 0.86 mm long and 0.55 mm wide (avg). Pest on Gossypium, also feeds on Phaseolus, and many weeds. Found in Central America (Fig.17)..... Trialeurodes abutiloneus Haldeman
- 18a. Marginal crenulations broad, less than 17 in 0.1 mm. Submarginal papillae broadly conical, apex acute. Anterior marginal setae present. Vasiform orifice usually subcordate without a distinct tooth at end. Hosts variable or diverse..... 19
19. Caudal furrow elongate, at least twice the length of vasiform orifice. Submarginal papillae elongate, distal end acute, in a continuous row. About 16 crenulations in 0.1 mm. Pupal case elliptical, 1.19 mm long and 0.85 mm wide (avg). Found in Leucaena in Colombia and Honduras (Fig.18)..... Trialeurodes floridensis (Quaintance)
- 19a. Caudal furrow short, no more than twice orifice length. Submarginal papillae broadly conical, never in a continuous row. Less than 16 crenulations in 0.1 mm. Pupal case elliptical, usually with irregular margin. Seven or eight abdominal segments visible. Hosts diverse. 20
20. Seven abdominal segments visible along midline. Submarginal papillae usually not developed. About 14 crenulations in 0.1 mm. Pupal case small, 0.81 mm long and 0.50 mm wide (avg). Hosts usually glabrous, very common pest on Manihot, and Carica. Found in Central America and Colombia (Fig. 19)..... Trialeurodes variabilis (Quaintance)

- 20a. Eight abdominal segments visible along midline. Submarginal papillae usually developed. Less than 12 crenulations in 0.1 mm. Pupal case 0.91 mm long and 0.58 mm wide (avg). Hosts glabrous or hairy, feeds on many economically important crops and many weeds. Found in Central America and Colombia above 800 m, usually higher than 1000 m. The second most important species worldwide (Fig. 20)..... **Trialeurodes vaporariorum** (Westwood)
21. Pupal case brown or tan, with the dorsal disk distinctly separated from submarginal area by a suture-like line or depression..... 22
- 21a. Pupal case usually pale, sometimes brown, with dorsal disk not separated from submarginal area..... 26
22. Pupal case usually with a row of submarginal teeth. Margin usually dentate. One pair of setae on thorax. Vasiform orifice subcircular or transversely elliptical..... 23
- 22a. Pupal case without a row of submarginal teeth. Margin lobulate. Two pairs of setae on thorax. Vasiform orifice subcordate. (Genus **Tetraleurodes**)..... 25
23. Dorsum with a central ridge or trachea-like elevation. Submarginal setae absent on anterior half of pupa. Setae of abdominal segment VIII never longer than caudal ones. Vasiform orifice subcircular to subcordate. Pupal case brown. (Genus **Aleurotrachelus**)..... 24
- 23a. Dorsum without a central trachea-like structure. About six pairs of short setae on anterior half of submarginal area. Setae of abdominal segment VIII always much longer than caudal ones. Vasiform orifice broadly subcordate. Pupal case tan, 1.16 mm long and 0.81 mm wide (avg). Pest on Citrus, Psidium, and other hosts. Very common in Central America and Colombia (Fig. 21).....
..... **Aleurothrixus floccosus** (Maskell)
24. Submarginal area without subrectangular sculptures. Submarginal row of teeth very distinctive. Margin with pore at base of each tooth. Vasiform orifice located on caudal cordiform plate. Metathoracic, abdominal VIII, caudal, and posterior marginal setae prominent, stout, always present. Pupal case elliptical, 0.90 mm long and 0.58 mm wide (avg). Feeds on Manihot, pest in some regions of Colombia (Fig. 23).....
..... **Aleurotrachelus socialis** Bondar

- 24a. Submarginal area with subrectangular sculptures. Submarginal row of teeth inconspicuous. Marginal teeth without basal pore. Vasiform orifice not located on plate. Setae absent or inconspicuous. Pupal case broadly elliptical, 0.71 mm long and 0.49 mm wide (avg). Feeding on Terminalia in Colombia (Fig. 24)..... **Aleurotrachelus cacaorum Bondar**
25. Submargin with 6-22 pairs of pores, without punctures. Cephalic setae present. Pupal case 0.98 mm long and 0.70 mm wide (avg). Feeds on Phaseolus, Gliricidia, Cassia, and other hosts, including many legumes. Potential pest for several crops. Very common in Central America and Colombia (Fig. 25)... **Tetraleurodes acaciae (Quaintance)**
- 25a. Submargin without pores but with punctures separated by transverse lines located between the teeth. Cephalic setae absent. Pupal case 0.86 mm long and 0.61 mm wide (avg). Feeds on Psidium, Musa, and Rosa. Found in Central America (Fig. 26)..... **Tetraleurodes mori (Quaintance)**
26. Pupal case brown, margin dentate. Dorsum with many tiny pores. Vasiform orifice subcordate, longer than wide. Operculum subrectangular, distal margin narrower than the basal one. Caudal furrow absent. Pupal case usually with irregular margin, 0.97 mm long and 0.70 mm wide (avg). Feeding on Cocos, Theobroma, Psidium, Anacardium, Terminalia, and other wild hosts. Found in Central America and Colombia (Fig. 22)..... **Aleuroplatus sp.**
- 26a. Pupal case pale yellow, margin smooth to indentate. Dorsum without pores. Vasiform orifice variable. Caudal furrow present, lingula visible..... 27
27. Pupal case with thoracic tracheal folds evident in ventral view. Vasiform orifice relatively small and roundly subcordate. Operculum almost filling orifice, obscuring lingula. Pupal case broadly elliptical, flat and without setae (Genus Dialeurodes)..... 28
- 27a. Pupal case with thoracic tracheal folds usually not evident in ventral view. Vasiform orifice triangular, elongate. Operculum small and transversely elliptical, lingula long and visible. Pupal case elliptical, sometimes elongate, elevated middorsally, bearing setae (Genus Bemisia)..... 29

28. Dorsal area over caudal furrow sculptured by irregular markings. Thoracic tracheal folds with few or no spinules (ventral view). Thoracic tracheal pores with three to five internal teeth. Pupal case occasionally scaled, 1.60 mm long and 1.21 mm wide (avg). Common on Citrus, also feeds on Gardenia. Found in Central America and Colombia (Fig. 27). Dialeurodes citrifolii (Morgan)
- 28a. Dorsal area over caudal furrow not sculptured by markings but with many spinules ventrally. Thoracic tracheal folds also with numerous spinules (ventral view). Thoracic tracheal pores with one internal tooth. Pupal case not scaled, 1.60 mm long and 1.10 mm wide (avg). Not common on Citrus, feeds on Melia in Honduras (Fig. 28).....
..... Dialeurodes citri (Ashmead)
29. Caudal setae stout, longer than caudal furrow. Vasiform orifice longer than caudal furrow. A median tooth at distal end of vasiform orifice and usually two to three teeth at anterior end of caudal furrow. Pupal case 0.90 mm long and 0.70 mm wide (avg). Common at less than 1000 m. Feeds on more than 500 hosts, including most economically important crops. Found in Central America and Colombia (Fig. 29)..... Bemisia tabaci (Gennadius)
- 29a. Caudal setae smaller than caudal furrow, usually very small. Vasiform orifice smaller than caudal furrow. Teeth absent. Pupal case 1.20 mm long and 0.90 mm wide (avg). Feeds on Manihot. Found in Central America and Colombia (Fig. 30)..... Bemisia tuberculata Bondar

FIELD KEY TO IMMATURE WHITEFLIES

1. Pupal case usually bearing long, glassy, wax rods dorsally (Plate I b, II c); if not conspicuous, pupal case noticeably colored or patterned (Plate IV b, IV d); occasionally completely covered by cottony wax secretions (Plate V c). Pupal case over 1 mm (except Paraleyrodes). Feeding on trees, shrubs, and sporadically, herbaceous plants (Subfamily ALEURODICINAE)..... 2
- 1a. Pupal case without long, glassy, wax rods dorsally (Plate VI c, VII b), shorter ones may be on margin (Plate VI f, VIII e). Pupal case transparent (Plate VI c) to yellow (Plate IX c), or black (Plate X e). Inconspicuous (Plate VII b), short (Plate VIII e), or large (Plate VII f) wax secretions may surround pupal case. Pupal case less than 1 mm (except Aleurocanthus, Aleuroglandulus, and Dialeurodes). Feeding mostly on herbaceous, and some shrubby plants (Subfamily ALEYRODINAE)..... 12
2. Pupal case with conspicuous, dorsal, long, glassy, wax rods, or pupal case noticeably colored or patterned... 3
- 2a. Pupal case completely covered by cottony wax secretions... 10
3. Pupal case with conspicuous, dorsal, long, glassy, wax rods..... 4
- 3a. Pupal case colored or patterned..... 8
4. Pupal case with a marginal fringe of white wax secretions..... 5
- 4a. Pupal case without a marginal fringe of white wax secretions..... 6
5. Pupal case purple to pale brown with a short, thin, sectioned, wax fringe. Dorsal wax rods white and very long. Pupal case 1.57 mm long and 0.96 mm wide (avg). Feeds on parasitic Laurantaceae (Oryctanthus) in Colombia (Plate I a-b)..... Leonardius lahillei (Leonardi)
- 5a. Pupal case grayish to pale brown usually with a cottony wax fringe. Dorsal wax rods glassy, usually medium in size. Pupal case 1.64 mm long and 1.27 mm wide (avg). Feeds on Citrus, Cocos, Heliconia, Musa, Persea, Psidium, and Terminalia. Found in Central America and Colombia..... Aleurodicus cocois (Curtis) (Plate I d-e).....

6. Pupal case usually in a nest of broken, wax rods; pale yellow, elliptical, flat, 0.87 mm long and 0.54 mm wide (avg). Common on Citrus; may occurs on Cassia, Capsicum, and Psidium. Found in Central America and Colombia (Plate II c-d)..... **Paraleyrodes sp.**
- 6a. Pupal case not in a nest of broken, glassy, wax rods; pale yellow to yellow, elliptical to elliptical-elongate, slightly to noticeably elevated from substratum, over 1 mm long..... 7
7. Pupal case pale yellow; elliptical, tapered apically, slightly elevated from substratum, 2.40 mm long and 1.60 mm wide (avg). Feeds on an ornamental (Heliconia) in Guatemala (Plate II f, III a)..... **Undescribed species #4**
- 7a. Pupal case yellow; elliptical-elongate, tapered apically, noticeably elevated from substratum, 1.07 mm long and 0.51 mm wide (avg). Feeds on Psidium, Tectona, and other undetermined hosts. Found in Colombia (Plate III b)..... **Undescribed species #1**
8. Margin with short fringe of glassy wax curls. Pupal case colored and patterned. Elliptical-elongate or elliptical; medium to noticeably elevated from substratum..... 9
- 8a. Margin without conspicuous wax fringe. Pupal case pale to pale yellow with 20 ridges perpendicular to body margin, usually conspicuously yellow. Elliptical to elliptical-elongate; fairly flat, 2.65 mm long and 1.50 mm wide (avg). Feeds on Persea in Honduras (Plate IV a)..... **Dialeurodicus sp.**
9. Pupal case bluish black with submarginal orange spots. Vasiform orifice usually inconspicuous. Elliptical-elongate, slightly asymmetrical anteriorly, 3.38 mm long and 1.80 mm wide (avg). Feeds on Persea in Honduras (Plate IV b)..... **Ceraleurodicus ingae (Baker)**
- 9a. Pupal case gray to whitish with two longitudinal, subdorsal, dark bands. Vasiform orifice usually conspicuous. Elliptical, noticeably elevated from substratum, 3.20 mm long and 2.00 mm wide (avg). Feeds on Inga, Phaseolus, and other hosts. Found in Central America and Colombia (Plate IV d)..... **Ceraleurodicus altissimus (Quaintance)**

10. Pupal case with short, dorsal, wax secretions. Marginal wax secretions short and sectioned, less than width of pupal case. Pupal case faintly elliptical, usually surrounded by many broken wax rods, 0.96 mm long and 0.62 mm wide (avg). Feeds on an undetermined host in Colombia (Plate V a)..... **Undescribed species #3**
- 10a. Pupal case with large, dorsal and marginal, wax secretions; longer than pupal width..... 11
11. Wax secretions dense and sticky. Pupae usually in a line along main leaf vein, 1.79 mm long 0.98 mm wide. Feeds on Eucalyptus in Colombia (Plate V b-c).....
.....**Lecanoideus giganteus (Cockerell)**
- 11a. Wax secretions fairly tufted and not sticky. Pupae not in line, scattered under leaf. Feeds on undetermined Euphorbiaceae in Colombia (Plate V e).....
.....**Aleurodicus dispersus Russell**
12. Pupal case transparent to yellow, may have dorsal patterns. Marginal wax fringe absent or as transparent wax rods..... 13
- 12a. Pupal case tan to black, dorsum may be covered by wax secretions. Marginal wax fringe white, short to long.. 20
13. Pupal case elliptical to broadly elliptical; flat to somewhat elevated from substratum..... 14
- 13a. Pupal case elliptical-elongate; conspicuously elevated from substratum; if elliptical, marginal wax fringe as thin ribbons..... 17
14. Pupal case with four prominent dorsal horns. Pupal case yellowish to bright yellow; broadly elliptical, 1.34 mm long and 0.87 mm wide (avg). Feeds on Colocasia, Caladium, and other hosts, mainly Araceae. Found in Central America and Colombia (Plate VI a-b).....
.....**Aleuroglandulus malangae Russell**
- 14a. Pupal case without horns; variable in color, shape and size..... 15
15. Pupal case broadly elliptical; fairly inconspicuous, very flat, 1.51 mm long and 1.11 mm wide (avg). Common on Citrus; also feeds on Gardenia. Found in Central America and Colombia (Plate VI c).....
.....**Dialeurodes citrifolii (Morgan)**
- 15a. Pupal case usually elliptical; pale to pale yellow, moderately flat..... 16

16. Caudal setae usually very short. Pupal case usually yellowish with thoracic tracheal folds usually evident. Vasiform orifice usually located at least twice its length from caudal end. Pupal case usually elliptical, fairly flat dorsally, 0.82 mm long and 0.57 mm wide (avg). Feeds on Manihot in Central America and Colombia (Plate VI e-f)..... **Bemisia tuberculata** Bondar
- 16a. Caudal setae long and stout if not broken. Pupal case usually pale and thoracic tracheal folds usually not evident. Vasiform orifice usually located at less than twice its length from caudal end. Pupal case elliptical, sometimes elongate and more elevated middorsally, bearing several pairs of subdorsal setae; 0.83 mm long and 0.57 mm wide (avg). Feeds on more than 500 hosts, including Solanaceae, Leguminosae, Cucurbitaceae, and Malvaceae. Found in Central America and Colombia, usually below 1000 m. (Plate VII b-d)..... **Bemisia tabaci** (Gennadius)
17. Pupal case elliptical, tapered apically. Marginal wax fringe ribboned, long, at least half pupal width. Pupal case moderately elevated from substratum, 1.11 mm long and 0.83 mm wide (avg). Feeds on Leucaena and Carica. Found in Central America and Colombia (Plate VII f)..... **Trialeurodes floridensis** (Quaintance)
- 17a. Pupal case elliptical-elongate. Marginal wax fringe short to long separated wax curls. Pupal case conspicuously elevated from substratum..... 18
18. Pupal case usually with middorsal dark stripe. Pupal case 0.88 mm long and 0.55 mm wide (avg). Feeds on Gossypium, and many weeds (Plate VIII b)..... **Trialeurodes abutiloneus** (Haldeman)
- 18a. Pupal case without such stripe..... 19
19. Pupal case pale to pale yellow; medium, 0.73 mm long and 0.49 mm wide (avg). Feeds on more than 250 hosts including Solanaceae, Leguminosae, and Cucurbitaceae. Found in Central America and Colombia, mostly above 1000 m (Plate VIII e-f). **Trialeurodes vaporariorum** (Westwood)
- 19a. Pupal case pale yellow to yellow; small, 0.62 mm long and 0.39 mm wide (avg). Feeds on Manihot and Carica in Central America and Colombia (Plate IX b-c)..... **Trialeurodes variabilis** (Quaintance)
20. Pupal case tan to blackish, usually covered by large, dorsal, floccous, grayish white, wax threads; elliptical, conspicuously elevated from substratum, 0.99 mm long and 0.68 mm wide (avg). Common on Citrus and Psidium, also

- feeds on Persea, Musa, Spondias, and other hosts. Found in Central America and Colombia (Plate IX e-f).....
..... Aleurothrixus floccosus (Maskell)
- 20a. Pupal case black without dorsal wax threads..... 21
21. Stellate. Pupal case with fringe of about 20 glassy wax ribbons. Moderately convex, 0.94 mm long and 0.68 mm wide (avg). Feeds on Anacardium, Cocos, Psidium, Terminalia, Theobroma, and other hosts. Found in Central America and Colombia (Plate X b-c)..... Aleuroplatus sp.
- 21a. Not star-shaped. Pupal case with fringe of cottony wax, may be very short..... 22
22. Dorsum with many sclerotized spines. Marginal wax fringe very short, occasionally inconspicuous. Pupal case convex, 1.11 mm long and 0.67 mm wide (avg). Feeds on Citrus in Central America and Colombia (Plate X e-f).....
..... Aleurocanthus woglumi Ashby
- 22a. Dorsum without sclerotized spines. Marginal wax fringe conspicuous..... 23
23. Marginal wax fringe shorter than half pupal width. Pupal case 0.70 mm long and 0.48 mm wide (avg). Feeds on Cassia, Gliricidia, Inga, Leucaena, Phaseolus, and other hosts, mostly legumes. Found in Central America and Colombia (Plate XI b) Tetraleurodes acaciae (Quaintance)
- 23a. Marginal wax fringe longer than half pupal width..... 24
24. Marginal wax fringe shorter than pupal width..... 25
- 24a. Marginal wax fringe much longer than pupal width. Fringe usually separated into several long ribbons. Pupal case 0.89 mm long and 0.59 mm wide (avg). Feeds on Musa, Psidium, and Rosa. Found in Central America and Colombia (Plate XI d-e)..... Tetraleurodes mori (Quaintance)
25. Pupal case broadly elliptical. Marginal wax fringe evenly formed by a basal dense fringe and an apical, ribboned, larger one. Pupal case somewhat flattened, 0.78 mm long and 0.51 mm wide (avg). Single or few per leaf. Feeds on Terminalia in Colombia (Plate XII b-c).....
..... Aleurotrachelus cacaorum Bondar
- 25a. Pupal case elliptical elongate. Marginal wax fringe unevenly formed around margin. Pupal case somewhat convex, 0.92 mm long and 0.54 mm wide. Usually gregarious under leaf. Feeds on Manihot in Colombia (Plate XII d-e).
..... Aleurotrachelus socialis Bondar

FIELD KEY TO ADULT WHITEFLIES

1. Body length usually over 1.5 mm (except Paraleyrodes). Wings usually rectangular or subcircular, broader apically; colored or conspicuously patterned. Usually feeding on trees, shrubs, and occasionally on herbaceous plants (Subfamily ALEURODICINAE)..... 2
- 1a. Body length less than 1.4 mm (except Aleuroglandulus and Dialeurodes). Wings usually rectangular elongate to triangular; pale white to white, occasionally patterned, rarely black. Usually feeding on herbaceous plants (Subfamily ALEYRODINAE)..... 10
2. Body length about 0.91 mm. Triangular-elongate in dorsal view. Wings held fairly flat at rest and with two transverse, irregular, pale brown bands. Antennae conspicuously thick, directed backward and laterally. Usually found singly in a nest surrounded by waxy scales. Common on Citrus, also feeds on Capsicum, Cassia, Psidium, and Theobroma. Found in Central America and Colombia (Plate II e)..... Paraleyrodes sp.
- 2a. Body length over 1.4 mm. Varying in shape and wing position at rest. Antennae not thick and directed laterad or cephalad. Usually not found in a nest..... 3
3. Body triangular to narrowly triangular elongate in dorsal view. Vertex of head produced, eyes green yellowish... 4
- 3a. Body rectangular to subcircular in dorsal view. Vertex of head variable..... 6
4. Body triangular. Wings pale with yellowish and small, dark spots; held flat and widely separated distally at rest. Distinct yellow spot at 2/3 length on costal margin. Antennae usually directed 45° toward. Body length 2.57 mm (avg). Feeds on Persea in Honduras (Plate III e-f)..... Dialeurodicus sp.
- 4a. Body narrowly triangular elongate. Wings with brownish patterns; held strongly roof-like, separated middorsally, at rest. Antennae usually directed laterally..... 5
5. Wings with three conspicuous dark spots at basal half. Body length 3.21 mm (avg). Feeds on Persea in Honduras (Plate IV c)..... Ceraleurodicus ingae (Baker)
- 5a. Wings without dark spots. Body length 4.60 mm (avg). Feeds on Inga, Phaseolus, and other other legumes. Found in Central America and Colombia (Plate IV e-f)..... Ceraleurodicus altissimus (Quaintance)

6. Wings uniformly gray, held fairly flat at rest. Somewhat rectangular in dorsal view. Vertex of head produced, eyes red. Body length 1.68 mm (avg). Feeds on Psidium, Tectona, and other undetermined hosts. Found in Colombia (Plate III c-d)..... Undescribed species #1
- 6a. Wings whitish to white with or without patterns. Varying in shape and wing position at rest position. Vertex and eye color variable..... 7
7. Wings uniformly whitish, somewhat waxless; held fairly flat at rest. Subcircular in dorsal view. Vertex bilobate, eyes light brown. Body length 4.01 mm (avg). Feeds on Eucalyptus and Ficus. Found in Honduras and Colombia (Plate V d)... Lecanoideus giganteus (Cockerell)
- 7a. Wings patterned, conspicuously waxed. Varying in shape and wing position at rest. Vertex and eyes variable..... 8
8. Wings with two dark spots, one at 2/3 length and other distal; held somewhat flat at rest. Subrectangular in dorsal view, broader distally. Vertex rounded, eyes light brown. Body length 1.65 mm (avg). Feeds on Citrus, Cocos, Heliconia, Musa, Persea, Psidium, and Terminalia. Found in Central America and Colombia (Plate I f)..... Aleurodicus cocois (Curtis)
- 8a. Wings with many spots. Varying in shape and wing position at rest. Vertex and eyes variable..... 9
9. Wings with rounded spots distributed at random; held flat at rest and separated middorsally. Subcircular in dorsal view. Vertex of head produced, eyes reddish brown. Body length 1.50 mm (avg). Feeds on parasitic Lorantheae: Oryctanthus. Found in Colombia (Plate I c)..... Leonardius lahillei (Leonardi)
- 9a. Wings with four irregular transverse bands; held somewhat rooflike at rest and fairly separated middorsally. Somewhat triangular in dorsal view. Vertex of head rounded, eyes brownish. Body length 1.39 mm (avg). Feeds on Gossypium, Musa, Persea, and Psidium. Found in Honduras and Nicaragua (Plate II a-b) Aleurodicus dugesii Cockerell
10. Wings black; held rooflike at rest. Parallel-sided in dorsal view. Eyes red. Body length 1.11 mm (avg). Feeds on Citrus in Central America and Colombia (Plate XI a)..... Aleurocanthus woqlumi Ashby
- 10a. Wings pale white to white with or without patterns. Varying in shape and wing position at rest. Eye color variable..... 11

11. Wings patterned..... 12
- 11a. Wings unpatterned..... 14
12. Wings with a distal dark area, varying in intensity; held flat at rest. Somewhat triangular in dorsal view. Body length 1.74 mm (avg). Common on Citrus, also feeds on Gardenia. Found in Central America and Colombia (Plate VI d)..... Dialeurodes citrifolii (Morgan)
- 12a. Wings with three transverse irregular bands; held roof like at rest. Somewhat paralleled-sided in dorsal view. 13
13. Second band reddish and not conspicuously zigzagged. Head and thorax with pale brown spots laterally. Body length 0.87 (avg). Feeds on Musa, Psidium, and Rosa. Found in Central America and Colombia (Plate XI f, XII a)..... Tetraleurodes mori (Quaintance)
- 13a. Second band brownish and conspicuously zigzagged. Head and thorax without spots. Body length 0.90 mm (avg). Feeds on Gossypium, and many weeds. Found in Central America (Plate VIII c-d)..... Trialeurodes abutiloneus (Haldeman)
14. Body yellow, about 1.75 mm in length. Wings held somewhat flat at rest. Triangular in dorsal view. Feeds on Colocasia, Caladium, other hosts, mostly Araceae. Found in Honduras and Colombia (Plate V f)..... Aleuroglandulus malangae Russell
- 14a. Body pale to yellowish, less than 1.35 mm in length. Varying in shape and wing position at rest..... 15
15. Wings held completely flat at rest. Triangular elongate in dorsal view..... 16
- 15a. Wings not flat at rest. Somewhat parallel-sided in dorsal view..... 17
16. Wings immaculately white. Body length 1.10 mm (avg). Feeds on more than 250 hosts, including Cucurbitaceae, Leguminosae, and Solanaceae. Found in Central America and Colombia, usually above 800 m (Plate IX a)..... Trialeurodes vaporariorum (Westwood)
- 16a. Wings whitish to white. Body length 1.20 mm (avg). Feeds on Leucaena and Carica. Found in Central America and Colombia (Plate VIII a)..... Trialeurodes floridensis (Quaintance)

17. Wings held strongly rooflike at rest, creamy white. Parallel-sided in dorsal view. Body length 1.08 mm (avg). Feeds on more than 500 hosts including Cucurbitaceae, Leguminosae, Malvaceae, Solanaceae, but not common on Manihot. Found in Central America and Colombia, usually below 1000 m (Plate VII e)... Bemisia tabaci (Gennadius)
- 17a. Wings held somewhat rooflike at rest, varying in color intensity. Somewhat parallel-sided in dorsal view.... 18
18. Wings pale white, somewhat transparent. Body yellowish to yellow..... 19
- 18a. Wings whitish to white. Body pale yellow to white.... 21
19. Adults associated with yellowish nymphs. Body length 0.81 mm (avg). Feeds on Manihot and Carica. Found in Central America and Colombia (Plate IX d)..... Trialeurodes variabilis (Quaintance)
- 19a. Adults associated with tan to black nymphs. Hosts other than Manihot and Carica..... 20
20. Adults associated with tan to brown nymphs with large, floccous wax threads. Body length 1.34 mm (avg). Common on Citrus and Psidium, also feeds on Musa, Persea, Spondias, and other hosts. Found in Central America and Colombia (Plate X a).. Aleurothrixus floccosus (Maskell)
- 20a. Adults associated with black nymphs with a star-like marginal fringe. Body length 1.07 mm (avg). Feeds on Anacardium, Cocos, Manilkara, Psidium, Terminalia, Theobroma, and other hosts. Found in Central America and Colombia (Plate X d)..... Aleuroplatus sp.
21. Adults associated with yellowish nymphs. Body length 1.32 mm (avg). Feeds on Manihot in Central America and Colombia (Plate VII a)..... Bemisia tuberculata Bondar
- 21a. Adults associated with black nymphs with white wax fringe. Hosts diverse..... 22
22. Adults associated with nymphs with a short, even, wax fringe. Usually single or few under leaf. Body length 1.02 mm (avg). Feeds on Cassia, Gliricidia, Inga, Leucaena, Phaseolus, and other hosts, mostly legumes. Found in Central America and Colombia (Plate XI c)..... Tetraleurodes acaciae (Quaintance)

- 22a. Adults associated with nymphs with a larger, uneven, wax fringe. Usually gregarious under leaf. Body length 0.95 mm (avg). Feeds on Manihot in Colombia (Plate XII f).....
..... **Aleurotrachelus sociales** Bondar

FAMILY ALEYRODIDAE

Winged adults of both sexes resemble tiny moths, with waxy wings nearly similar in size. Usually less than 1 mm long, rarely over 2 or 3 mm. Antennae filiform, usually seven-segmented, but three- and four-segmented in one genus. Usually two ocelli present. Tarsi with two tarsomeres, ending in two claws and a median process or paronychium (Quaintance and Baker 1913). Sucking mouthparts, three-segmented beak, arising between front coxae, elongate labium. Males with prominent claspers; females with acute ovipositor; both without cornicles. Anus opening dorsally at vasiform orifice.

Whitefly metamorphosis is somewhat different than that of most other Homoptera (Borror et al. 1989). The first instar is active, others are sessile and look like scales. The scalelike appearance is due to shape, flatness, and presence of wax secretions of the immature. The late fourth instar is termed a pupa which surrounds the pharate adult.

Whitefly pupae are unique because of the presence of the vasiform orifice, operculum and lingula. Aleyrodids also differ from female Coccidae because of the presence of a well developed anal cleft and two triangular plates covering the anus in the latter. Female Ortheziidae and Margarodidae have a well developed anal ring that is absent in whitefly pupae.

SUBFAMILY ALEURODICINAE

PUPAE: Mounted specimens usually transparent, some have dorsal patterns. Shape elliptical, elongate, or subcircular. Average length 1.88 mm, with a minimum of 0.89 mm and a maximum of 3.04 mm. Margin usually smooth to indentate, sometimes with rows of simple pores, varying in shape and size. Simple pores may be present dorsally, grouped or scattered. Compound pores usually present dorsally; absent in one genus and modified in another. Compound pores thimble-shaped or cup-shaped. Submarginal and dorsal setae usually present. Thoracic legs with prominent claws. Vasiform orifice usually cordate. Operculum subrectangular, may have short setae. Lingula large, included within the orifice or exceeding its margin caudally, bearing two pairs of subterminal setae.

FIELD APPEARANCE: Pupae mostly pale yellow to yellow; some reddish, brownish or blackish; other patterned dorsally. Usually with long, dorsal, glassy, wax rods produced by the compound pores. May be hidden by abundant cottony wax secretions; margin usually with short wax fringe, usually whitish. Elliptical, ranging from elongate, to subcircular, to somewhat flat, to noticeably elevated from substratum. Usually longer than 1 mm. Mostly gregarious; but may occur singly or a few may be scattered on lower surface of leaves.

ADULTS: Body whitish, grayish, or brownish, sometimes with spots or bands on thorax or abdomen. Average length 2.35 mm, with a minimum of 0.91 mm and a maximum of 4.60 mm. Eyes usually green yellowish or light brown, sometimes red, occasionally reddish brown. Wings pale, white, gray or brownish, may be patterned. Costal-subcostal, radial sector, and medial veins present; radius, usually present, except in one genus; cubitus usually faintly indicated. Wings held from flat to roof-like over the abdomen at rest. Tarsal paronychium spine-like. Shape usually subrectangular to subcircular in dorsal view, sometimes triangular. Gregarious or solitary, usually associated with nymphs.

HOSTS: Wild trees, shrubs, occasionally herbaceous plants, and some fruit trees. Very rarely short-cycle, extensively cultivated hosts or grasses.

ECONOMIC IMPORTANCE: Most species are found in undisturbed environments, far from agricultural systems and are not considered economically important. A few inhabit fruit trees, usually at low densities. The latter could cause economic loss and need to be carefully monitored.

CLASSIFICATION: Ten species from six genera and four undescribed species are discussed:

Genus Aleurodicus Douglas

Pupal case usually pale yellow to whitish. Broadly elliptical to subcircular, usually elevated from substratum, never flat. Sides of pupal case flat, not deflected under ventral surface. Margin smooth to crenulate. Usually seven pairs of thimble-shaped compound pores present, one on head and six on abdomen, only five pairs in one species. Submarginal, simple pores present, sometimes also on dorsum. Simple pores diverse in size and shape. Submarginal setae numerous. Cephalic ones usually present. Thoracic, VIII abdominal, and caudal setae present. Vasiform orifice broadly cordate. Operculum transversely rectangular, usually armed by single pair of distal, short, thin setae. Lingula large, tongue-shaped, larger than vasiform orifice, bearing four subterminal setae.

Adult with radius, present in forewings, sometimes with an indication of the cubitus. Vertex of head rounded. Tarsal paronychium a large spine (Quaintance and Baker 1913).

World species: Twenty-eight species reported worldwide; 23 occur in America, mostly tropical (Mound and Halsey 1978):

A. antillensis Dozier - Puerto Rico

A. aranjoi Sampson & Drews - Mexico

A. bondari Costa Lima - Brazil

A. capianguae Bondar - Trinidad, Surinam, Anguilla, Brazil.

- A. coccolobae Quaintance & Baker - Mexico, Honduras, Panama, Brazil.
 - A. cocois (Curtis) - Mexico, Jamaica, Trinidad, Grenada, Barbados, St. Vincent, Monserrat, Anguilla, Guyana, Honduras, Venezuela, Brazil.
 - A. dispersus Russell - U.S.A., Cuba, Haiti, Barbados, Dominica, Martinique, Canary Islands, Costa Rica, Panama, Ecuador, Peru, Brazil.
 - A. dugesii Cockerell - Mexico
 - A. essigi Sampson & Drews - Mexico
 - A. flavus Hempel - Brazil
 - A. fucatus Bondar - Brazil
 - A. griseus Dozier - Puerto Rico
 - A. guppyii Quaintance & Baker - Trinidad
 - A. jamaicensis Cockerell - Jamaica
 - A. juleikae Bondar - Brazil
 - A. magnificus Costa Lima - Brazil
 - A. maritimus Hempel - Mexico, Trinidad, Brazil
 - A. marmoratus Hempel - Brazil
 - A. neglectus Quaintance & Baker - Trinidad, Barbados, Guayana, Brazil.
 - A. ornatus Cockerell - Jamaica
 - A. poriferus Sampson & Drews - Mexico
 - A. pulvinatus (Maskell) - Trinidad, Guyana, Brazil.
 - A. trinidadensis Quaintance & Baker - Trinidad
- Two undetermined species one each from Trinidad and Colombia.

Aleurodicus cocois (Curtis)

Slide-mounted Pupae: Transparent. Broadly elliptical to subcircular, averaging 1.58 mm long and 1.26 mm wide. Margin fairly smooth with continuous row of simple pores (Fig. 13.2). Approximately 12 pairs of submarginal setae present, extending beyond pupal margin (Fig. 13.1). Submarginal area covered by rounded simple pores with central openings (Fig. 13.2). Dorsum without conspicuous pores. Compound pores thimble-shaped (Fig. 13.3), last two abdominal pairs smaller than others. Operculum with pair of short, distal setae, sometimes difficult to observe (Fig. 13.4). Lingula usually hairy marginally; lingular setae longer than width of lingula.

Field appearance: Pupae pale yellow, usually covered by cottony white wax secretions. A long, thin, glassy, wax rod arises from each compound pore unless broken (Plate I d-e). Much white dust may cover pupae and substratum. Pupae broadly elliptical, elevated from substratum, averaging 1.64 mm long and 1.27 mm wide. Pupae gregarious on lower surface of leaves.

Adults: Body whitish, short and broad, averaging 1.65 mm in length, from top of head to apex of wings. Wings whitish with dark spot on 2/3 of length, between ramification of radius, and other distally (Plate I f). Wings held somewhat flat over the abdomen at rest. Gregarious, sedentary, associated with nymphs on lower surface of leaves.

Hosts: Citrus reticulata, Cocos nucifera, Heliconia sp., Musa sp., Persea americana, Psidium guajava, Terminalia catappa.

Natural enemies: Encarsia sp., Euderomphale sp. (species 1), Dirphys sp., Nephaspis sp.

Economic importance: The most important Aleurodicinae species in Central America and Colombia. Found in many cultivated fruit trees. Pest category: C.

Additional references: Quaintance and Baker (1913)

Aleurodicus dispersus Russell

Common name: Spiraling whitefly

Slide-mounted pupae: Transparent. Elliptical, averaging 1.32 mm long and 0.90 mm wide. Margin fairly smooth. Submarginal area with outer row of continuous, elongate, simple pores, and inner row of larger, subcircular ones (Fig. 4.2). Submarginal area covered by smaller, circular, simple pores with central openings. Simple pores also present dorsally. Approximately 12 pairs of submarginal setae present, extending beyond margin (Fig. 4.1). Eight abdominal setae very short; caudal and posterior marginal ones relatively large. No other dorsal setae observed. Five pairs of thimble-shaped compound pores, similar in size, present, one on head and four on abdomen. (Fig. 4.3). Vasiform orifice broadly cordate, acute caudally.

Operculum transversely rectangular, lateral margins rounded, caudal margin straight with short pair of middistal setae. Lingula tongue-shaped, hairy marginally, with large setae, much longer than its width (Fig. 4.4).

Field appearance: Pupae color and size not known. Completely covered dorsally and marginally by long, cottony wax secretions. Long ribbons of wax discernible marginally (Plate V e); there is one dorsal ribbon. Vasiform orifice region without noticeable wax secretions. Some slender, glassy wax rods conspicuous in cottony wax secretions.

Adults: Not found.

Hosts: "fox tail" (Euphorbiaceae)

Natural enemies: None collected.

Economic importance: Recorded from ornamental plant in Colombia. Probably not economically important. Pest category: F.

Additional references: Russell (1965).

Aleurodicus dugesii Cockerell

Slide-mounted Pupae: Transparent. Elliptical, averaging 1.37

mm long and 0.98 mm wide. Margin indentate (Fig. 14.2). Approximately 12 pairs of submarginal setae present, not extending beyond pupal margin (Fig. 14.1). Submarginal area completely covered by rounded simple pores with central openings. Dorsum without noticeable simple pores. Meso and metathorax have pair of subdorsal punctures. Compound pores thimble-shaped (Fig. 14.3), the last two abdominal pairs smaller than others. Operculum without noticeable distal setae. Lingula with setae shorter than its widest width (Fig. 14.4).

Field appearance: Pupae pale yellow, usually covered with whitish dust. Up to seven pairs of long, thin, glassy wax rods dorsally, if not broken. Elliptical, elevated from substratum, averaging 1.39 mm long and 1.09 mm wide. Usually gregarious on lower surface of leaves. (Not shown on Plates).

Adults: Body gray whitish, stout, averaging 1.39 mm long. Wings gray whitish with one basal dark spot and three dark transverse bands. First band at basal third, second one about half wing length, third one almost apical. Second and third bands usually conspicuously joined by a longitudinal one (Plate II a-b). Bands, however, variable in intensity and in regularity. Wings held roof-like over the abdomen at rest. Usually gregarious, associated with nymphs on lower surface of leaves.

Hosts: Baccharis trinervis, Gossypium hirsutum, Persea americana, Psidium guajava.

Natural enemies: Dirphys sp.

Economic importance: A common species occurring in many fruit trees in Central America. Probably the second most important species in the subfamily. Pest category: C.

Additional references: Quaintance and Baker (1913).

Aleurodicus linguosus Bondar

Slide-mounted Pupae: Transparent. Elliptical to broadly elliptical, averaging 1.17 mm long and 0.84 mm wide. Margin fairly smooth (Fig. 12.2). Approximately 12 pairs of submarginal setae present, extending beyond pupal margin (Fig. 12.1). Submarginal area has distal, thick row of rounded simple pores with central openings; and two separated rows of septate simple pores. Septate, simple pores at least twice size of rounded ones. Simple pores, including septate ones, also present on dorsum. Compound pores thimble-shaped (Fig. 12.3), last two pairs on abdomen smaller than others. Operculum bears pair of short, distal setae. Length of lingular setae about width of lingula. (Fig. 12.4). This species is considered a synonym of A. maritimus Hempel by Mound and Halsey (1978). However, according to S. Nakahara

there are morphological differences between the two species (R. J. Gill, personal correspondence).

Field appearance: Pupae pale to pale yellow, usually covered by cottony white wax secretions. Seven pairs of long, thin, glassy wax rods present on dorsum unless broken. Much white dust may cover pupae and substratum. Elliptical, elevated from substratum, averaging 1.28 mm long and 0.99 mm wide. Pupae gregarious on lower surface of leaves. (Not shown on Plates).

Adults: Body whitish, averaging 1.31 mm long. Wings white, with little white dust; two grayish spots on distal half, sometimes not very discernible, depending on angle of view and on amount of sunlight. Wings held roof-like over the abdomen at rest. Gregarious, usually perpendicular at main leaf vein. Not very active when on leaves, but rapid flyers. (Not shown on Plates).

Hosts: Psidium guajava

Natural enemies: None collected.

Economic importance: This species only recorded from Central America. Possibly a pest of some fruit trees. Pest category: C.

Genus CERALEURODICUS Hempel

Pupal case grayish to dark gray or black, usually with colored patterns. Usually elliptical, few elliptical-elongate or tapered apically. From somewhat convex to noticeably elevated from substratum. Margin fairly smooth to indentate. Six pairs of cup-like compound pores present, one on head and five on abdomen. Simple pores usually present on submargin, sometimes on dorsum. Submarginal setae numerous. Cephalic ones usually present. Thoracic, VIII abdominal, and caudal setae always present. Vasiform orifice cordate to broadly cordate. Operculum transversely rectangular. Lingula tongue-shaped or conical, with four subterminal setae. Lingula usually included and about same length as vasiform orifice.

Adult venation as Aleurodicus, except with radius, much longer. Antennae and paronychium similar to Aleurodicus. Head with vertex rounded. Male claspers short and thick, adeagus rather long. Lingula broad, rounded, large, and exerted (Quaintance and Baker 1913).

World species: Ten of 11 described species occur in America, especially in Brazil (Mound and Halsey 1978):

C. altissimus (Quaintance) - Mexico

C. asymmetricus (Bondar) - Trinidad, Brazil

C. bakeri (Bondar) - Brazil

- C. hempeli Costa Lima - Brazil
C. ingae (Baker) - Mexico
C. moreirai Costa Lima - Brazil
C. neivai (Bondar) - Brazil
C. octifer (Bondar) - Brazil
C. splendidus Hempel - Brazil
C. varus (Bondar) - Brazil

One undetermined species from Trinidad.

Ceraeurodicus altissimus Quaintance

Slide-mounted pupae: Transparent to grayish with some radial shaded patterns on subdorsal and submarginal area. Two dark areas present middorsally (Fig. 6.1). Elliptical, somewhat tapered apically, averaging 2.05 mm long and 1.34 mm wide. Margin indentate (Fig. 6.2). Fifteen pairs of submarginal setae present, extending beyond body margin (Fig. 6.1). Cephalic, thoracic, VIII abdominal, and caudal setae medium in length, about width of vasiform orifice. Dorsum with groups of about six simple pores. Stellate structures present on prothorax and abdominal segment III (Fig. 6.3). Compound pores similar in size and relatively small (Baker 1937), located on submarginal area. Vasiform orifice broadly cordate and about length of lingula. Operculum transversely rectangular. Lingula protruded, tongue-shaped with four large, subterminal setae. Lingular setae longer than lingula width (Fig. 6.4).

Field appearance: Pupae grayish to whitish, usually with two middorsal bands. Submarginal area usually with transverse dark bands. Margin bears short, whitish wax tufts (Plate IV d). Pupae elliptical, noticeably elevated from substratum, averaging 3.20 mm long and 2.00 mm wide. Lingula usually discernible.

Adults: Body gray brown, averaging 4.60 mm long. Eyes green yellowish. Antennae relatively slender, usually directed laterally. Dorsum of abdomen with transverse bands of dark pigmentation. Wings gray whitish with light brown patterns, forming five irregular, transverse bands (Plate IV e). Costal margins of wings noticeably curved; anal margin with visible undulation at mid-length. Wings held widely separate distally at rest, strongly roof-like over the abdomen (Plate IV f). In dorsal view, body triangular in shape.

Hosts: Inga spuria, Phaseolus sp., and two undetermined species.

Natural enemies: Euderomphale sp., Euderomphale sp. (species 2)

Economic importance: Recorded from Central America and Colombia. It has a tendency for legume hosts. Found on Phaseolus in El Salvador. Probably not a pest at present. Pest category: D.

Ceraleurodicus ingae Baker

Slide-mounted pupae: Grayish to blackish with some whitish spots on subdorsal and submarginal area (Fig. 7.1). Elliptical-elongate, averaging 3.04 mm long and 1.65 mm wide. Margin indentate (Fig. 7.2). Fourteen pairs of submarginal setae present, extending beyond body margin (Fig. 7.1). Cephalic, thoracic, VIII abdominal, and caudal setae present. Submarginal area with dispersed double rimmed simple pores (Fig. 7.2). Compound pores (Fig. 7.3) relatively large, last pair much reduced (Baker 1937), located on subdorsal area. Vasiform orifice cordate. Operculum transversely rectangular. Lingula included, angled basally, tongue-shaped, with four large, subterminal setae. Lingular setae much longer than lingula width (Fig. 7.4).

Field appearance: Pupae bluish black with some orange markings on subdorsal and submarginal area (Plate IV b). Elliptical-elongate, slightly curved laterally, averaging 3.38 mm long and 1.80 mm wide. Pupae smoothly convex with short, marginal fringe of wax curls; dorsally without conspicuous wax rods.

Adults: Body gray brown. Average length of female 2.7 mm, male 3.73 mm. Eyes green yellowish. Antennae relatively slender, basal half clear, distal half gray. Base of dorsum of abdomen in male darkly pigmented, U-shaped in female. Distal dorsal half of claspers dark. Wings gray with dark and light brown

patterns. Three dark spots, forming triangle, present on basal half of wings. Two transverse light brown bands also present, one short about half length of wings, and one longer, distal, slightly curved (Plate IV c). Costal margins of wings noticeably curved; anal margin with visible basal lobe. Wings held separate and strongly roof-like over the abdomen at rest. Body narrow and parallel-sided in dorsal view.

Hosts: Persea americana

Natural enemies: None collected.

Economic importance: Recorded from Honduras in low density. Importance might be due to importance of host. Pest category: D.

Genus DIALEURODICUS Cockerell

Pupal case usually pale yellow to transparent. Elliptical-elongate to subcircular, fairly flat. Margin smooth, indentate, or crenulate, sometimes obscured by tubular simple pores. No compound pores present, but simple pores either scattered or grouped over surface. Numerous submarginal setae present. Cephalic, pro-, meso-, metathoracic, VIII abdominal, and caudal setae present. Vasiform orifice cordate, sometimes

somewhat elongate. Operculum transversely rectangular. Lingula included, conical, relatively short, wide basally, with four subterminal setae.

Adults with radius₁ developed. Vertex produced into prominent cone-shaped process. Antennae with seven segments, third longest. Tarsal paronychium stout, spine-like (Quaintance and Baker 1913).

World species: Ten species worldwide (Mound and Helsay 1978). All are tropical, primarily from Brazil, most described by Bondar (1923):

D. cockerellii (Quaintance) - Brazil

D. coelhi Bondar - Brazil

D. cornutus Bondar - Brazil

D. frontalis Bondar - Brazil

D. maculatus Bondar - Brazil

D. niger Bondar - Brazil

D. silvestri (Leonardi) - Mexico

D. similis Bondar - Brazil

D. tessellatus Quaintance & Baker - Brazil

D. tracheiferus Sampson & Drews - Mexico, Trinidad

One undetermined species recorded from Brazil.

Dialeurodicus sp.

Slide-mounted pupae: Transparent, with some radial shaded

patterns on subdorsal and submarginal area. A dark band present middorsally (Fig. 1.1). Elliptical-elongate to elliptical, averaging 2.35 mm long and 1.40 mm wide. Margin crenulate with row of elongate, wax secreting simple pores (Fig. 1.2). Fourteen pairs of short, stout, submarginal setae present, not extending beyond body margin, and sometimes inconspicuous in very pale or highly colored specimens (Fig. 1.1). Cephalic, thoracic, and caudal setae very short; VIII abdominal ones longer than vasiform orifice width. Subdorsal and submarginal areas have 20 radial ridges with simple pores. Basally, each ridge has group of about six pores (Fig. 1.1). Abdomen also with groups of middorsal simple pores. Compound pores absent. Vasiform orifice cordate, somewhat elongate. Operculum transversely rectangular. Lingula included, wider basally, relatively short, with four subterminal setae. Operculum and lingula subequal in length (Fig. 1.3).

Field appearance: Pupae pale to pale yellow with 20 ridges. Ridges usually conspicuously dark; located on subdorsal and submarginal area, perpendicular to pupal margin (Plate IV a). Elliptical-elongate with apex somewhat tapered. Pupae flat, not convex, averaging 2.65 mm long and 1.50 mm wide.

Adults: Body yellow, averaging 2.57 mm in length. Eyes green yellowish with central dark point. Latero-dorsal orange markings present behind eyes, prothorax, and abdomen. Distal,

dorsal half of abdomen yellower than remainder. Wings fairly pale to grayish with yellowish patterns. A characteristic dark yellow marking present at 2/3 length on costal margin (Plate III e). Small dark spots along wing margins and centrally. Wings held almost flat over the abdomen at rest, noticeably separate distally (Plate III f). Wings usually angled transversely, costal margins in contact with substratum and anal margins somewhat elevated.

Hosts: Persea americana

Natural enemies: Encarsia sp. (species 1), Encarsia sp. (species 2).

Economic importance: Recorded only from Honduras. Might be important pest of avocado. Pest category: D.

Genus LECANOIDEUS Quaintance and Baker

Pupal case usually pale yellow to whitish. Elliptical to elliptical-elongate, usually elevated from substratum, never flat. Lateral margins deflected, curving under ventral surface (Quaintance and Baker 1913). Margin covered by many simple pores. Usually five pairs of large, thimble-shaped compound pores present, one on head and four on abdomen; two extra

caudal pairs may be present in some species. Pupa devoid of small compound pores near vasiform orifice (Quaintance and Baker 1913). Submarginal simple pores present on submedian area. Submarginal setae numerous. Thoracic, VIII abdominal, and caudal setae always present. Vasiform orifice broad and transversely elliptical. Operculum transversely rectangular, usually armed with pair of short, thin setae. Lingula large, tongue-shaped, larger than vasiform orifice, bearing two pairs of subterminal setae.

Adults with radius, present in forewings; sometimes with an indication of cubitus. Vertex of head bilobed. Tarsal paronychium a large spine. Lingula narrow and included (Quaintance and Baker 1913).

World species: Two species worldwide, both occur in tropical America (Mound and Halsey 1978):

L. giganteus (Quaintance & Baker) - Guyana, Panama, Brazil.

L. mirabilis (Cockerell) - Mexico, Trinidad, Colombia.

Lecanoideus giganteus (Quaintance and Baker)

Slide-mounted pupae: Pale to light brown. Elliptical, elongate if mounted with lateral margins deflexed, averaging 2.13 mm long and 1.56 mm wide. True margin usually not observed, deflexed specimens show many tubular simple pores (Fig. 3.2). Twelve pairs of submarginal setae present,

extending beyond body margin (Fig. 3.1). Cephalic setae not observed; thoracic, VIII abdominal, and caudal setae present. Submarginal and subdorsal area completely covered by simple pores. Submedian area without pores. Five pairs of compound pores present (Fig. 3.3). Vasiform orifice broad, transversely elliptical. Operculum transversely rectangular, with pair of short, distal setae (Fig. 3.4). Lingula tongue-shaped, bearing two pairs of subterminal setae.

Field appearance: Pupae light brown to brown, occasionally reddish. Elliptical, averaging 1.79 mm in length and 0.98 mm in width. Always completely covered by abundant, cottony, sticky wax secretions (Plate V b). Several pairs of slender, glassy wax rods conspicuous from cottony wax. Pupae gregarious aligned along main vein on lower surface of leaves (Plate V c).

Adults: Body stout, averaging 4.01 mm long, female larger. Dorsally, thorax dark brown and abdomen pale brown. Eyes light brown. Wings pale white, somewhat transparent (Plate V d); subrectangular, averaging 3.57 mm long and 1.92 mm wide (ratio: 1.86:1.00). Wings held fairly flat over the abdomen at rest; appearing fairly rounded or cordiform in dorsal view. Associated with nymphs on lower surface of leaves, hidden beneath their cottony wax secretions.

Hosts: Eucalyptus sp., Ficus benjamina, Musa sp.

Natural enemies: Chrysoperla externa, Dirphys sp.

Economic importance: Found in Honduras and Colombia. Probably not economically important. However, its ability to completely cover the undersides of leaves gives it potential pest status in bananas and plantains. Pest category: D.

Additional references: Quaintance and Baker (1913).

Genus LEONARDIUS Quaintance and Baker

Pupal case usually pale yellow to pale gray. Elliptical, slightly convex. Lateral margins of pupal case flat, not deflected under ventral surface. True compound and agglomerate pores present on dorsum, caudal ones sometimes smaller. Submarginal setae short, usually present. Eight abdominal ones present. Vasiform orifice cordiform. Operculum rectangular, usually armed with pair of short, thin setae. Lingula relatively short, somewhat conical.

Adults with radius₁, cubitus discernible in newly emerged adults, sometimes recognized in mature specimens. Wings rounded, generally mottled. Vertex of head produced, somewhat

cone-shaped. Antennae with seven segments, third longest. Tarsal paronychium a narrow spined process (Quaintance and Baker 1913).

World species: Two species described, both endemic to America (Mound and Halsey 1978):

L. lahillei (Leonardi) - Puerto Rico, Brazil, Argentina.

L. loranthi Bondar - Venezuela, Brazil.

One undetermined species from Paraguay

Leonardius lahillei (Leonardi)

Slide-mounted pupae: Yellow, changing to reddish brown near margin. Elliptical, tapered apically, slightly convex, averaging 1.44 mm long and 0.88 mm wide. Margin smooth. Submarginal setae numerous, not extending beyond margin (Fig. 2.1). Eight abdominal setae short, stout, others not observable. Submarginal area with two or three rows of rounded, papilla-like simple pores (Fig. 2.2). First two anterior pairs of abdominal pores compound (Fig. 2.3); the other five pairs of agglomerate type, one pair on head and four on abdomen (Fig. 2.1). Vasiform orifice elongate cordate, with prominent projection caudally. Operculum subrectangular, with rounded corners, armed with two latero-caudal, short setae (Fig. 2.4). Lingula relatively short, somewhat conical. Length of lingular setae equal width of lingula (Quaintance and Baker 1913).

Field appearance: Pupae pale purple to pale brown. Elliptical, fairly flat, 1.49 to 1.65 mm long and 0.89 to 1.04 mm wide. A short, white, marginal, wax fringe present, broken into several ribbons (Plate I a). Four long, whitish wax rods, corresponding to compound pores, present dorsally at base of abdomen. Pupae usually gregarious, grouped with compound pore wax rods (Plate I b).

Adults: Body dark brown, prothorax whitish. Average body length 1.5 mm. Eyes reddish brown. Distal half of claspers darker dorsally. Costal-apical angle of forewings rounded; anal margin straight, with a basal flexure. Fore and hind wings spotted. Forewings usually with ten blackish spots, four along costal area, two between radius, and radial sector, and four on anal area (Plate I c). Some might be merged forming fairly discernible short bands. Wings held flat over the abdomen at rest.

Hosts: Oryctanthus occidentalis.

Natural enemies: Dirphys sp.

Economic importance: Not common, recorded only from Colombia feeding on a parasitic plant (Lauranthaceae). Not economically important. Pest category: F.

Genus PARALEYRODES Quaintance

Pupal case usually pale to yellowish. Usually elliptical, fairly flat. Margin usually indentate. Seven pairs of compound pores present, one on head and six on abdomen, first two anterior abdominal pairs may be reduced. Submarginal setae numerous, may extend beyond margin. Cephalic, thoracic, and VIII abdominal setae not observable; caudal and posterior marginal ones visible. Vasiform orifice broadly cordate. Operculum subrectangular with caudal corners usually rounded. Lingula relatively large, tongue-shaped, setose, exerted, with four long, subterminal setae.

Forewings of adults with radial sector and rudiment of media, radius, absent, cubitus sometimes faintly indicated by a fold. Vertex of head rounded. Antennae with four segments in females and three in males, third longest. Claspers short and stout; aedeagus bilobed. Tarsal paronychium a long stout spine (Quainance and Baker 1913).

World species: Mound and Halsey (1978) report ten species worldwide. All of them are tropical and endemic to America:

P. bondari Peracchi - Brazil

P. citri Bondar - Brazil

P. citricolus Costa Lima - Brazil

P. crateraformans Bondar - Brazil

- P. goyabae (Göldi) - Brazil
P. naranjæ Dozier - Puerto Rico
P. perseæ (Quaintance) - U.S.A., Mexico, Cuba.
P. pulverans Bondar - Brazil
P. singularis Bondar - Brazil
P. urichii Quaintance & Baker - Trinidad, Barbados.
One undetermined species from Jamaica.

Paraleyrodes sp.

Slide-mounted pupae: Transparent to pale yellow. Elliptical, flat, averaging 0.89 mm long and 0.59 mm wide. Margin indentate with row of groove-like simple pores (Fig. 9.2). Thirteen pairs of short, stout, submarginal setae present, usually not extending beyond margin (Fig. 9.1). Anterior marginal setae about one third length of posterior marginal ones. Caudal setae equal length of the latter ones (Fig. 9.1). Other dorsal setae not observable. Compound pores with 12 spinnerets arranged in circle (Fig. 9.3). First two abdominal pairs smaller and closer to midline than others. First pair much closer to midline than second (Fig. 9.1). Lateral margins of operculum rounded, pair of short, stout, apical setae usually present (Fig. 9.4). Setae of lingula about equal to its width. According to R. J. Gill (personal correspondence) this species has similarities with P. perseæ (Quaintance).

Field appearance: Pupae yellow to pale yellow. Short,

marginal, whitish, wax fringe present. Up to seven pairs of very large, glassy wax rods dorsally (Plate II c). Elliptical, fairly flat, averaging 0.87 mm long and 0.54 mm wide. Pupae occur singly or with few per leaf, usually surrounded by pile of broken wax rods (Plate II d).

Adults: Body white yellowish to light brown, averaging 1.21 mm in length. Antennae, especially in females, conspicuously thick, imbricate. Antennae directed backward and laterally at rest. Wings whitish to slightly gray whitish. Two transverse, irregular, pale brown bands present on forewings, one at half length and other distally (Plate II e). Wings conspicuously slender, slightly wider apically, averaging 0.91 mm long and 0.37 mm wide; held flat over the abdomen at rest. Female usually found in a nest of wax rods for oviposition on lower surface of leaves, and not easily disturbed.

Hosts: Capsicum frutescens, Cassia siamea, Citrus aurantifolia, C. aurantium, C. sinensis, Psidium guajava, Theobroma cacao.

Natural enemies: Amitus sp., Encarsia formosa.

Economic importance: Common in Central America and Colombia. Usually found in low densities, but a potential pest on citrus. Pest category: D.

UNDESCRIBED SPECIES

Undescribed species #1

Slide-mounted pupae: Transparent to grayish. Elliptical-elongate, averaging 1.60 mm long and 0.83 mm wide. Margin fairly smooth with row of short, tube-like, simple pores (Fig. 5.2). Submarginal area with outer row of conspicuous septate simple pores and inner row of large, double-rimmed simple pores. Simple pores present on dorsal disk. Ten pairs of short, submarginal setae present, not extending beyond margin (Fig. 5.1). Anterior marginal and VIII abdominal setae very short. Caudal ones thicker than posterior marginal ones, but similar in length. Other dorsal setae not observable. Six pairs of compound pores, similar in size, present, one on head and five on abdomen. Thimble-shaped with short, basal, cup-like sheath (Fig. 5.3). Vasiform orifice broadly cordate, rounded caudally. Operculum broadly rectangular, lateral margins straight, caudal margin rounded without setae. Lingula broadly spatulate and hairy; setae shorter than broadest width of lingula (Fig. 5.4).

Field appearance: Pupae yellow, usually pale yellow middorsally. Several pairs of slender, glassy wax rods present on dorsum. Marginal fringe of shorter, glassy, wax curls present (Plate III b). Pupae elliptical elongate, narrower apically, noticeably elevated from substratum, 0.81 to 1.33 mm

long and 0.34 to 0.68 mm wide. Vasiform orifice and lingula fairly discernible, whitish in color. Pupae in lateral view usually covered by a wall of transverse, glassy, wax rods.

Adults: Body gray, averaging 1.68 mm in length. Eyes red. Wings uniformly gray; somewhat rectangular, averaging 1.34 mm long and 0.67 mm wide; held fairly flat over the abdomen at rest (Plate III c-d).

Hosts: Psidium guajava, Tectona grandis; and two undetermined, a legume and a 5 m tall tree.

Natural enemies: None collected.

Economic importance: Not common, recorded from Colombia in very low density. Probably without economic importance, although found on two economically important plants. Pest category: D.

Undescribed species #2

Slide-mounted pupae: Transparent. Elliptical, averaging 1.22 mm long and 0.69 mm wide. Margin smooth with continuous row of rounded, simple pores with central openings (Fig. 8.2). Dorsum without conspicuous simple pores. Submarginal setae apparently absent (Fig. 8.1). Eight abdominal and caudal setae very short, about half size of posterior marginal ones. Other

dorsal setae not observable. Seven pairs of compound pores present, one on head and six on abdomen. Three anterior abdominal pairs developed; with short, basal, cup-like sheath; three caudal pairs reduced. Vasiform orifice cordate. Operculum transversely rectangular, caudal margin convex, with short pair of middistal setae. Lingula tongue-shaped with large setae, longer than lingula width (Fig. 8.4).

Field appearance: Empty pupal cases pale or whitish. No discernible dorsal or marginal wax secretions. Vasiform orifice fairly discernible. Elliptical, somewhat elevated, averaging 1.22 mm long and 0.76 mm wide. (Not shown on Plates).

Adults: Not found.

Hosts: Undetermined, a 5 m tall tree.

Natural enemies: None collected.

Economic importance: Only recorded from Colombia, few specimens on one host. Not economically important. Pest category: F.

Undescribed species #3

Slide-mounted pupae: Transparent. Elliptical, slightly narrower caudally, averaging 1.22 mm long and 0.83 mm wide. Margin indentate (Fig. 10.3). Dorsum without conspicuous simple pores. About 13 pairs of short, stout, submarginal setae present, not extending beyond margin (Fig. 10.1). Eight abdominal setae shorter than caudal and posterior marginal ones; latter two pairs similar in length (Fig. 10.1). Remaining dorsal setae inconspicuous or absent. Seven pairs of compound pores present, one on head and six on abdomen, with about 11 spinnerets arranged in circle (Fig. 10.2). First two abdominal pairs smaller and closer to midline than others; first pair slightly closer than second. Vasiform orifice cordate. Operculum transversely rectangular, lateral margins rounded, caudal margin slightly protruded and without setae. Lingula tongue-shaped, with setae longer than its width (Fig. 10.4).

Field appearance: Pupal color not observed. Elliptical, slightly broader across thorax, averaging 0.96 mm long and 0.62 mm wide. Dorsum covered by short, white, wax secretion; marginal fringe of white wax present, shorter than pupal width (Plate V a). Vasiform orifice region without wax secretion. Some slender, glassy, wax rods may be present on dorsum; many may be broken, scattered around pupa.

Adults: Not found.

Hosts: Undetermined, apparently a Ficus-type, about 4 m tall.

Natural enemies: None collected.

Economic importance: Not considered important, few collected from one host in Colombia. Pest category: F.

Undescribed species #4

Slide-mounted pupae: Transparent to pale yellow. Elliptical, somewhat narrower apically, averaging 1.58 mm long and 0.97 mm wide. Margin indentate or somewhat lobulate, with row of angled-elongate, simple pores (Fig. 11.2). Dorsum without simple pores. Ten pairs of submarginal setae present, extending beyond margin (Fig. 11.1). Eight very short abdominal setae present; caudal and posterior marginal ones relatively large, similar in length to submarginal setae. Remaining dorsal setae inconspicuous or absent. Seven pairs of compound pores present, one on head and six on abdomen. Third and last abdominal ones reduced. Thimble-shaped with basal, cup-like sheath (Fig. 11.3). Vasiform orifice cordate with an inward flexure at half length, rounded caudally. Operculum transversely rectangular, lateral margins rounded, caudal margin undulated, without setae. Lingula tongue-shaped, with large setae, longer than its width (Fig. 11.4). This species

has similarities with Aleuronudus induratus Hempel (R. J. Gill, personal correspondence).

Field appearance: Pupae pale yellowish to yellow, faintly elevated from substratum. Elliptical, narrower apically, averaging 2.40 mm long and 1.60 mm wide (Plate III a). Twelve or fewer pairs of prominent, glassy, wax rods present dorsally, some may be broken (Plate II f). Short, marginal fringe of glassy, wax curls usually present. Lingula conspicuous. Abdominal segments usually with faint narrow band middorsally. Two conspicuous yellow ones usually also present.

Adults: Not found.

Hosts: Heliconia sp.

Natural enemies: None collected.

Economic importance: Recorded from Guatemala from an ornamental plant. Probably not of economic importance. Pest category: F.

Subfamily ALEYRODINAE

PUPAE: Mounted specimens usually transparent, few have dorsal patterns; some genera tan, brown or black. Usually elliptical, ranging from elongate to subcircular. Average size 0.90 mm, with minimum of 0.60 mm and a maximum of 1.60 mm in length. Margin smooth, crenulate or dentate. Mostly flat, some elevated from substratum; others have dorsal ridges or depressions. Dorsum smooth, although papillae, tubercles, or spines may be present. Compound pores absent, although simple ones may be present, large in one genus. Most genera with dorsal setae. Thoracic legs without claws. Vasiform orifice variable in shape and size, may be triangular, cordiform or circular. Lingula may have pair of subterminal setae; variable in length and shape, may be completely obscured by operculum.

FIELD APPEARANCE: Pupae usually pale to yellowish; other tan, brown or black; some have dorsal patterns. Most produce wax secretions, sometimes inconspicuous due to transparency; usually as white fringes of variable length. Usually elliptical, few elongate or subcircular; from flat to elevated from substratum. Usually less than 1 mm in length. Pupae may be single or gregarious, found under leaves of hosts.

ADULTS: Body pale brown, pale yellow, or white. Eyes usually pale yellow to light brown or red, occasionally bicolored.

Wings usually white, sometimes with colored bands or spots. Occasionally, body and wings black. Costal-subcostal veins reduced, radial sector present, radius, very short or absent, cubitus also distinct in most genera, media always absent. Radial sector forms the main wing vein. Wings may be held from flat to roof-like over abdomen at rest. Tarsal paronychium blade-like, broad and clothed with spinules. Body length usually less than 1 mm, larger in three genera.

HOSTS: Herbaceous plants, shrubs, and occasionally trees or grasses.

ECONOMIC IMPORTANCE: Hosts include domestic plants used by man. In addition to feeding damage, they may also transmit virus diseases. Therefore, this group of whiteflies are of economic importance worldwide.

CLASSIFICATION: Sixteen species from nine genera are discussed:

Genus ALEUROCANTHUS Quaintance and Baker

Pupal case usually dark brown or black. Subelliptical in outline, margin toothed, wax tubes very prominent. Submarginal area not separated from dorsal disk, dorsum without papillae

or pores, though bearing many heavily chitinized spines variously arranged. Tracheal folds usually not discernible, though evident in a few species. Wax secretion usually present as a narrow fringe from marginal wax tubes. Vasiform orifice small rounded or subcordate in outline, situated on tubercle-like projection of dorsum. Operculum similar in shape and almost entirely filling it, obscuring the lingula.

Adult with one flexure in radial sector of forewings. Wings usually blotched or shaded. Males much smaller than females.

World species: Of 68 described species, only A. woglumi is reported from America (Mound and Halsey 1978). It has been reported from: U.S.A., Bahamas, Cayman Islands, Barbados, Bermuda, Cuba, Jamaica, Haiti, Dominican Republic, Mexico, Nicaragua, Costa Rica, Panama, Colombia, and Ecuador.

Aleurocanthus woglumi Ashby

Common name: Citrus blackfly

Slide-mounted pupae: Completely black. Elliptical, averaging 1.48 mm long and 1.10 mm wide. Natural shape may be distorted by slide-mounting. Margin conspicuously toothed, averaging 4.5 teeth in 0.1 mm (Fig. 16.2). Dorsum with many sclerotized, large, spines. Eleven pairs on submarginal area,

antepenultimate one with an inner pair. Dorsal disk with four pairs on meso-abdominal segments I, II, III and VII. Six pairs of submedial spines on abdominal segments II to VII. Setae on VIII and caudal ones short and slender. Four pairs of spines present on anterior region of thorax, including cephalic pair which is short and slender. Two pairs on submedian area of thoracic segments II and III; and three pairs on subdorsal area. Anterior and posterior marginal setae present (Fig. 16.1). Vasiform orifice subcordate, situated on tubercle-like projection of dorsum. Operculum similar in shape and almost entirely filling it. Lingula not visible (Fig. 16.3).

Field appearance: Pupae black, 0.87 to 1.36 mm long, averaging 0.67 mm wide. Female pupae larger; both sexes noticeably elevated from substratum. Mature nymphs surrounded by narrow fringe of white wax (Plate X e-f). Number and location of dorsal spines same as described in slide-mounted pupae.

Adults: Dorsum of head, thorax and abdomen bluish black. Eyes red. Front wings bluish black with whitish spots at costal margins. Wings held roof-like over the abdomen at rest, with whitish spots dorsally (Plate XI a). Females larger than males, both average 0.87 mm in length.

Hosts: Citrus sinensis, C. aurantifolia, Citrus sp.

Natural enemies: None collected.

Economic importance: Destructive in Central America, especially in El Salvador and Nicaragua. Successfully controlled biologically in El Salvador. It also occurs in Colombia where it may be economically important. Pest category: B.

Additional references: Dowell et al. (1981), Knapp et al. (1981).

Genus ALEUROGLANDULUS Bondar

Pupal case pale to grayish. Broadly elliptical, broadest across thorax. Margin indentate, wax tubes usually developed. Thoracic and caudal tracheal openings dentate. Submarginal area not separated from dorsal disk. Dorsum with pair of large, simple pores on prothorax, sometimes also on abdominal segment III. Anterior marginal, posterior marginal, VIII abdominal and caudal setae present. Tracheal folds usually not discernible, sometimes faint. Vasiform orifice medium in size, triangular. Operculum subcordate. Lingula lobulate bearing long pair of setae. Caudal furrow not very distinct.

Adults relatively large, white in color. One flexure in radial sector of forewings. Antennae with seven segments. Sexes about equal in size.

World species: The five described species are reported in America by Mound and Halsey (1978):

A. emmae Russell → U.S.A., Mexico

A. magnus Russell → Panama

A. malangae Russell → Cuba

A. striatus Sampson & Drews → Mexico, Guatemala, Honduras

A. subtilis Bondar → Brazil, Panama

Aleuroglandulus malangae Russell

Slide-mounted pupae: Pale to grayish. Broadly elliptical, averaging 1.38 mm long and 1.06 mm wide. Wax tubes well developed extending across width of submarginal area (Fig. 15.2). Large, simple pores present on prothorax and abdominal segment III (Fig. 15.1). Eight abdominal setae short, caudal setae medium in size; anterior and posterior marginal setae also present. Vasiform orifice medium in size, triangular, bilobate distally (Fig. 15.3). Operculum subcordate. Lingula lobulate bearing long pair of setae. Caudal furrow not very distinct.

Field appearance: Pupae bright yellow, with four dorsal horns corresponding to the four large simple pores (Plate VI a-b).

Broadly elliptical, averaging 1.34 mm long and 0.87 mm wide. Found from low to high density on lower surface of leaves.

Adults: Body yellow with white wings. The largest species in this subfamily, averaging 1.75 mm in length. Wings not completely flat over the abdomen at rest (Plate V f). Female and male of approximate same size.

Hosts: Colocasia esculenta, Caladium sp.

Natural enemies: Amitus sp., Delphastus sp., Encarsia sp. (group A).

Economic importance: A tropical species found in Central America and Colombia. Potential pest on Araceae: Colocasia, Xanthosoma, etc. Pest category: C.

Genus ALEUROPLATUS Quaintance & Baker

Pupal case usually dark brown to blackish, sometimes yellowish, many species with variously located dark spots. Elliptical to subcircular, dentate, wax tubes moderately developed. Submarginal area not separated from dorsal disk. Dorsum without prominent pores or papillae, some species with many minute pore-like structures. Thoracic tracheal folds

evident, distally dentate at pupal margin where wax rods may arise which are different in color from the amorphous wax secreted by the marginal wax tubes that surrounds the pupa. Vasiform orifice small, transversely elliptical, rounded, or roundly quadrangular. Lingula obscured by operculum which nearly fills the orifice.

Adults with one flexure in radial sector of forewing (Quaintance and Baker 1914).

World species: Eighty-five species worldwide, 29 are reported in America by Mound and Halsey (1978):

A. berbericolus Quaintance & Baker → Canada, U.S.A., Mexico

A. bignoniae Russell → U.S.A.

A. cockerelli (Ihering) → Brazil

A. cococolus Quaintance & Baker → Cuba, Trinidad, Panama, Brazil.

A. coronata (Quaintance) → U.S.A.

A. crustatus Bondar → Brazil

A. dentatus Sampson & Drews → Mexico

A. denticulatus Bondar → Brazil

A. elemarae Mound & Halsey → U.S.A.

A. epigaeae Russell → Canada, U.S.A.

A. gelatinosus (Cockerell) → U.S.A.

A. graphicus Bondar → Brazil

A. ilicis Russell → U.S.A.

- A. integellus Bondar → Brazil
- A. lateralis Bondar → Brazil
- A. magnoliae Russell → U.S.A.
- A. myricae Quaintance & Baker → U.S.A.
- A. oculiminutus Quaintance & Baker → Trinidad
- A. oculireniformis Quaintance & Baker → Brazil
- A. ovatus Quaintance & Baker → U.S.A.
- A. panamensis Sampson & Drews → Panama
- A. plumosus (Quaintance) → U.S.A.
- A. quercusaquaticae (Quaintance) → U.S.A.
- A. sculpturatus Quaintance & Baker → Panama
- A. semiplumosus Russell → U.S.A.
- A. vaccinii Russell → Canada, U.S.A.
- A. validus Quaintance & Baker → Jamaica
- A. variegatus Quaintance & Baker → Costa Rica
- A. vinsonioides (Cockerell) → Mexico, Cuba

Aleuroplatus sp.

Slide-mounted pupae: Dark brown to blackish. Elliptical to broadly elliptical, averaging 0.97 mm long and 0.70 mm wide; usually undulated in outline (Fig. 22.1). Margin and submargin crenulate. Submarginal area with finger-like crenulae and one or two pores (Fig. 22.2). Most of dorsum covered by tiny pores. Cephalic, meso- and metathoracic setae short, stout. Eight abdominal setae medium in size; caudal ones short, usually converging. Anterior and posterior marginal setae not

observable. Middorsal ridge usually distinctive. Vasiform orifice sucordate, longer than wide (Fig. 22.3). Operculum usually subrectangular, distal margin concave and narrower. Lingula not visible.

Field appearance: Pupae black, flat. Broadly elliptical, averaging 0.94 mm long and 0.68 mm wide. Marginal fringe of glassy wax forming 20 curls giving an appearance of a star (Plate X b-c). Curls about length of pupal width. Sometimes occur in high density under leaves.

Adults: Body yellowish; wings transparent to whitish. Body averages 1.07 mm in length (Plate X d).

Hosts: Anacardium occidentale, Cocos nucifera, Cordia dentata, Psidium fridrichsthalianum, Terminalia catappa, Theobroma cacao, and other undetermined hosts.

Natural enemies: None collected.

Economic importance: Occurs in Central America and Colombia, usually in low densities. Although found in fruit trees, it is not yet considered a pest. Pest category: D.

Genus ALEUROTHRIXUS Quaintance & Baker

Pupal case color ranging from yellow to blackish. Elliptical, margin sometimes angled, with double row of teeth, wax tubes well developed at base of marginal teeth. Submarginal area separated from dorsal disk. Dorsum without papillae or pores, with several pairs of long, stout hairs along midline. Tracheal folds inconspicuous. Wax secretions usually copious, flocculent or woolly, secreted by marginal wax tubes. Vasiform orifice small, transversely elliptical, broadly subcordate or subcircular. Lingula obscured by operculum which nearly fills the orifice.

Adults with one flexure in radial sector of forewing. Antennae with seven segments, third longest. Sexes nearly equal in size.

World species: There are 18 described species, 15 are reported in America (Mound and Halsey 1978):

A. aepim (Göldi) → Argentina, Brazil

A. aguiari Costa Lima → probably Brazil

A. bondari Costa Lima → Brazil

A. floccossus (Maskell) → U.S.A., Mexico, Bahamas, Leeward Islands (Dominica, Guadeloupe, Nevis, St. Kitts), Barbados, Trinidad, Cuba, Jamaica, Puerto Rico, Haiti, Panama, Argentina, Brazil, Chile, Guyana, Paraguay and

Surinam.

- A. guareae Costa Lima → Brazil
- A. guimaraesi Costa Lima → Brazil
- A. interrogationis (Bemis) → U.S.A.
- A. lucumai Costa Lima → Brazil
- A. miconiae Hempel → Brazil
- A. myrtacei Bondar → Brazil, Guadeloupe, Barbados.
- A. ondinae Bondar → Brazil
- A. porteri Quaintance & Baker → Argentina, Brazil, Chile
- A. proximans Bondar → Brazil
- A. similis Sampson & Drews → Mexico
- A. solani Bondar → Brazil

Aleurothrixus floccosus (Maskell)

Common name: Woolly whitefly

Slide-mounted pupae: Tan or brown. Elliptical, averaging 1.16 mm long and 0.81 mm wide. Margin dentate, averaging 7.5 teeth in 0.1 mm (Fig. 21.2). Long, stout setae on metathorax, VIII abdominal segment and caudal end. As many as five short, submarginal setae on anterior half of pupa. Anterior and posterior marginal setae also present. Caudal furrow absent (Fig. 21.1). Vasiform orifice subcordate, wider than long, with six to eight branched setae connected by a membrane arising from its caudal margin (Fig. 21.3). Those setae may be inconspicuous when pupal case is mounted on a microscope slide (Hamon 1981). The vasiform orifice may become distorted in

slide-mounted specimens (Martin 1987). Operculum transversely elliptical, narrower distally. Lingula seen only in very clear mounted specimens.

Field appearance: Pupae usually yellowish brown, sometimes blackish. Elliptical, averaging 0.99 mm long and 0.68 mm wide. Normally covered by many floccous, grayish, white, wax threads (Plate IX e-f). Usually gregarious; probably, due to vertical position of many leaves of some hosts, pupae observed colonizing upper surface of some leaves.

Adults: Body relatively narrow, narrower anteriorly. The third largest species in this subfamily, averaging 1.34 mm long. Wings white, held flat over the abdomen at rest (Plate X a).

Hosts: Baccharis trinervis, Citrus sinensis, C. reticulata, Citrus sp., Cordia dentata, Musa sapientum, Persea americana, Psidium guajava, Spondias sp.

Natural enemies: Encarsia sp. (group D), Eretmocerus californicus, Eretmocerus sp.

Economic importance: Sporadic pest on Citrus spp. and other fruit hosts. Common species in low densities in Central America and Colombia. Sometimes observed in higher densities on Citrus spp. Pest category: C.

Genus ALEUOTRACHELUS Quaintance & Baker

Pupal case brown to blackish. Elliptical, cephalic margin sometimes somewhat acute. Margin usually with double row of teeth, wax tubes well developed. Submarginal area separated from dorsal disk. Dorsum without pores or papillae, though body sutures prominent, prominent folds on each side near midline. Tracheal-like ridge present middorsally, terminating proximad, sometimes arrow-shaped; caudad in vasiform orifice. Tracheal folds not discernible; wax secretions usually present as fringe from marginal wax tubes. Vasiform orifice small, broadly cordate or subcircular. Operculum similar in shape, obscuring lingula.

Adults with one flexure in radial sector of forewing. Antennae seven-segmented, third longest. Sexes nearly equal in size.

World species: Nineteen of 75 worldwide species are reported in America by Mound and Halsey (1978). Most of these are found in Brazil and were described by Bondar (1923):

- A. atratus Hempel → Brazil
- A. cacaorum Bondar → Brazil
- A. camamuensis Bondar → Brazil
- A. cecropiae Bondar → Brazil
- A. distinctus Hempel → Brazil
- A. fenestellae Hempel → Brazil

- A. fumipennis (Hempel) → Brazil
- A. granosus Bondar → Brazil
- A. graciosus Bondar → Brazil
- A. ingafolii Bondar → Brazil
- A. myrtifolii Bondar → Brazil
- A. parvus (Hempel) → Brazil
- A. rosarius Bondar → Brazil
- A. rubromaculatus Bondar → Brazil
- A. socialis Bondar → Brazil
- A. stellatus Bondar → Brazil
- A. theobromae Bondar → Brazil, Guyana
- A. tracheifer (Quaintance) → Mexico
- A. trachoides (Back) → Cuba, Jamaica, Puerto Rico, Antigua, Barbados, Trinidad, and Guyana.

Alurotrachelus cacaorum Bondar

Slide-mounted pupae: Brown to dark brown. Broadly elliptical, averaging 0.71 mm long and 0.49 mm wide. Margin noticeably dentate, averaging 6 teeth in 0.1 mm (Fig. 24.2). Marginal teeth without basal pore. No submarginal teeth. Submarginal area sculptured by irregular rectangles. Abdomen with submarginal, subdorsal, and submedian area with longitudinal row of small pores. Body setae not observable. Middorsal ridge sometimes not prominent. Vasiform orifice subcircular, not located on a plate. Operculum similar in shape, filling orifice. Lingula not observable (Fig. 24.3).

Field appearance: Pupae black, flat. Broadly elliptical, averaging 0.78 mm long and 0.51 mm wide. Pupae without wax secretion dorsally; a fringe of white, glassy wax that surrounds pupae produced by marginal wax tubes. Fringe longer than pupal width. Another inner, thinner, white fringe present (Plate XII b-c). One or few pupae found per leaf.

Adults: Unknown.

Hosts: Terminalia catappa

Natural enemies: None collected.

Economic importance: Native species from South America that feeds on several wild hosts. Found in Colombia. Bondar (1923) found it on Theobroma cacao in Brazil. Pest category: D.

Aleurotrachelus socialis Bondar

Slide-mounted pupae: Dark brown. Elliptical, slightly broader across thorax, averaging 0.90 mm long and 0.58 mm wide. Margin toothed, about 7.5 teeth in 0.1 mm. Second row of teeth shorter, wider, and darker than first. A pale band located between rows of teeth (Fig. 23.2); with a pore for each tooth. Submarginal area with snake-like integument. Long pair of stout setae present on metathorax. Dorsum with elevation which turns cylindric in shape on abdomen, terminating on cordiform

plate at vasiform orifice. Eight abdominal and caudal setae, both elongate, located on plate. Anterior and posterior marginal setae present, medium in size (Fig. 23.1). Vasiform orifice broadly subcircular. Operculum similar in shape and size. Lingula with globular, hairy apex, extending beyond operculum, discernible only in clear specimens (Fig. 23.3).

Field appearance: Pupae black, moderately convex. Elliptical, averaging 0.92 mm long and 0.54 mm wide. Normally surrounded by mealy wax secretion which equals pupal width (Plate XII d). Occasionally, pupae are gregarious with white wax also covering pupae dorsally (Plate XII e).

Adults: Body whitish with fairly parallel sides, averaging 0.95 mm long. Eyes reddish. Wings held roof-like over the abdomen at rest (Plate XII f).

Hosts: Manihot esculenta, undetermined Solanaceae.

Natural enemies: None collected.

Economic importance: One of the three most economically important species that feeds on cassava in Colombia. Pest category: B.

Additional references: Bondar (1923), CIAT (1983, 1986).

Genus BEMISIA Quaintance & Baker

Pupal case usually pale yellowish. Elliptical, broadest across thorax, varying much in size; margin smoothly tentate, wax tubes of irregular size and shape. Submarginal area not separated from dorsal disk. Dorsum without papillae or pores. Thoracic tracheal folds sometimes faintly visible. Caudal furrow very distinct. Vasiform orifice triangular, long, narrow. Operculum subcircular to subcordate, covering less than half of basal portion of lingula. Lingula triangular-elongate, with pair of subterminal setae.

Adults with one flexure in radial sector of forewing. Antennae with seven segments, third longest, distal ones subequal.

World species: Thirty-seven described species worldwide (Mound and Halsey 1978), five found in America:

B. berbericola (Cockerell) → Chile, U.S.A.

B. caudasculptura Quaintance & Baker → Mexico

B. poinsettiae Hempel → Brazil, Argentina

B. tabaci (Gennadius) → Jamaica, Puerto Rico, Barbados, Brazil, Argentina.

B. tuberculata Bondar → Brazil

One undetermined species from Venezuela and Chile.

Bemisia tabaci (Gennadius)

Common name: Sweetpotato whitefly

Slide-mounted pupae: Pale. Variable in shape, usually elliptical, broadest mid-transversely, averaging 0.90 mm long and 0.70 mm wide. Sometimes elliptical-elongate with irregular outline or asymmetrical. Margin crenulate (Fig. 29.3). Thoracic tracheal folds occasionally discernible (Fig. 29.2). Thorax and abdomen usually smooth, occasionally with up to six pairs of setae (Fig. 29.1). Eight abdominal and caudal setae present. Caudal ones always long and stout; longer than caudal furrow. Vasiform orifice longer than caudal furrow; with median tooth at apex and three to five others at base of first. Operculum broadly curved around posterior margin (Fig. 29.4).

Field appearance: Pupae pale to pale yellowish. Wax secretion also transparent, very thin and inconspicuous. Shape varies according to host. Usually elliptical on glabrous leaves, broadest across thorax, averaging 0.83 mm long and 0.57 mm wide. Dorsal surface smooth, flat or slightly convex (Plate VII b-c). On hairy leaves, usually elliptical-elongate, convex mid-dorsally. Dorsal surface with up to six pairs of setae on thorax and abdomen, occasionally pigmented dorsally (Plate VII d). Caudal setae conspicuous if unbroken and larger than caudal furrow. Vasiform orifice located at less than twice its length from caudal end.

Adults: Body and wings creamy-whitish. Body elongate with parallel sides. Female about 1.18 mm long, male 0.98 mm. Both sexes hold wings roof-like over the abdomen at rest (Plate VII e). Anal margins of wings separated at rest, especially in males (Plate VII e, bottom).

Hosts: Capsicum annuum, C. frutescens, Citrullus lanatus, Cucumis melo, C. sativus, Cucurbita moschata, Eclipta alba, Elephantopus spicatus, Euphorbia heterophylla, E. hirta, E. pulcherrima, Ficus sp. Glycine max, Gossypium hirsutum, Hibiscus rosasinensis, Lycopersicum lycopersicum, Manihot esculenta, Nicandra physalodes, Phaseolus vulgaris, Sida acuta, Solanum melongena S. tuberosum, Sonchus oleraseus,

Natural enemies: Encarsia tabacibora, Geocoris sp., undetermined Miridae.

Economic importance: The most important species worldwide. It attacks more than 500 different host plants in over 80 families including common and important crops. Important as a virus-vector, transmitting more than 70 viruses. The most important group are the geminiviruses. It occurs in Central America and Colombia, especially below 1000 m, likely less than 800 m, under high temperature and humidity. Pest category: A.

Additional references: Hamon and Salguero (1987), Russell (1975).

Bemisia tuberculata Bondar

Slide-mounted pupae: Pale or transparent. Elliptical, broadest mid-transversely, averaging 1.20 mm long and 0.90 mm wide. Margin crenulate (Fig. 30.3). Thoracic tracheal folds occasionally visible. Dorsum smooth with regular outline (Fig. 30.1). Occasionally, even on same host, irregular or asymmetrical in outline with up to six pairs of dorsal setae (Fig. 30.2). Anterior marginal, VIII abdominal, caudal, and posterior marginal setae present. Caudal ones shorter than caudal furrow (Fig. 30.2), usually very short (Fig. 30.1). Vasiform orifice shorter than caudal furrow, without teeth at caudal end. Operculum narrowly curved around posterior margin (Fig. 30.4).

Field appearance: Pupae usually yellow. Elliptical, fairly flat, averaging 0.82 mm long and 0.57 mm wide. Often, thoracic tracheal folds evident, as well as thin curls of marginal wax (Plate VI e-f). Caudal setae, even when not broken, much shorter than caudal furrow. Vasiform orifice located at least twice its length from caudal end of pupa.

Adults: Body pale-yellow with white wings. Body shape slightly tapering anteriorly, averaging 1.32 mm in length. Wings not

held completely flat over the abdomen at rest, anal margins of wings joined or scarcely separated (Plate VII a).

Hosts: Manihot esculenta

Natural enemies: Undetermined Coccinellidae.

Economic importance: One of three most economically important species feeding on cassava. Occurs in Central America and Colombia, sometimes in high densities. Pest category: B.

Additional references: Bondar (1923), Russell (1975).

Genus DIALEURODES Cockerell

Pupal case usually pale or yellowish, some species brownish. Elliptical to subcircular in outline, margin smooth to dentate. Wax tubes irregular in outline, poorly developed. Submarginal area not separated from dorsal disk. Dorsum without papillae or pores. Tracheal folds usually evident, very conspicuous in some species, terminating on margin as a pore. Folds often with dotted, linear, or polygonal markings. Wax secretion absent or scant. Vasiform orifice small, transversely oval, subcircular, or subcordate, with or without dentations on inner lateral and caudal margins. Operculum

large mostly filling orifice and obscuring lingula.

Adults with one flexure in radial sector of forewing. Antennae seven-segmented, VII usually slightly longer than IV-VI. Male claspers with few prominent spines. Sexes about equal in size.

World species: Mound and Halsey (1978) report 131 species worldwide, 15 occur in America:

D. buscki Quaintance & Baker → Puerto Rico

D. citri (Ashmead) → U.S.A., Mexico, Brazil, Chile

D. citrifolii (Morgan) → U.S.A., Mexico, Cuba, Jamaica, Puerto Rico, Bermuda, Barbados, Trinidad, Venezuela, Brazil.

D. egregissima Sampson & Drews → Mexico

D. heterocera Bondar → Brazil

D. imperialis Bondar → Brazil

D. kirkaldyi (Kotinsky) → U.S.A., Cuba, Jamaica, Trinidad, Guyana.

D. maculatus Bondar → Brazil

D. maculipennis Bondar → Brazil

D. michoacanensis Sampson & Drews → Mexico

D. natickis Baker & Moles → Chile

D. navarroii Bondar → Brazil

D. platicus Bondar → Brazil

D. struthanthi Hempel → Brazil

D. tricolor Quaintance & Baker → Brazil

Three undetermined species from Jamaica.

Dialeurodes citri (Ashmead)

Common name: Citrus whitefly

Slide-mounted pupae: Transparent. Broadly elliptical, averaging 1.60 mm long and 1.10 mm wide. Margin crenulate. Submarginal area with transverse wax tubes, occasionally not discernible. Thoracic tracheal folds with numerous spinules (Fig. 28.2). Thoracic tracheal pores with internal tooth. Dorsum smooth. Anterior marginal, VIII abdominal and posterior marginal setae small (Fig. 28.1). Caudal ones not visible. Caudal furrow with many spinules (Fig. 28.3).

Field appearance: Pupae flat, transparent, often inconspicuous under leaves. Subcircular in shape. Thoracic tracheal folds and caudal furrow usually discernible. (Not shown on Plates).

Adults: Body grayish to pale yellow. Wings uniformly white, without spots. Wings held flat over the abdomen at rest, tapering anteriorly. (Not shown on Plates).

Hosts: Melia azedarach

Natural enemies: Undetermined Coccinellidae.

Economic importance: Not important in Central America and Colombia. Although the species name citri suggests this species is common in Citrus spp., it is not found on these

hosts. Recorded only from Honduras. Pest category: D.

Dialeurodes citrifolii (Morgan)

Common name: Cloudy-winged whitefly

Slide-mounted pupae: Transparent. Broadly elliptical to subcircular, flat, averaging 1.60 mm long and 1.21 mm wide. Margin fairly smooth. Submarginal area with transverse wax tubes. Thoracic tracheal folds with few or no spinules (Fig. 27.2) Thoracic tracheal pores with three to five internal teeth. Dorsum smooth, occasionally appears scaled depending upon light intensity of microscope (Fig. 27.1). Anterior marginal, VIII abdominal, and posterior marginal setae short. Caudal ones not observable. Caudal furrow sculptured by irregular markings resembling a stone road (Fig. 27.3).

Field appearance: Pupae flat, transparent, often inconspicuous under leaves. Subcircular, 1.28 to 1.75 mm long and 1.00 to 1.23 mm wide. Thoracic tracheal folds and caudal furrow usually discernible (Plate VI c). At high density, pupae cover entire lower leaf area.

Adults: Body grayish to pale yellow. Wings white with dark area distally on each forewing (Plate VI d), occasionally faint depending on angle and intensity of sunlight. Wings held flat over the abdomen at rest, a little higher anteriorly. In dorsal view, wing bases narrower than apex. The second largest

species in this subfamily, 1.61 to 1.88 mm in length, females larger than males.

Hosts: Citrus aurantifolia, C. limetta, C. reticulata, C. sinensis, Citrus sp., Gardenia sp.

Natural enemies: Amitus, Encarsia sp. (group A), Scymnus sp.

Economic importance: A common species and potential pest on Citrus spp in Central America and Colombia. Usually found in low densities, occasionally high populations occur. Pest category: C.

Additional references: Nguyen and Hamon (1985).

Genus TETRALEURODES Cockerell

Pupal case usually black. Size variable, elliptical to broadly oval, margin crenulate to dentate, wax tubes usually developed. Submarginal area separated from dorsal disk and conspicuously fluted by suture-like lines. Dorsum without papillae, though minute pores may be present. Reniform eye-like spots often evident on cephalic portion of pupa. Tracheal folds never discernible. Wax secretion usually a copious fringe from marginal wax tubes. Vasiform orifice small,

subcordate, sometimes rounded; usually elevated on tubercle-like projection of dorsum. Operculum similar in shape and almost entirely filling orifice, obscuring lingua.

Adults with one flexure in radial sector of forewing. Antennae with seven segments, third longest. Sexes about equal in size. Forewings sometimes shaded.

World species: Fifty species are known worldwide, 21 are reported in America (Mound and Halsey 1978):

- T. abnormis (Quaintance) → U.S.A.
- T. acaciae (Quaintance) → U.S.A., Mexico, Jamaica.
- T. bidentatus Sampson & Drews → Mexico
- T. corni (Haldeman) → U.S.A.
- T. dorseyi (Kirkaldy) → U.S.A.
- T. errans (Bemis) → U.S.A.
- T. fici Quaintance & Baker → U.S.A., Mexico, Cuba
- T. herberti (Penny) → U.S.A.
- T. marshalli Bondar → Brazil
- T. melanops (Cockerell) → U.S.A.
- T. mori (Quaintance) → U.S.A., Mexico, Cuba, Jamaica
- T. nudus Sampson & Drews → Mexico
- T. papilliferus Sampson & Drews → Panama
- T. perileuca (Cockerell) → U.S.A.
- T. pringlei Quaintance & Baker → Mexico
- T. quadratus Sampson & Drews → Mexico

T. splendens (Bemis) → U.S.A.

T. stanfordi (Bemis) → U.S.A.

T. stellata (Maskell) → Jamaica

T. truncatus Sampson & Drews → Mexico

T. ursorum (Cockerell) → U.S.A., Mexico, Puerto Rico

One undetermined species from Trinidad and two others from Jamaica.

Tetraleurodes acaciae (Quaintance)

Common name: Acacia whitefly

Slide-mounted pupae: Dark brown to black. Broadly elliptical, averaging 0.98 mm long and 0.70 mm wide. Margin crenulate. Submarginal area with average row of 22 pores (Fig. 25.2). Cephalic, pro- and mesothoracic setae short. Eight abdominal, ventral abdominal, and caudal setae stout. Some specimens, have pair of short setae between abdominal segments VII and VIII. (Fig. 25.1). Vasiform orifice subcordate or subcircular, sometimes distorted after slide-mounting. Operculum with same shape as vasiform orifice, almost filling it. Lingula bulbous, only discernible in bleached specimens, covered with minute setae, not extending beyond vasiform orifice (Fig. 25.3).

Field appearance: Pupae shiny black, surrounded by short fringe of white wax (Plate XI b). Elliptical, moderately convex, 0.54 to 0.87 mm long and 0.40 to 0.57 mm wide. Marginal and middorsal longitudinal ridge usually evident. Wax

band always shorter than pupal width. Pupae never gregarious, few found per leaf, usually along leaf veins.

Adults: Body light yellow with red eyes. Wings usually pale white, sometimes powdery-white (Plate XI c). Average length of body 1.02 mm.

Hosts: Cassia javanica, C. siamea, Cassia sp., Ficus sp., Gliricidia sepium, Inga spuria, Leucaena leucocephala, Phaseolus vulgaris, Phaseolus sp., Pithecellobium dulce, Sida rombifolia.

Natural enemies: None collected

Economic importance: Very common species in Central America and Colombia. Usually in low density, but a potential pest for many crops. Russell (1975) reports it on bean in the Western hemisphere. Pest category: C.

Additional references: Dowell (1983), Hamon (1978).

Tetraleurodes mori (Quaintance)

Common name: Mulberry whitefly

Slide-mounted pupae: Dark brown to black. Broadly elliptical, averaging 0.86 mm long and 0.61 mm wide. Margin dentate. Submarginal area with tiny punctures separated by transverse

sutures corresponding to each tooth (Fig. 26.2). Meso- and metathoracic setae stout and medium in size. Eight abdominal and caudal ones large; posterior marginal ones also present (26.1). Vasiform orifice subcircular. Operculum same shape and almost filling it. Lingula bulbous, only discernible in clear specimens (Fig. 26.3).

Field appearance: Pupae black, surrounded by large fringe of white wax, often divided in several tufts (Plate XI d). Elliptical, moderately convex, averaging 0.89 mm long and 0.59 mm wide. Wax band always much larger than pupal width (Plate XI e). Several pupae can be found per leaf.

Adults: Body grayish to whitish, averaging 0.87 mm long. Head with pale brown band on front joining upper eyes. Upper eyes red and lower ones blackish. Lateral pale brown spot or band on head and thorax; three transverse dorsal ones on abdomen. Wings not completely flat over the abdomen at rest, almost parallel sided, slightly tapering anteriorly (Plate XI f, XII a). Bright white wings with two basal orange-reddish spots; two transverse bands, one similar in color to the spots at half length, and a pale brownish one distally (Plate XI f).

Hosts: Musa paradisiaca, M. sapientum, Musa sp., Psidium guajava, Rosa sinensis.

Natural enemies: None collected.

Economic importance: Probably not presently important. Usually occurring in low density except in guava. Found in Central America and Colombia. Pest category: D.

Additional references: Quaintance and Baker (1914).

Genus TRIALEURODES Cockerell

Pupal case from whitish to dark brown. Small to medium in size, elliptical, usually elevated from substratum by a palisade of white wax. Margin crenulate, wax tubes moderately developed. Submarginal area not separated from dorsal disk, with row or number of large papillae or pores. Thoracic tracheal folds rarely distinguishable. Usually a distinct caudal furrow present. Wax secretion a series of brittle, glassy rods from dorsal papillae or pores and a palisade of white wax elevating pupal case from leaf. Vasiform orifice subcordate, usually notched on caudal end. Operculum transversely elliptical, filling about half of orifice. Lingula spatulate, distal extremity exposed caudad of operculum, lobulate, usually armed with two prominent setae.

Adults usually with one flexure in radial sector of forewing, no media except in freshly emerged specimens (Quaintance and Baker 1914). Antennae with seven imbricated segments, III longest, IV to VI subequal. Sexes nearly equal in size.

World species: Fifty-six species worldwide, 39 are reported in America by Mound and Halsey (1978):

- T. abutiloneus (Haldeman) → U.S.A., Mexico, Cuba, Puerto Rico, Trinidad, Jamaica.
- T. bellissima (Sampson & Drews) → U.S.A.
- T. bemisae Russell → U.S.A.
- T. coccolobae Russell → Mexico
- T. colcordae Russell → U.S.A.
- T. corollis (Penny) → U.S.A.
- T. diminutis (Penny) → U.S.A.
- T. drewsi Sampson → U.S.A.
- T. dubiensis (Bondar) → Brazil
- T. eriodictyonis Russell → U.S.A.
- T. euphorbiae Russell → U.S.A.
- T. fernaldi (Morrill) → U.S.A.
- T. floridensis (Quaintance) → U.S.A., Mexico, Panama, Cuba, Bahamas, Puerto Rico, Venezuela.
- T. glacialis (Bemis) → U.S.A.
- T. heucherae Russell → U.S.A.
- T. hutchingsi (Bemis) → U.S.A.
- T. intermedia Russell → U.S.A.

- T. madroni (Bemis) → U.S.A.
- T. magnoliae Russell → U.S.A.
- T. manihoti (Bondar) → Brazil
- T. merlini (Bemis) → Canada, U.S.A.
- T. mirissimus Sampson & Drews → Mexico, Jamaica, Trinidad, St. Kitts.
- T. multipori Russell → U.S.A.
- T. notata Russell → U.S.A.
- T. oblongifoliae Russell → U.S.A., Mexico
- T. packardi (Morrill) → Canada, U.S.A.
- T. pergandei (Quaintance) → U.S.A.
- T. ruborum (Cockerell) → U.S.A.
- T. shawundus Baker & Moles → Chile
- T. similis Russell → U.S.A.
- T. tabaci Bondar → Brazil
- T. tentaculatus (Bemis) → U.S.A.
- T. tephrosiae Russell → Mexico, Costa Rica, El Salvador, Panama.
- T. unadutus Baker & Moles → Chile
- T. vaporariorum (Westwood) → Canada, U.S.A., Mexico, Guatemala, El Salvador, Honduras, Puerto Rico, Barbados, Bermuda, Guyana, Colombia, Ecuador, Peru, Brazil, Chile, Argentina.
- T. varia Quaintance & Baker → Mexico
- T. variabilis Quaintance & Baker → U.S.A., Mexico, Guatemala, Honduras, Costa Rica, Puerto Rico, Cuba, Jamaica,

St. Croix, Trinidad.

T. vitrinellus (Cockerell) → Mexico

T. vittata (Quaintance) → U.S.A.

Trialeurodes abutiloneus (Haldeman)

Common name: Abutilonea whitefly

Slide-mounted pupae: Pale or transparent. Elliptical, averaging 0.86 mm long and 0.55 mm wide. Sometimes with asymmetrical or irregular outline (Fig. 17.1). Marginal crenulations narrow, at least 30 in 0.1 mm. Dorsum with or without papillae (Fig. 17.1 and 17.2). Submarginal papillae usually broadly conical with blunt apex (Fig. 17.3). Anterior marginal setae always absent. Cephalic, I, VIII abdominal, caudal and posterior marginal setae vary in length. Caudal furrow short, about length of vasiform orifice. Vasiform orifice elongate cordate with distal peg-like tooth at apex (Fig. 17.4).

Field appearance: Pupae pale to very pale yellow. Usually with dark band middorsally (Plate VIII b). Elliptical-elongate, averaging 0.88 mm long and 0.55 mm wide. With fringe of separated glassy wax curls, small to medium in size. Elevated from substratum.

Adults: Body brown yellowish, averaging 0.90 mm long. Wings white to creamy-white with two transverse zigzagged brown-gray

bands (Plate VIII d). Wings held roof-like over the abdomen at rest and thorax somewhat humpbacked (Plate VIII c).

Hosts: Ageratum conyzoides, Gossypium hirsutum, Heliotropium indicum, Sida acuta, Walteria indica.

Natural enemies: None collected.

Economic importance: Found in Central America on several crops and weeds, especially in lowlands. Potential pest on beans and cotton. It has been reported as a virus vector and as resistant to pesticides in other countries. Pest category: B.

Additional references: Hamon (1991), Russell (1948, 1975).

Trialeurodes floridensis (Quaintance)

Slide-mounted pupae: Pale to pale yellow. Broadly elliptical, averaging 1.19 mm long and 0.85 mm wide. Usually flat and symmetrical in outline (Fig. 18.1). Marginal crenulations broad, about 16 in 0.1 mm. Dorsum without papillae but with mid- and subdorsal tubercles. Submarginal papillae always in a continuous row, elongate with distal end acute (Fig. 18.2). Anterior marginal setae always present, sometimes broken in mounting. Cephalic, I, VIII abdominal, caudal and posterior marginal setae short and stout. Caudal furrow long, at least twice length of vasiform orifice. Vasiform orifice subcordate

(Fig. 18.3).

Field appearance: Pupae pale yellow to greenish, flat, surrounded by a glassy wax fringe. Broadly elliptical, slightly narrower anteriorly, averaging 1.11 mm long and 0.83 mm wide. Wax fringe normally divided into several tufts of irregular width. Thoracic tracheal folds usually visible. Vasiform orifice subcordate, yellowish brown, and conspicuous, located at least twice its length from caudal margin of pupa. Two middorsal yellowish spots on abdomen usually discernible (Plate VII f).

Adults: Body brown yellowish, averaging 1.20 mm long. White wings, held flat over the abdomen at rest, narrower basally (Plate VIII a).

Hosts: Leucaena leucocephala, Carica papaya.

Natural enemies: None collected.

Economic importance: Found in Central America and Colombia. Neither abundant nor common, except in Leucaena in Colombia. Pest category: D.

Additional references: Russell (1948).

Trialeurodes vaporariorum (Westwood)

Common name: Greenhouse whitefly

Slide-mounted pupae: Pale to pale yellowish. Elliptical, averaging 0.91 mm long and 0.58 mm wide. May be asymmetrical or irregular in outline (Fig. 20.1). Marginal crenulations broad, about 10 in 0.1 mm. Dorsum with or without papillae and with subdorsal tubercles. Submarginal papillae never in a continuous row, but at least a few present, broadly conical (Fig. 20.3). Anterior marginal setae always present, sometimes broken in mounting. Cephalic, I, VIII abdominal, caudal and posterior marginal setae vary in size. Caudal furrow short, less than twice length of vasiform orifice. Vasiform orifice subcordate (Fig. 20.4).

Field appearance: Pupae semitransparent to yellowish. Elliptical-elongate, 0.60 to 0.87 mm long and 0.44 to 0.54 mm wide (Plate VIII e). Noticeably elevated from substratum, never flat, with marginal fringe of glassy wax resembling hairs (Plate VIII f). Wax curls occasionally broken or not well developed. Pupae sometimes occupying entire lower surface of leaves, may be found on all leaves.

Adults: Body grayish. Wings immaculate, white. Wings held flat over the abdomen at rest and usually not separated middorsally (Plate IX a). Base narrower than apex. Females larger than males (Plate IX a, bottom), both sexes average 1.10 mm long.

Hosts: Ageratum conyzoides, Cucumis sativus, Eclypta alba,
Euphorbia graminea, Geranium grandiflorum, Glycine max,
Lycopersicum lycopersicum, Phaseolus vulgaris.

Natural enemies: Amitus sp., Encarsia tabacivora.

Economic importance: Second most important species worldwide, attacks about 250 different hosts in more than 80 families. Main importance due to feeding and excreted honeydew causing growth of sooty mold which interferes with photosynthesis. Some virus diseases reported for this species. Found in Central America and Colombia at more than 800 m. Pest category: A.

Additional references: Russell (1948, 1975, 1977), Quaintance and Baker (1914).

Trialeurodes variabilis (Quaintance)

Slide-mounted pupae: Pale. Elliptical, averaging 0.81 mm long and 0.50 mm wide. May be asymmetrical or irregular in outline (Fig. 19.1). Marginal crenulations broad, about 14 in 0.1 mm. Dorsum usually without papillae, few dorsal tubercles present. Submarginal papillae broadly conical, never in a continuous row, may be absent, few (Fig. 19.1), or many in number (Fig. 19.2). Anterior marginal setae always present, sometimes broken in mounting. Cephalic, I, VIII abdominal, caudal and

posterior marginal setae short or medium in size. Caudal furrow short, less than twice length of vasiform orifice. Vasiform orifice subcordate (Fig. 20.4).

Field appearance: Pupae usually yellowish. Elliptical-elongate, averaging 0.72 mm in length and 0.39 mm in width (Plate IX b). Elevated from substratum with marginal fringe of thin, glassy, wax curls (Plate IX c). Numerous pupae can be found under leaves of hosts.

Adults: Body usually yellowish, averaging 0.81 mm long. Wings usually pale whitish, almost parallel-sided, slightly tapered at base. Wings not held completely flat over the abdomen at rest (Plate IX d).

Hosts: Manihot esculenta, Carica papaya.

Natural enemies: Encarsia tabacivora, Eretmocerus californicus.

Economic importance: Found in Central America and Colombia. One of the three economically important species feeding in cassava. Associated with virus transmission in cassava in Colombia. Common in papaya where it frequently occurs at high density. Pest category: B.

Additional references: Russell (1948).

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Table 4. Whitefly species collected in Central America and Colombia.

<u>Aleurocanthus woglumi</u>	Ashby
<u>Aleurodicus cocois</u>	(Curtis)
<u>Aleurodicus dispersus</u>	Russell
<u>Aleurodicus dugesii</u>	Cockerell
<u>Aleurodicus linguosus</u>	Bondar
<u>Aleuroglandulus malangae</u>	Russell
<u>Aleuroplatus</u>	sp.
<u>Aleurothrixus floccosus</u>	(Maskell)
<u>Aleurotrachelus cacaorum</u>	Bondar
<u>Aleurotrachelus sociales</u>	Bondar
<u>Bemisia tabaci</u>	(Gennadius)
<u>Bemisia tuberculata</u>	Bondar
<u>Ceraleurodicus altissimus</u>	(Quaintance)
<u>Ceraleurodicus ingae</u>	(Baker)
<u>Dialeurodes citri</u>	(Ashmead)
<u>Dialeurodes citrifolii</u>	(Morgan)
<u>Dialeurodicus</u>	sp.
<u>Lecanoideus giganteus</u>	(Quaintance and Baker)
<u>Leonardius lahillei</u>	(Leonardi)
<u>Paraleyrodes</u>	sp.
<u>Tetraleurodes acaciae</u>	(Quaintance)
<u>Tetraleurodes mori</u>	(Quaintance)
<u>Trialeurodes abutiloneus</u>	(Haldeman)
<u>Trialeurodes floridensis</u>	(Quaintance)
<u>Trialeurodes vaporariorum</u>	(Westwood)
<u>Trialeurodes variabilis</u>	(Quaintance)
Undescribed species 1	(Aleurodicinae)
Undescribed species 2	(Aleurodicinae)
Undescribed species 3	(Aleurodicinae)
Undescribed species 4	(Aleurodicinae)

Table 5. Hosts and distribution of whitefly aphelinid parasitoids (HYMENOPTERA: Aphelinidae) from Central America and Colombia.

<u>Ref</u>	<u>SPECIES</u>	<u>HOST</u>	<u>DISTRIBUTION</u>
076	<u>Encarsia americana</u>	Aleyrodinae	Colombia
	<u>Encarsia formosa</u>	No data	Colombia
231	<u>Encarsia formosa</u>	<u>Paraleyrodes</u> sp.	Nicaragua
212	<u>Encarsia hispida</u>	<u>Aleuroglandulus</u> sp.	Honduras
030	<u>Encarsia tabacibora</u>	<u>T. vaporariorum</u>	Colombia
092	<u>Encarsia tabacibora</u>	<u>T. variabilis</u>	Colombia
112	<u>Encarsia tabacibora</u>	<u>T. variabilis</u>	Colombia
195	<u>Encarsia tabacibora</u>	<u>B. tabaci</u>	Honduras
359	<u>Encarsia</u> sp.	<u>A. cocois</u>	Honduras
102	<u>Encarsia</u> sp. A	<u>A. malangae</u>	Colombia
108	<u>Encarsia</u> sp. A	<u>D. citrifolii</u>	Colombia
055	<u>Encarsia</u> sp. B	Aleurodicinae	Colombia
	<u>Encarsia</u> sp. C	No data	Colombia
081	<u>Encarsia</u> sp. D	<u>Aleurothrixus</u> sp.	Colombia
222	<u>Encarsia</u> sp. 1	<u>Dialeurodicus</u> sp.	Honduras
222	<u>Encarsia</u> sp. 2	<u>Dialeurodicus</u> sp.	Honduras
084	<u>Dirphys</u> sp.	<u>L. giganteus</u>	Colombia
130	<u>Dirphys</u> sp.	<u>L. lahillei</u>	Colombia
147	<u>Dirphys</u> sp.	<u>A. cocois</u>	Nicaragua
219	<u>Dirphys</u> sp.	<u>A. dugesii</u>	Honduras
224	<u>Dirphys</u> sp.	<u>A. dugesii</u>	Honduras
359	<u>Dirphys</u> sp.	<u>A. cocois</u>	Honduras
092	<u>Eretmocerus californicus</u>	<u>T. variabilis</u>	Colombia
213	<u>Eretmocerus californicus</u>	<u>A. floccosus</u>	Honduras
012	<u>Eretmocerus</u> sp.	<u>Aleurothrixus</u> sp.	Colombia
090	<u>Eretmocerus</u> sp.	Undetermined	Colombia
091	<u>Eretmocerus</u> sp.	<u>Tetraleurodes</u> sp.	Colombia

Table 6. Hosts and distribution of whitefly eulophid and platygastroid parasitoids (HYMENOPTERA: Eulophidae and Platygastriidae) from Central America and Colombia.

<u>Ref</u>	<u>SPECIES</u>	<u>HOST</u>	<u>DISTRIBUTION</u>
EULOPHIDAE:			
013	<u>Euderomphale</u> sp.	<u>C. altissimus</u>	Colombia
359	<u>Euderomphale</u> sp. 1	<u>A. cocois</u>	Honduras
373	<u>Euderomphale</u> sp. 2	<u>C. altissimus</u>	Honduras
PLATYGASTRIDAE:			
011	<u>Amitus</u> sp.	Undetermined	Colombia
036	<u>Amitus</u> sp.	<u>A. malangae</u>	Colombia
047	<u>Amitus</u> sp.	<u>T. vaporariorum</u>	Colombia
106	<u>Amitus</u> sp.	Undetermined	Colombia
122	<u>Amitus</u> sp.	<u>T. vaporariorum</u>	Colombia
231	<u>Amitus</u> sp.	<u>Paraleyrodes</u> sp.	Nicaragua
315	<u>Amitus</u> sp.	<u>T. vaporariorum</u>	Guatemala

Table 7. Hosts and distribution of whitefly predators from Central America and Colombia.

Ref	SPECIES	HOST	DISTRIBUTION
HEMIPTERA: Lygaeidae			
174	<u>Geocoris</u> sp.	<u>B. tabaci</u>	Honduras
HEMIPTERA: Miridae			
275	Undetermined	<u>B. tabaci</u>	Dom. Rep.
NEUROPTERA: Mantispidae			
212	Undetermined	<u>Aleuroglandulus</u> sp.	Honduras
NEUROPTERA: Chrysopidae			
040	Undetermined	<u>Aleurodicus</u> sp.	Colombia
076	<u>Chrysoperla externa</u>	Aleyrodinae	Colombia
084	<u>Chrysoperla externa</u>	<u>L. giganteus</u>	Colombia
COLEOPTERA: Coccinellidae			
076	<u>Cycloneda sanguinea</u>	Aleyrodinae	Colombia
076	<u>Delphastus</u> sp.	Aleyrodinae	Colombia
112	<u>Delphastus</u> sp.	<u>A. malangae</u>	Colombia
147	<u>Nephaspis</u> sp.	<u>A. cocois</u>	Nicaragua
076	<u>Olla v-nigrum</u>	Aleyrodinae	Colombia
005	<u>Scymnus</u> sp.	<u>D. citrifolii</u>	Colombia
181	Undetermined	<u>D. citri</u>	Honduras
241	Undetermined	<u>B. tuberculata</u>	Nicaragua
DIPTERA: Syrphidae			
076	<u>Allograpta</u> sp.	Aleyrodinae	Colombia
114	<u>Toxomerus</u> sp.	Aleyrodinae	Colombia

Table 8. Collecting and mounting whitefly records from Central America and Colombia.

<u>COUNTRY</u>	<u>SAMPLES</u>		<u>SLIDE-MOUNTED</u>	
	<u>COLLECTED</u>	<u>MOUNTED</u>	<u>PUPAE</u>	<u>ADULTS</u>
Belize	11	8	7	16
Guatemala	62	41	88	6
El Salvador	42	42	74	7
Honduras	92	89	187	59
Nicaragua	71	55	144	13
Costa Rica	4	4	6	5
D. Republic	6	6	10	10
Colombia	132	82	183	39
Ecuador	1	1	3	0
Bolivia	2	2	5	0
TOTAL:	425	331	707	+ 155 = 862

Table 9. Economic important category bases for classification of whiteflies from Central America and Colombia.

<u>CAT.</u>	<u>PEST STATUS</u>	<u>CONTROL</u>	<u>DENSITY</u>	<u>HOSTS</u>	<u>CONTRIES</u>	<u>#SP.</u>
A	Key	Usually	High	Many	Many	2
B	Important	Occasional	Medium	Some	Some	5
C	Sporadic	Rarely	Low	Some	Some	7
D	Potential	None	Low	Some	Some	11
F	Innocuous	None	Lowest	One	One	5
						30

Table 10. Economic important classification of Aleurodicinae whiteflies collected in Central America and Colombia

<u>SPECIES</u>	<u>CATEGORY</u>				
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>F</u>
<u>Aleurodicus cocois</u>			X*		
<u>Aleurodicus dispersus</u>					X
<u>Aleurodicus dugesii</u>			X		
<u>Aleurodicus linguosus</u>			X		
<u>Ceraleurodicus altissimus</u>				X	
<u>Ceraleurodicus ingae</u>					X
<u>Dialeurodicus</u> sp.				X	
<u>Lecanoideus giganteus</u>				X**	
<u>Leonardius lahillei</u>					X
<u>Paraleyrodes</u> sp.				X	
Undescribed species 1				X	
Undescribed species 2					X
Undescribed species 3					X
Undescribed species 4					X

* Close to category B.

** Close to category C.

Table 11. Economic important classification of Aleyrodinae whiteflies collected in Central America and Colombia.

SPECIES	CATEGORY				
	A	B	C	D	F
<u>Aleurocanthus woglumi</u>		X			
<u>Aleuroglandulus malangae</u>			X		
<u>Aleuroplatus</u> sp.				X	
<u>Aleurothrixus floccosus</u>			X		
<u>Aleurotrachelus cacaorum</u>				X	
<u>Aleurotrachelus sociales</u>		X			
<u>Bemisia tabaci</u>	X				
<u>Bemisia tuberculata</u>		X			
<u>Dialeurodes citri</u>				X	
<u>Dialeurodes citrifolii</u>			X		
<u>Tetraleurodes acaciae</u>			X		
<u>Tetraleurodes mori</u>				X	
<u>Trialeurodes abutiloneus</u>		X			
<u>Trialeurodes floridensis</u>				X	
<u>Trialeurodes vaporariorum</u>	X				
<u>Trialeurodes variabilis</u>		X			

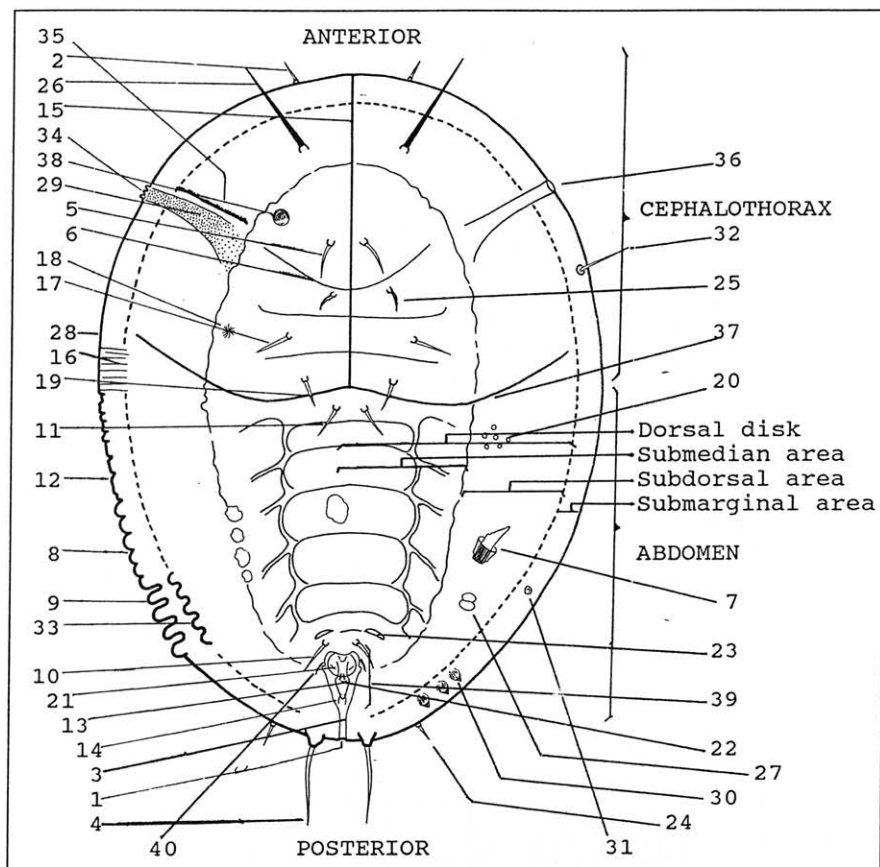


Fig. B: GENERAL MORPHOLOGY OF AN ALEYRODIDAE (dorsal view):
 1. Abdominal tracheal pore; 2. Anterior marginal seta; 3. Caudal furrow; 4. Caudal seta; 5. Cephalic seta; 6. Cephalothoracic suture; 7. Compound pore; 8. Crenulate margin; 9. Dentate margin; 10. Eight abdominal seta; 11. First abdominal seta; 12. Indentate margin; 13. Lingula; 14. Lingular seta; 15. Longitudinal molting suture; 16. Marginal lines; 17. Mesothoracic seta; 18. Metathoracic depression; 19. Metathoracic seta; 20. Minute simple pore; 21. Operculum; 22. Opercular seta; 23. Pocket; 24. Posterior marginal seta; 25. Prothoracic seta; 26. Sclerotized spine; 27. Septate pore; 28. Smooth margin; 29. Spinules; 30. Submarginal papilla; 31. Submarginal pore; 32. Submarginal seta; 33. Submarginal teeth; 34. Thoracic tracheal comb; 35. Thoracic tracheal fold; 36. Thoracic tracheal pore; 37. Transverse molting suture; 38. Tubercle; 39. Vasiform orifice; 40. Ventral abdominal seta.

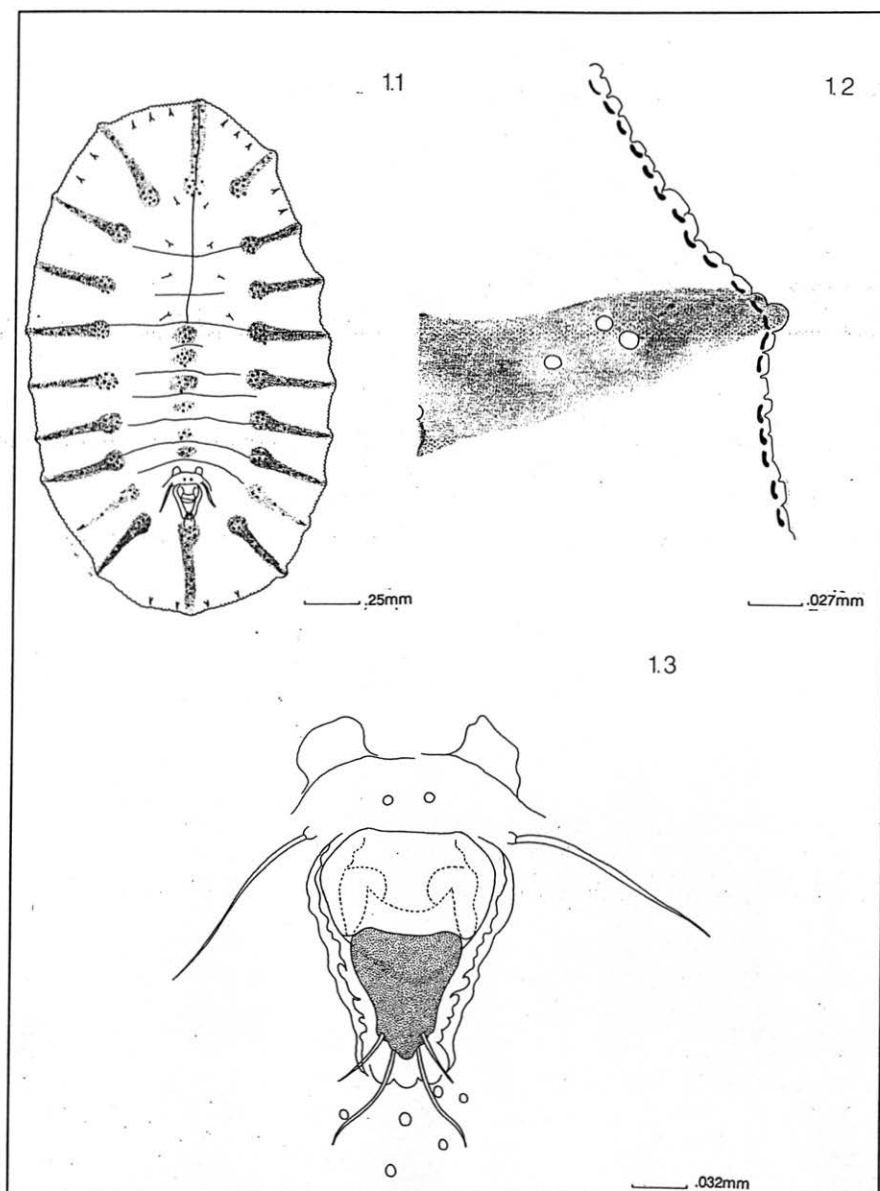


Fig. 1: *Dialeurodicus* sp.
 1.1. Pupal case; 1.2. Margin of pupal case;
 1.3. Vasiiform orifice.

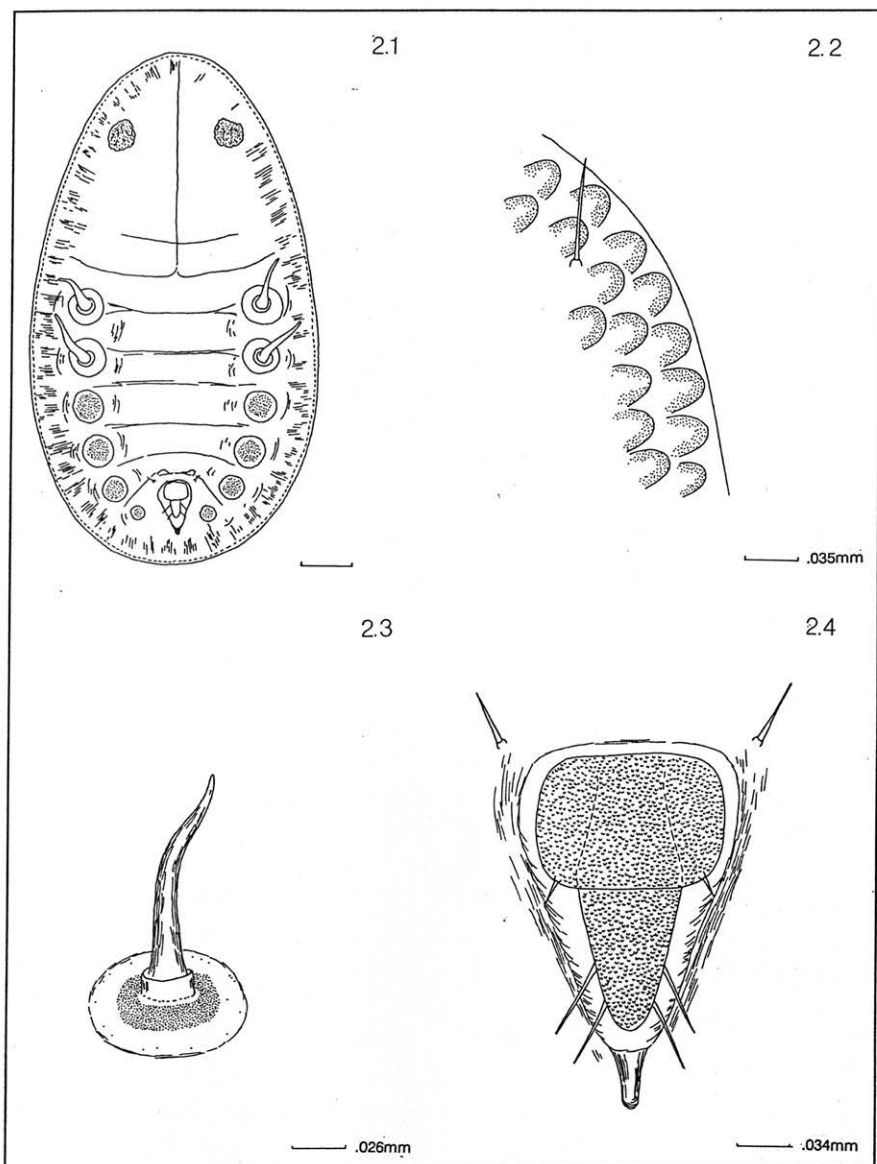


Fig. 2: *Leonardius lahillei* (Leonardi)
 2.1. Pupal case; 2.2. Margin of pupal case;
 2.3. Compound pore; 2.4. Vasiform orifice.
 (After Quaintance and Baker 1913).

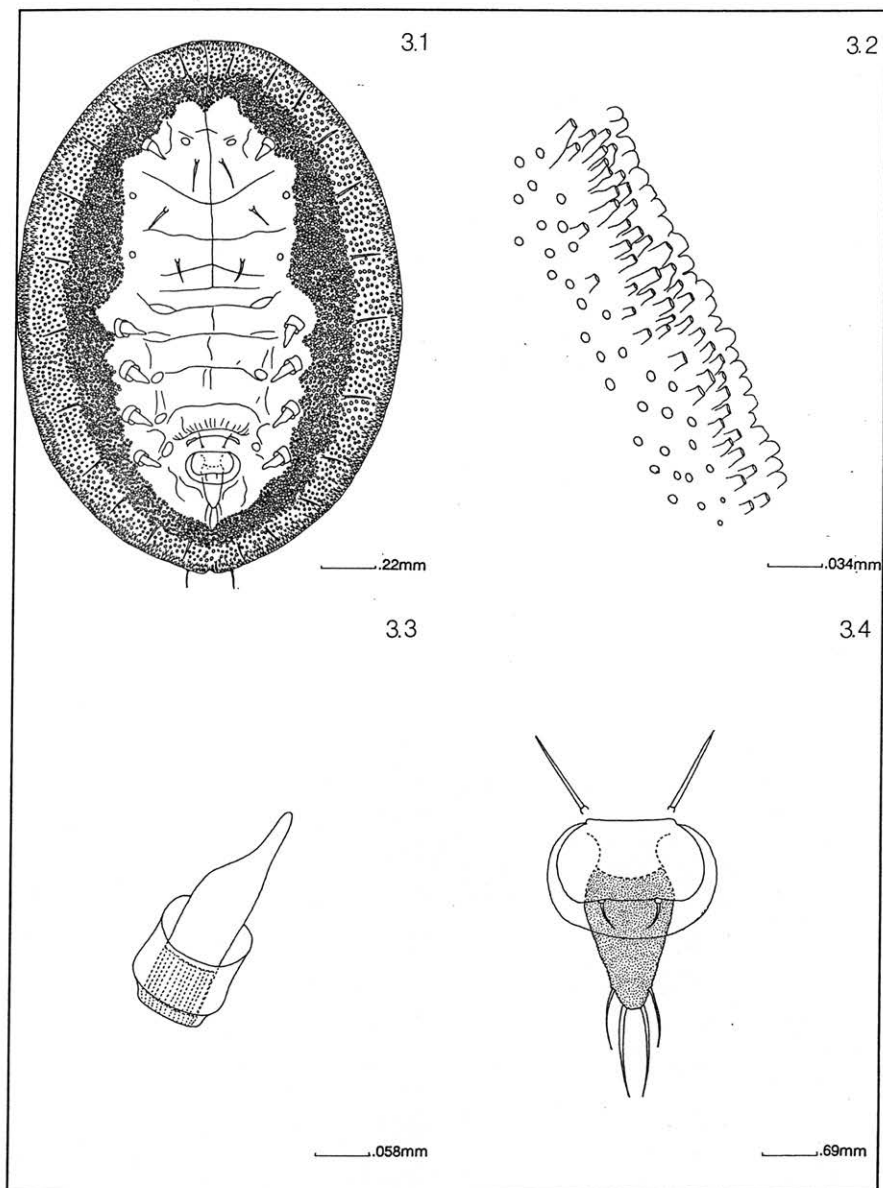


Fig. 3: *Lecanoideus giganteus* (Quaintance & Baker)
 3.1. Pupal case; 3.2. Margin of pupal case;
 3.3. Compound pore; 3.4. Vasiform orifice.

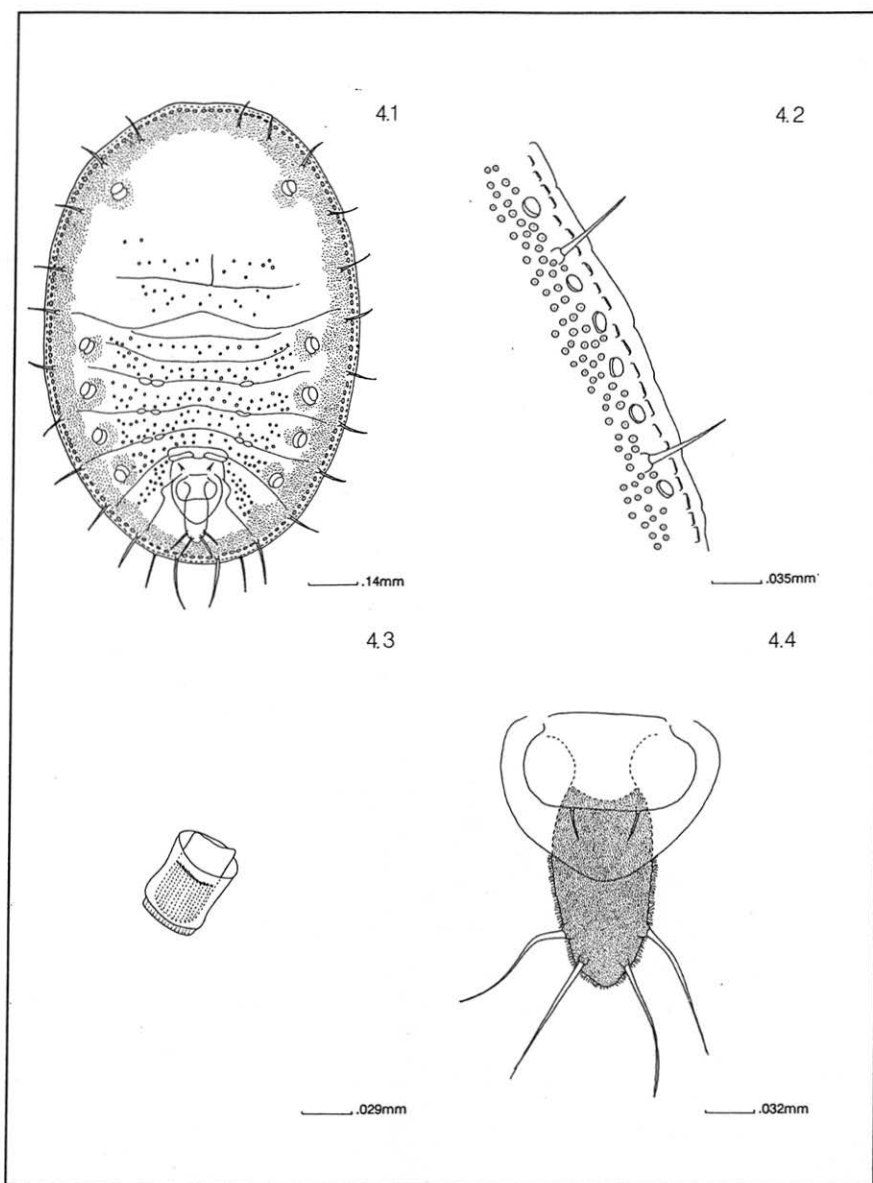


Fig. 4: *Aleurodicus dispersus* Russell
 4.1. Pupal case; 4.2. Margin of pupal case;
 4.3. Compound pore; 4.4. Vasiform orifice.

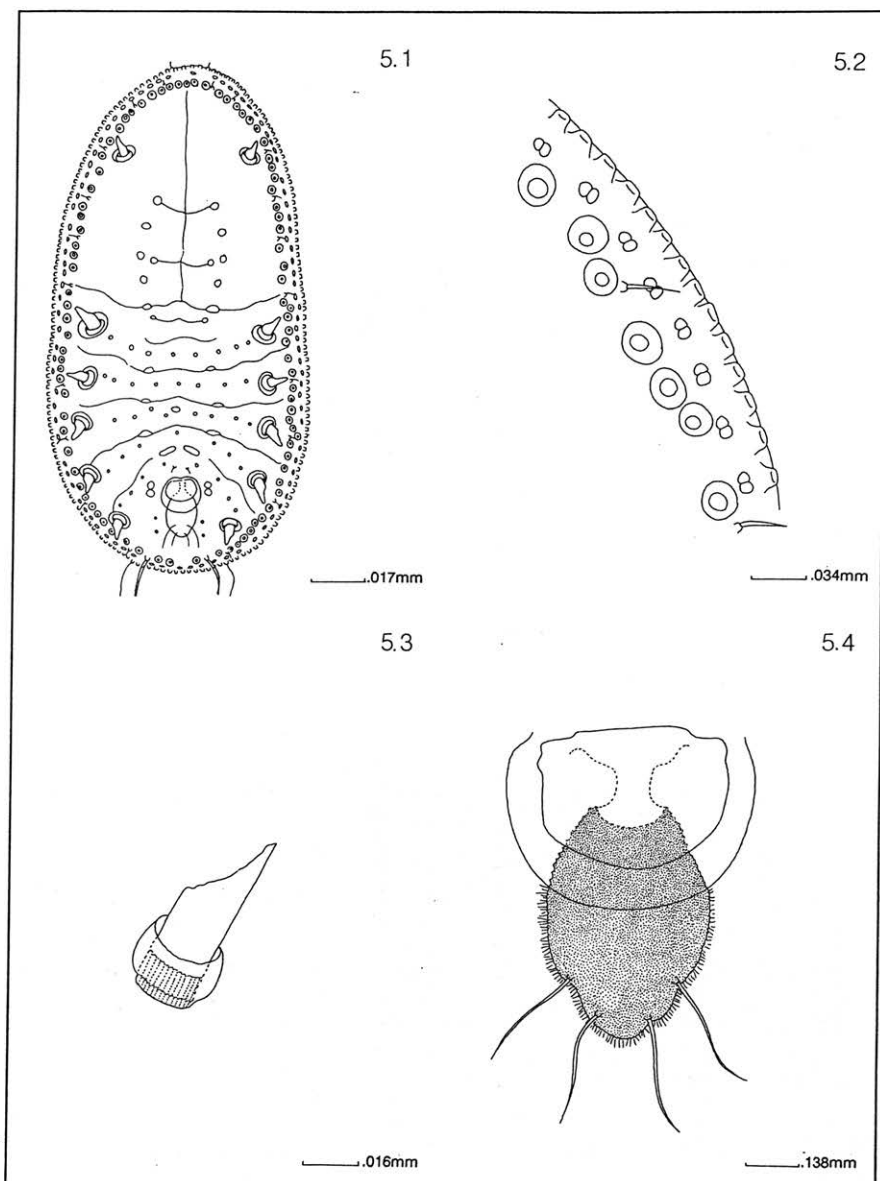


Fig. 5: Undescribed species #1
 5.1. Pupal case; 5.2. Margin of pupal case;
 5.3. Compound pore; 5.4. Vasiform orifice.

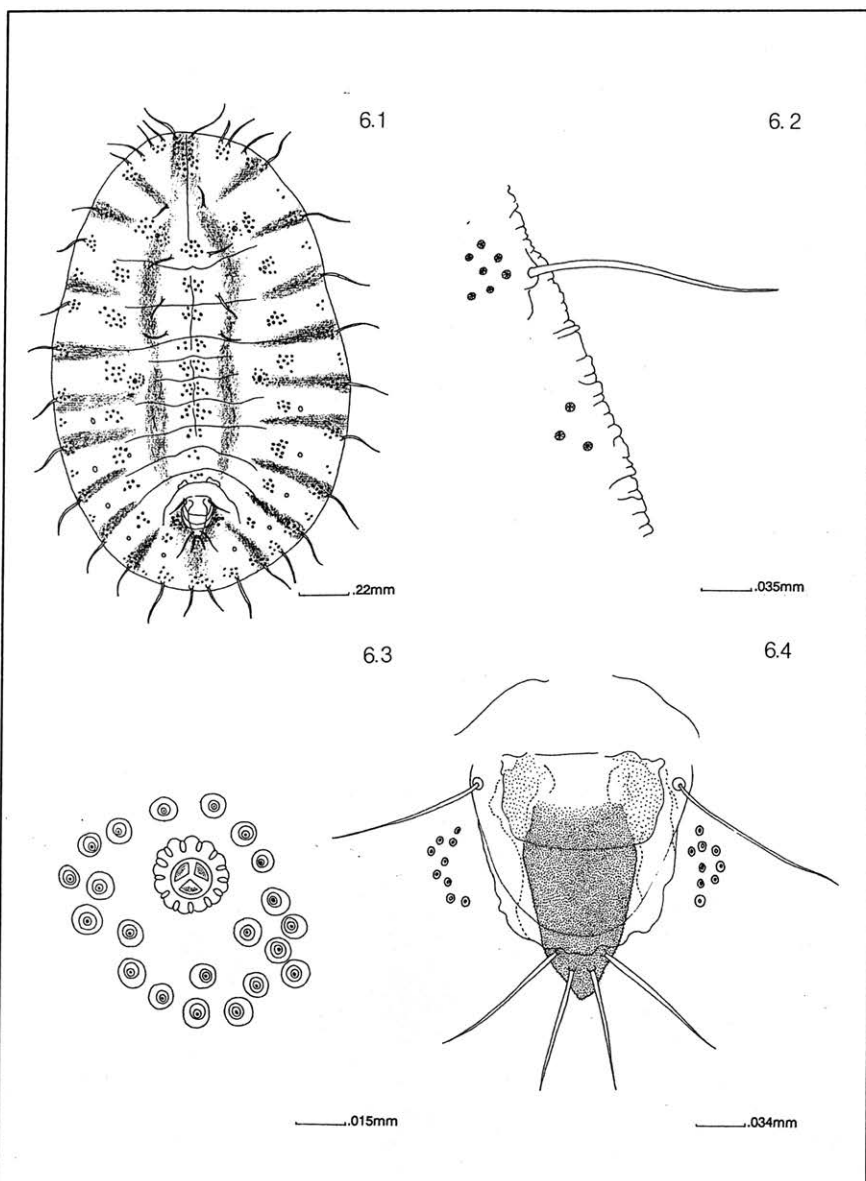


Fig. 6: *Ceraleurodicus altissimus* (Quaintance)
 6.1. Pupal case; 6.2. Margin of pupal case;
 6.3. Stellate structure; 6.4. Vasiform orifice.

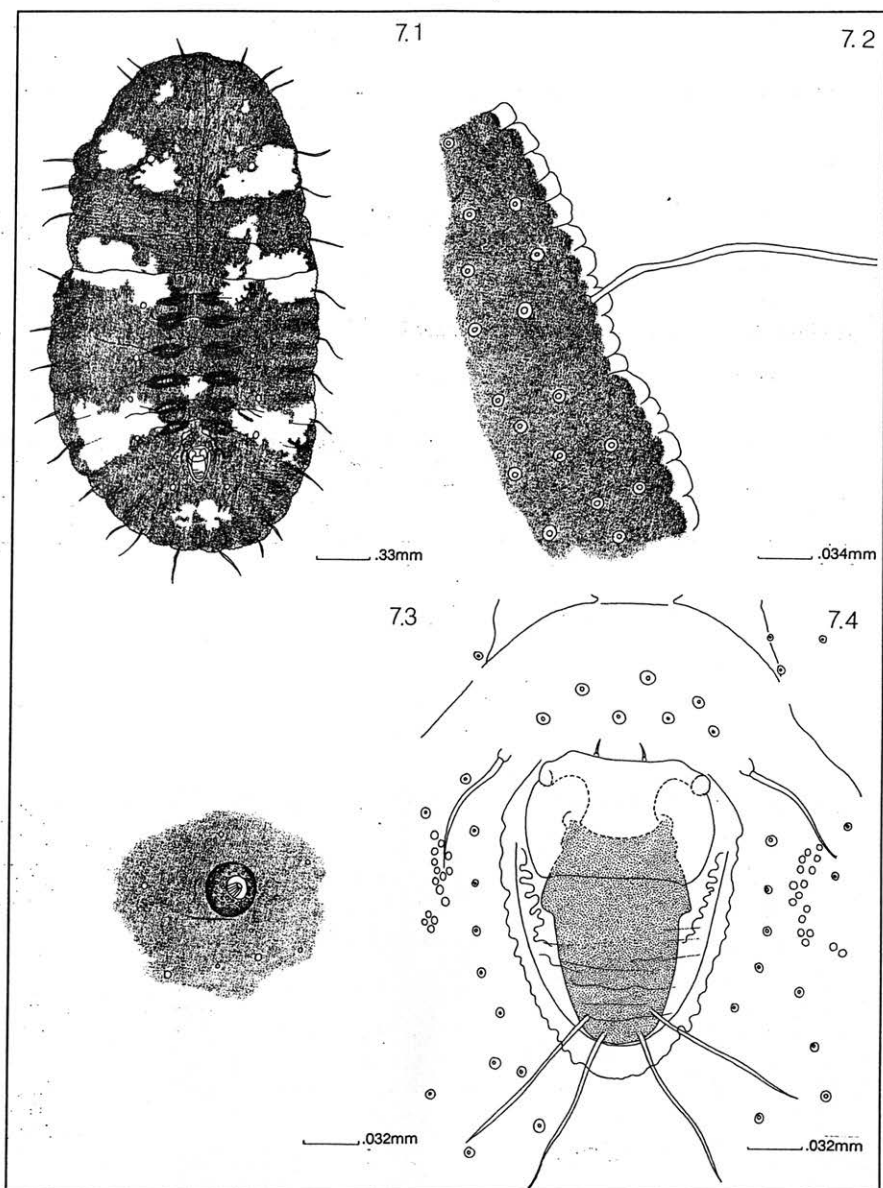


Fig. 7: *Ceraleurodicus ingae* (Baker)
 7.1. Pupal case; 7.2. Margin of pupal case;
 7.3. Compound pore; 7.4. Vasiform orifice.

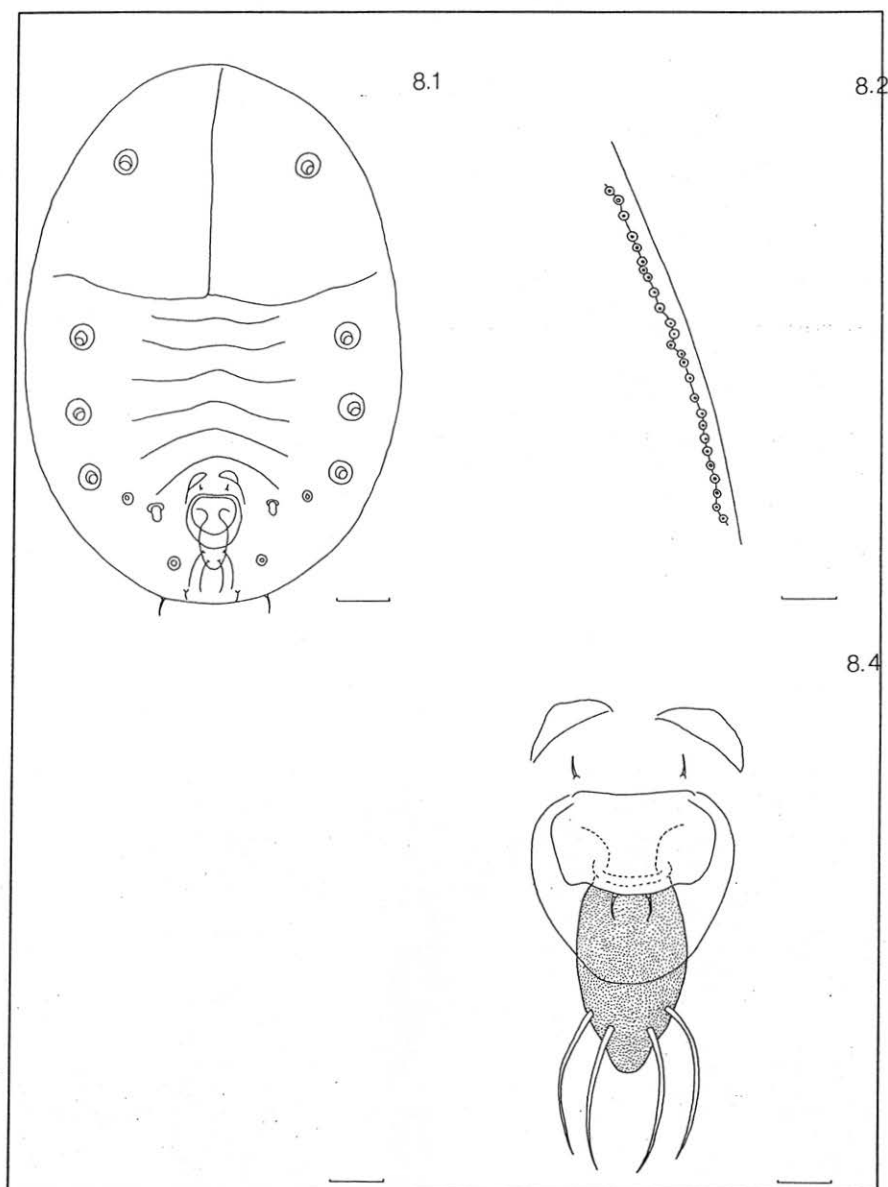


Fig. 8: Undescribed species #2
 8.1. Pupal case; 8.2. Margin of pupal case;
 8.4. Vasiform orifice.

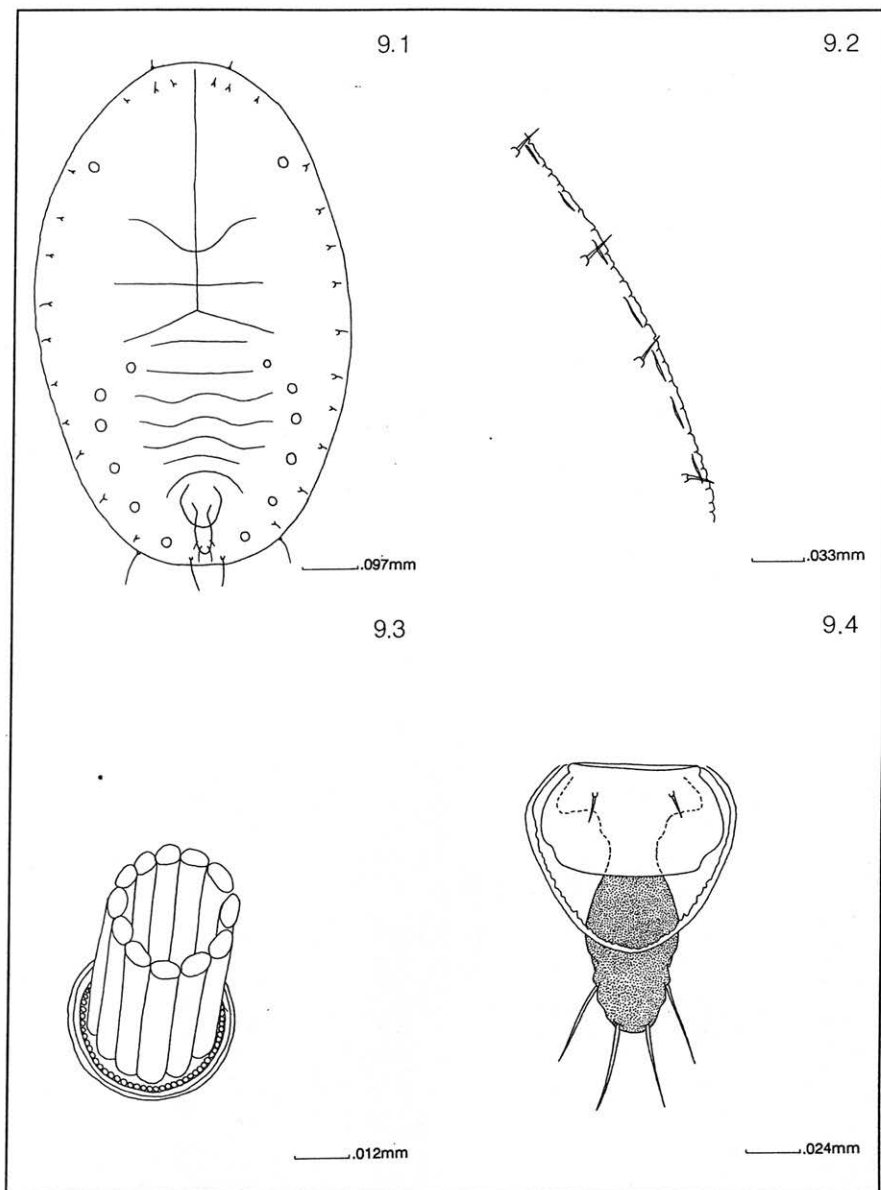


Fig. 9: *Paraleyrodes* sp.
 9.1. Pupal case; 9.2. Margin of pupal case;
 9.3. Compound pore; 9.4. Vasiform orifice.

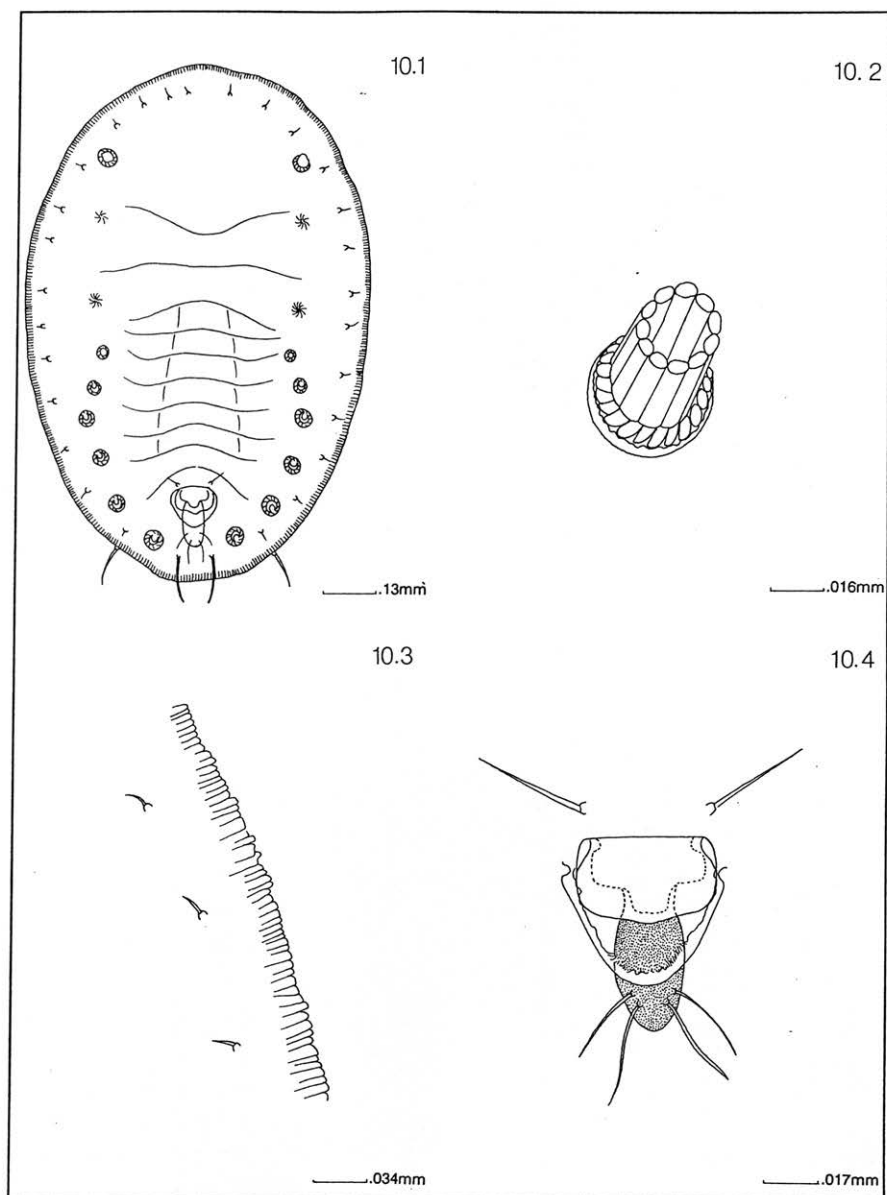


Fig. 10: Undescribed species #3

10.1. Pupal case; 10.2. Compound pore;

10.3. Margin of pupal case; 10.4. Vasiform orifice

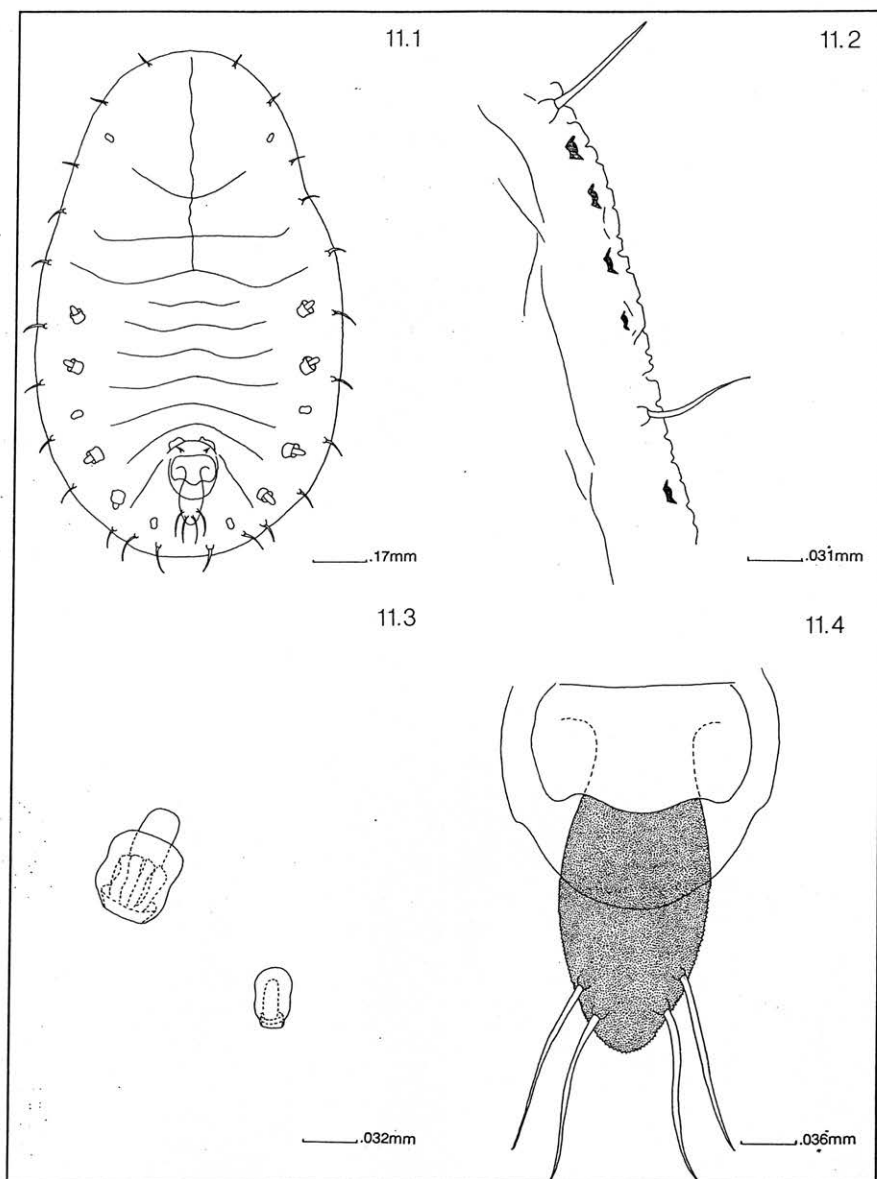


Fig. 11: Undescribed species #4

11.1. Pupal case; 11.2. Margin of pupal case;
 11.3. Compound pore; 11.4. Vasiiform orifice.

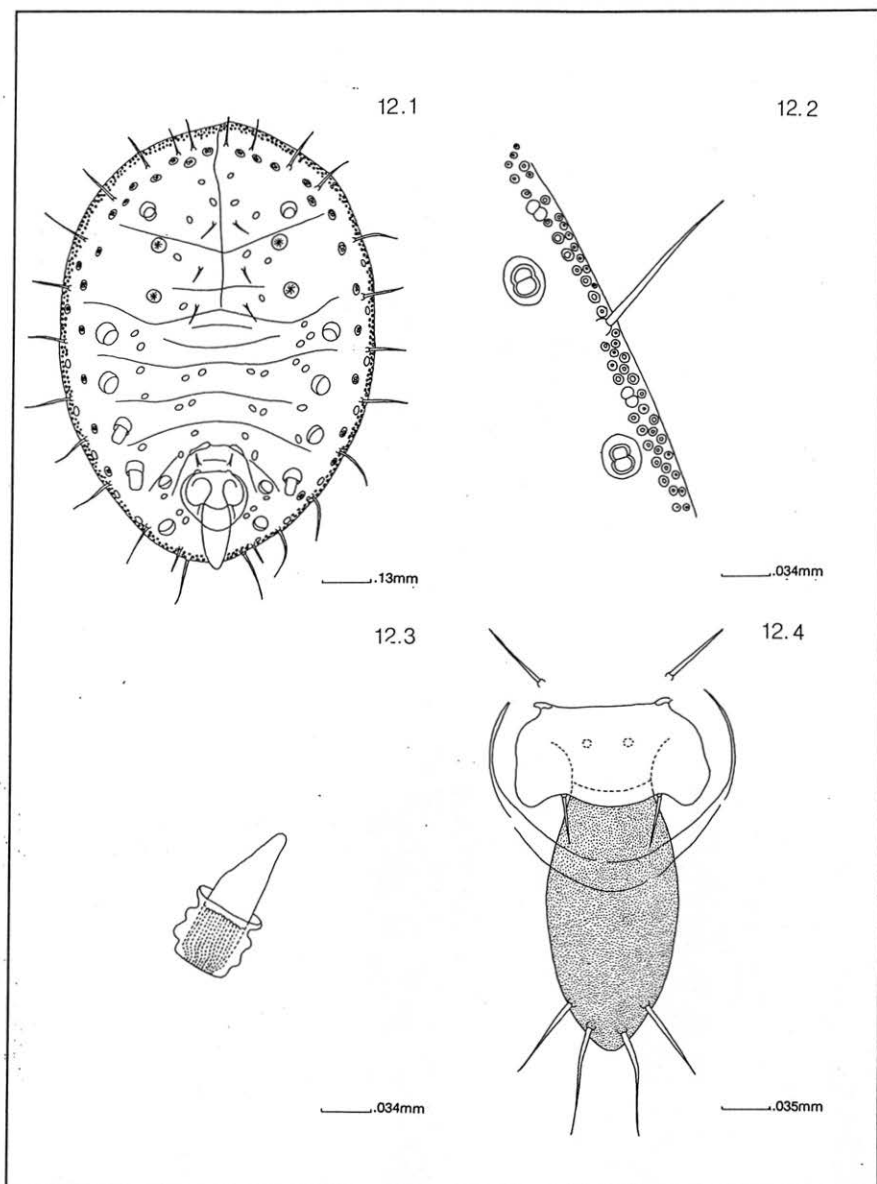


Fig. 12: *Aleurodicus linguosus* Bondar
 12.1. Pupal case; 12.2. Margin of pupal case;
 12.3. Compound pore; 12.4. Vasiiform orifice.

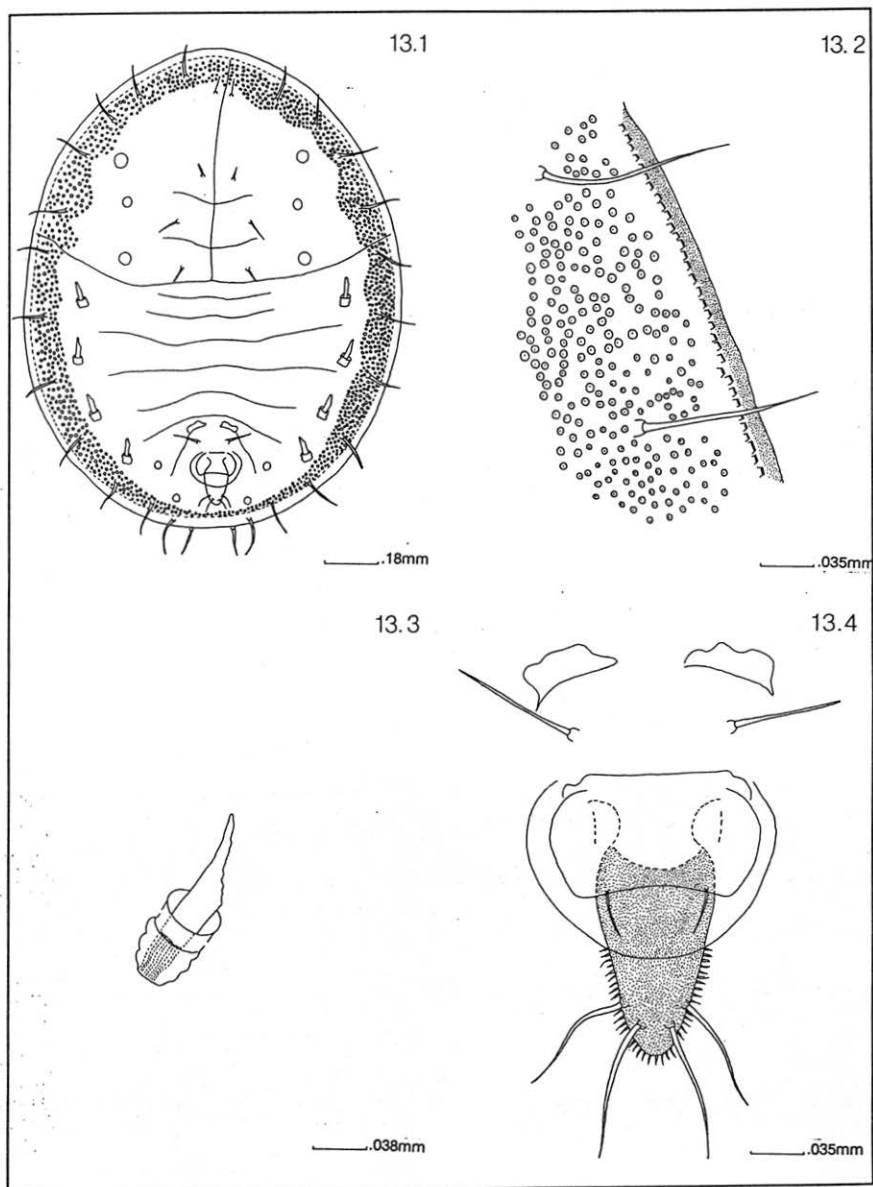


Fig. 13: *Aleurodicus cocois* (Curtis)
 13.1. Pupal case; 13.2. Margin of pupal case;
 13.3. Compound pore; 13.4. Vasisform orifice.

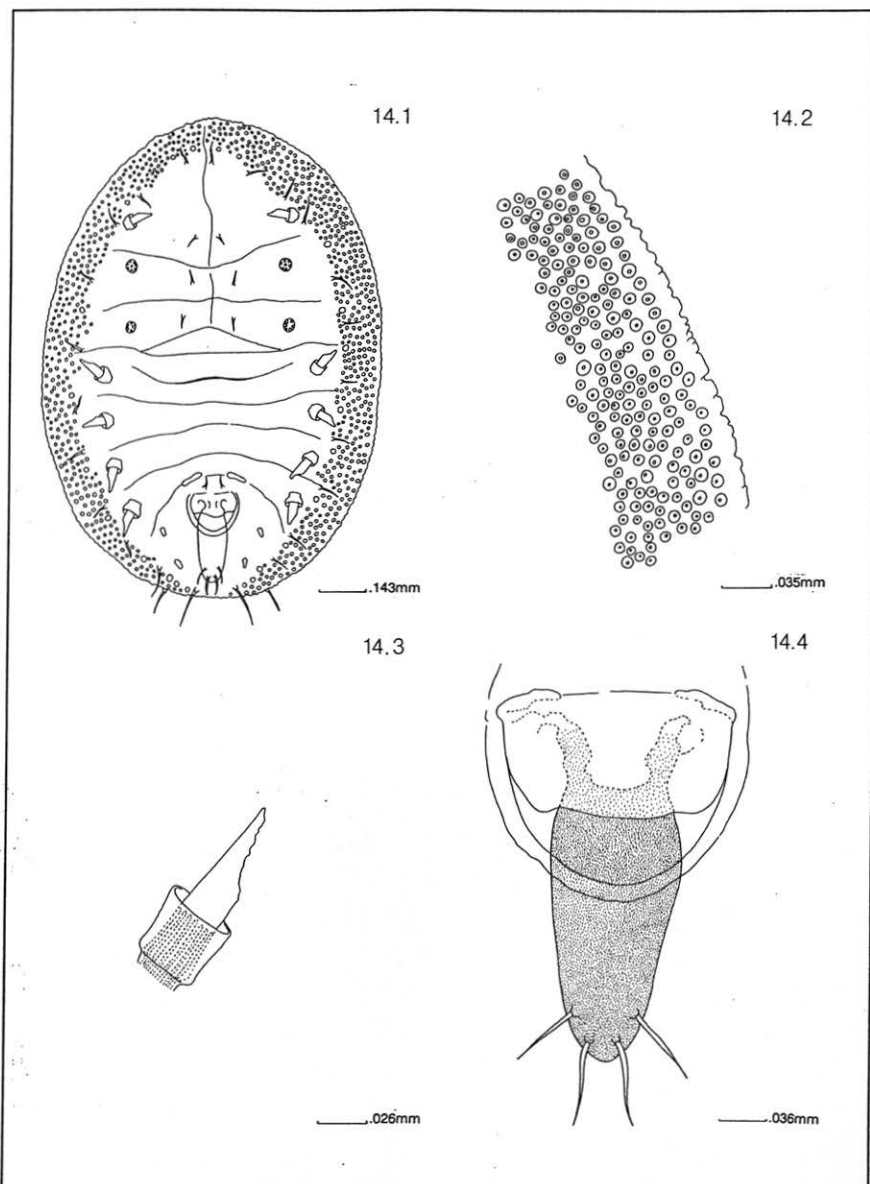


Fig. 14: *Aleurodicus dugesii* Cockerell
 14.1. Pupal case; 14.2. Margin of pupal case;
 14.3. Compound pore; 14.4. Vasiiform orifice.

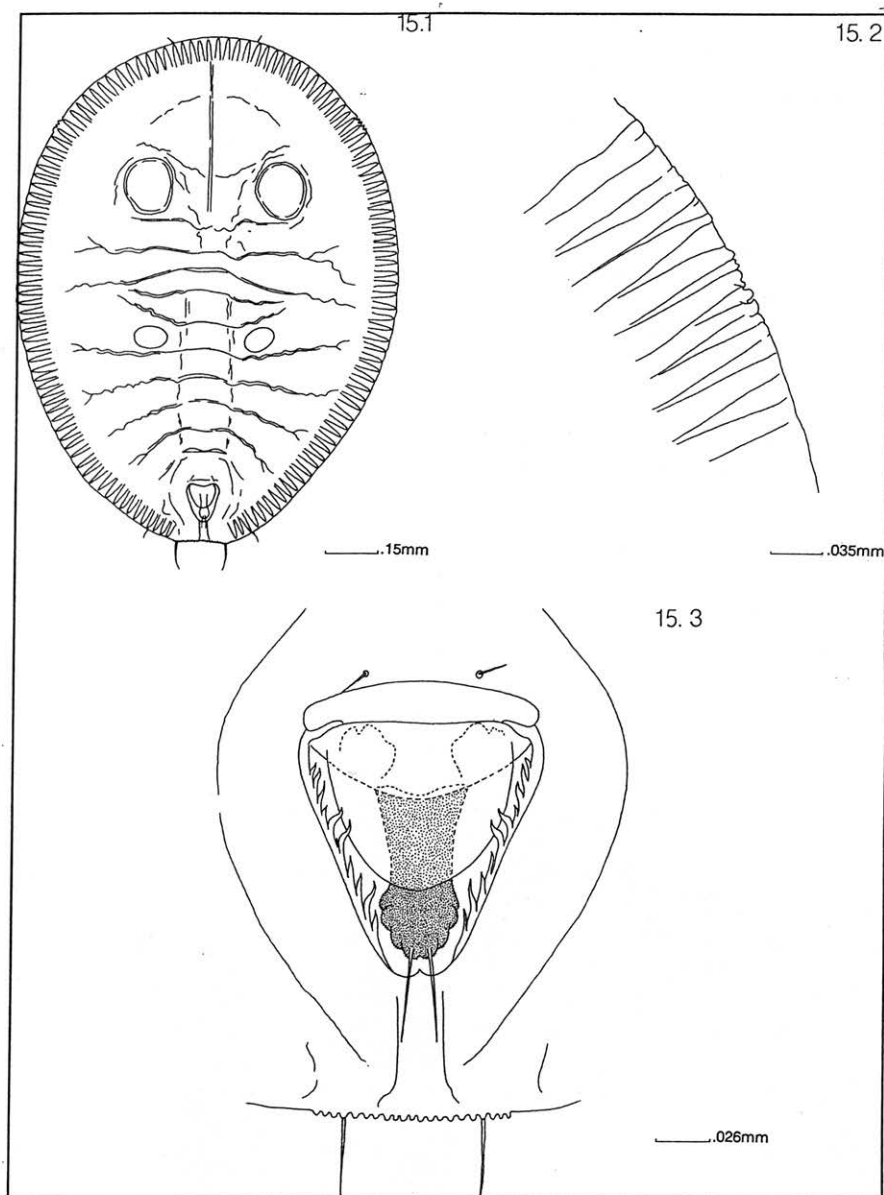


Fig. 15: *Aleuroglandulus malangae* Russell
 15.1. Pupal case; 15.2. Margin of pupal case at
 thoracic tracheal opening; 15.3. Vasiform orifice.

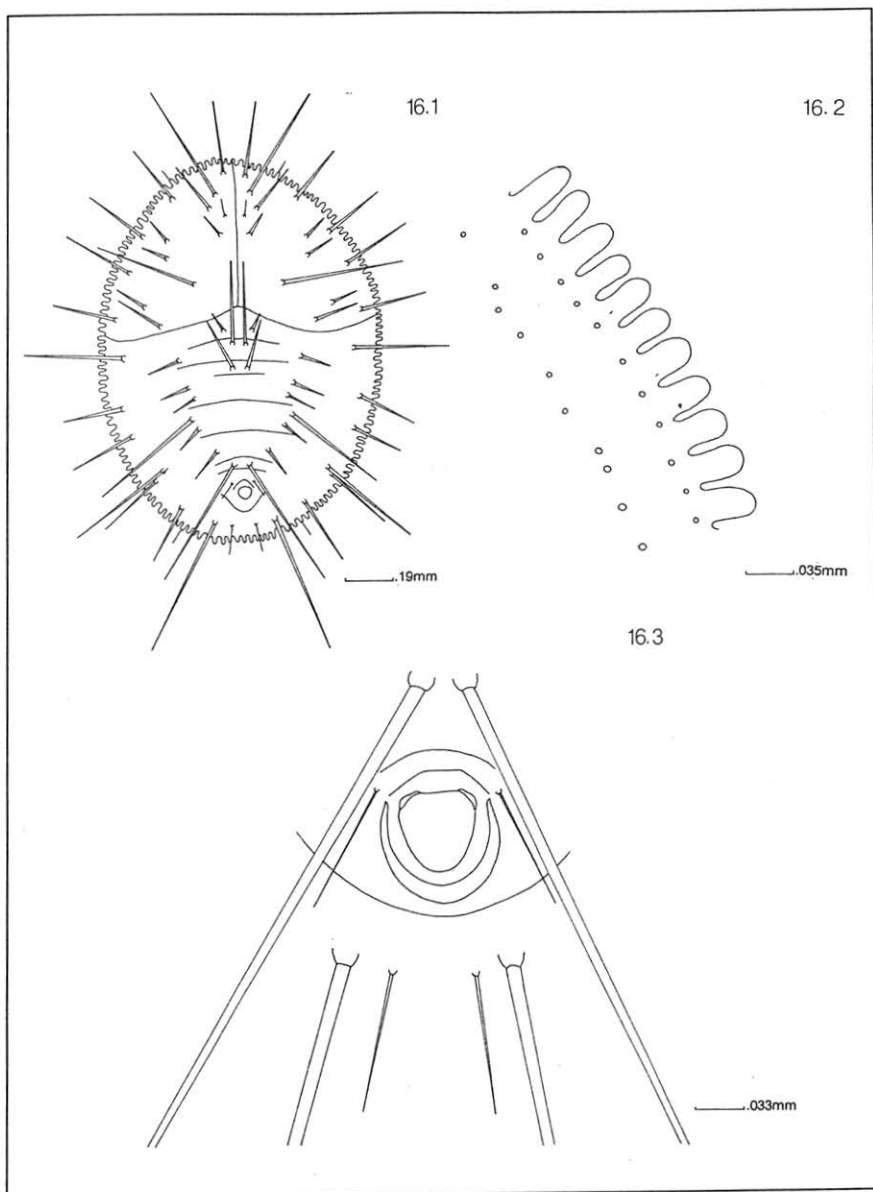


Fig. 16: *Aleurocanthus woglumi* Ashby
 16.1. Pupal case; 16.2. Margin of pupal case;
 16.3. Vasiform orifice.

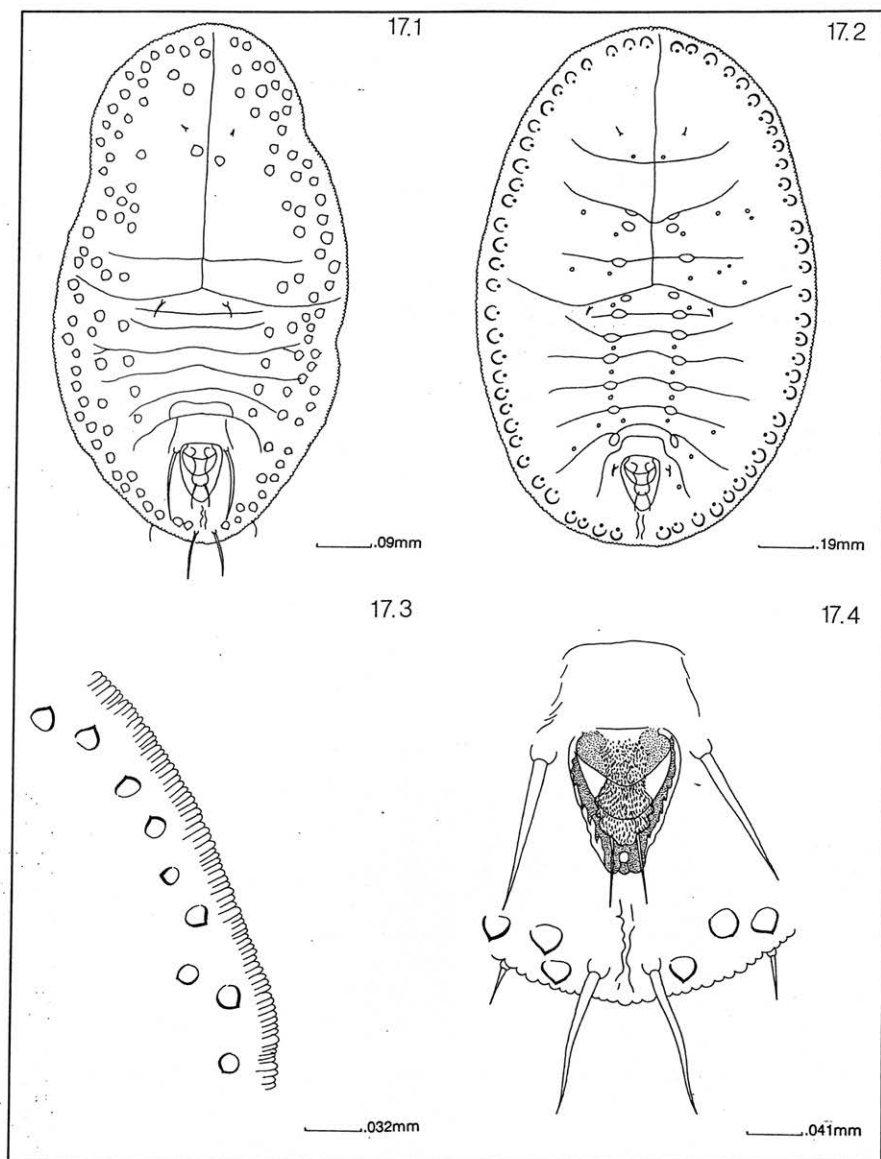


Fig. 17: *Trialeurodes abutiloneus* (Haldeman)
 17.1. Pupal case on hairy leaf; 17.2. Pupal case on glabrous leaf; 17.3. Margin of pupal case; 17.4. Vasiiform orifice.

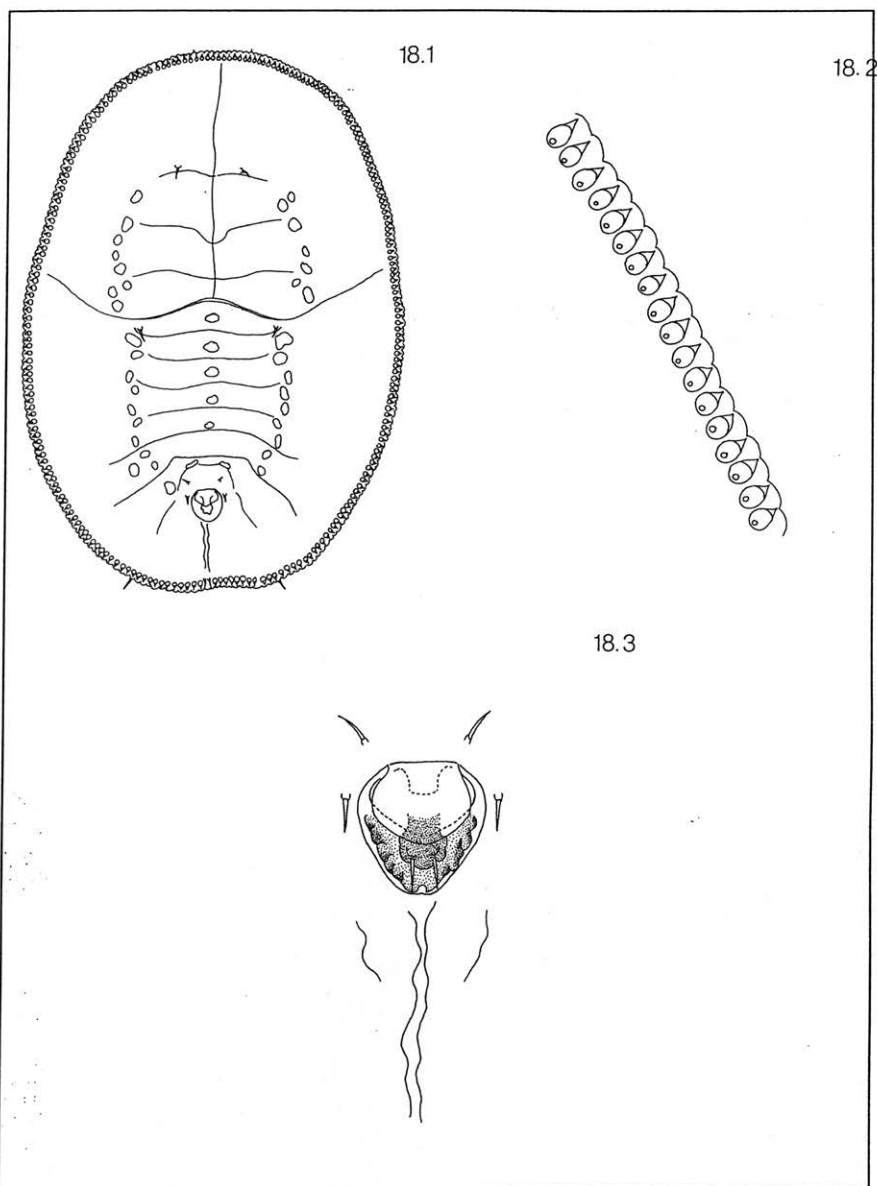


Fig. 18: *Trialeurodes floridensis* (Quaintance)
 18.1. Pupal case; 18.2. Margin of pupal case;
 18.3. Vasiform orifice.

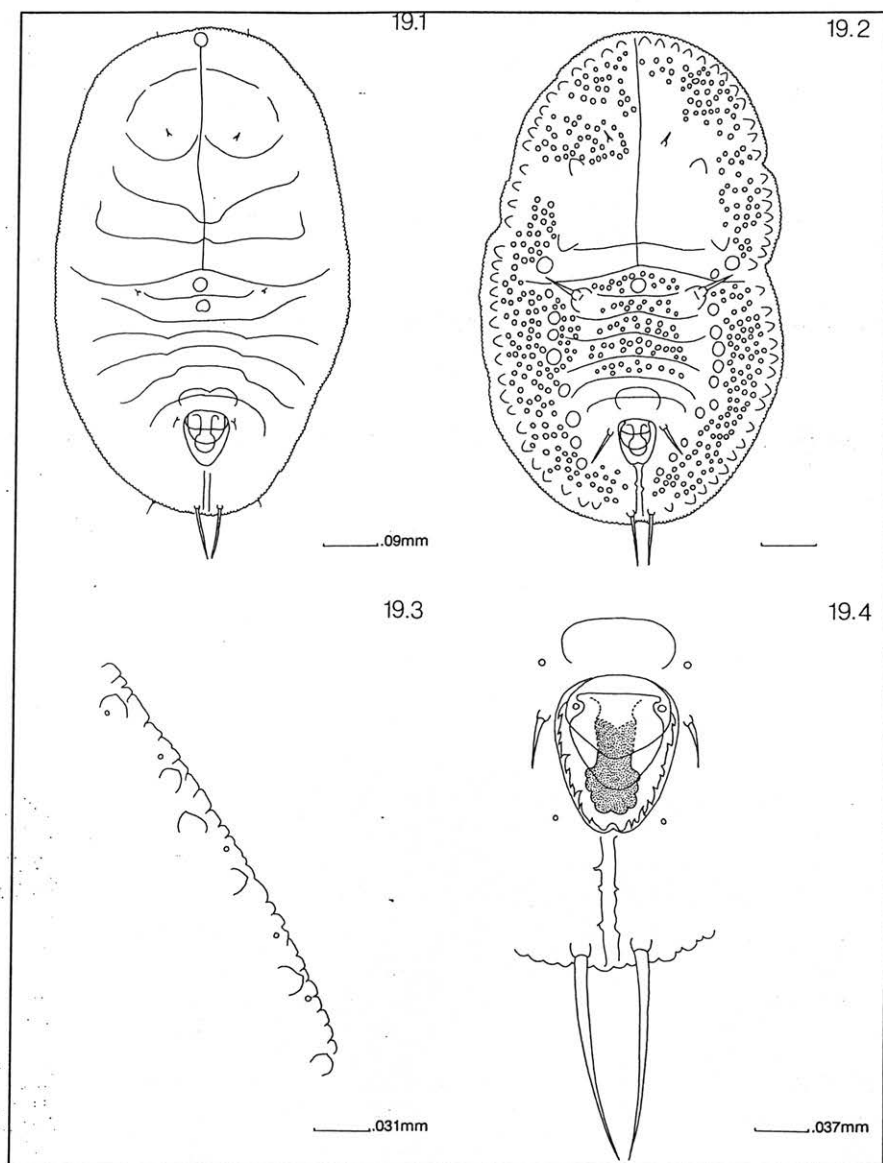


Fig. 19: *Trialeurodes variabilis* (Quaintance)
 19.1. Pupal case on glabrous leaf; 19.2. Pupal case on hairy leaf; 19.3. Margin of pupal case; 19.4. Vasiiform orifice.

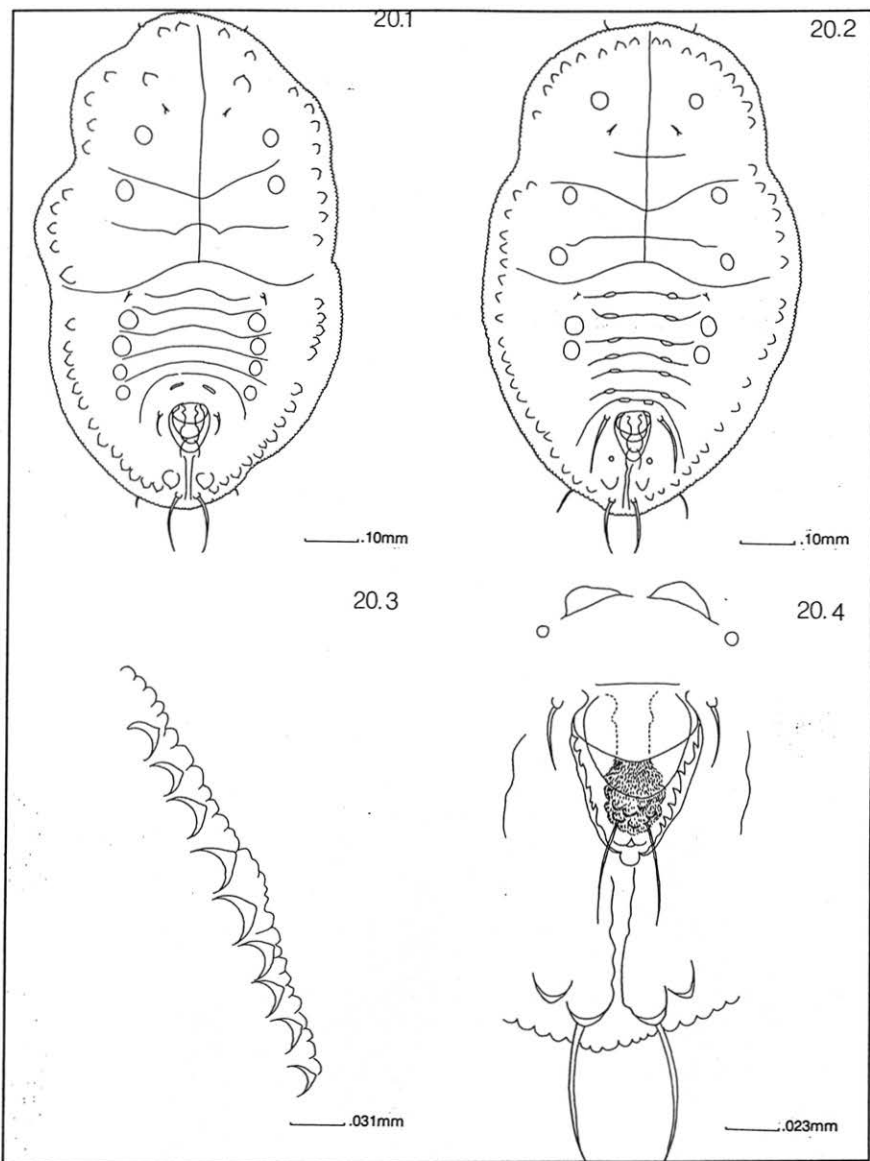


Fig. 20: *Trialeurodes vaporariorum* (Westwood)
 20.1. Pupal case on hairy leaf; 20.2. Pupal case on glabrous leaf; 20.3. Margin of pupal case; 20.4. Vasiform orifice.

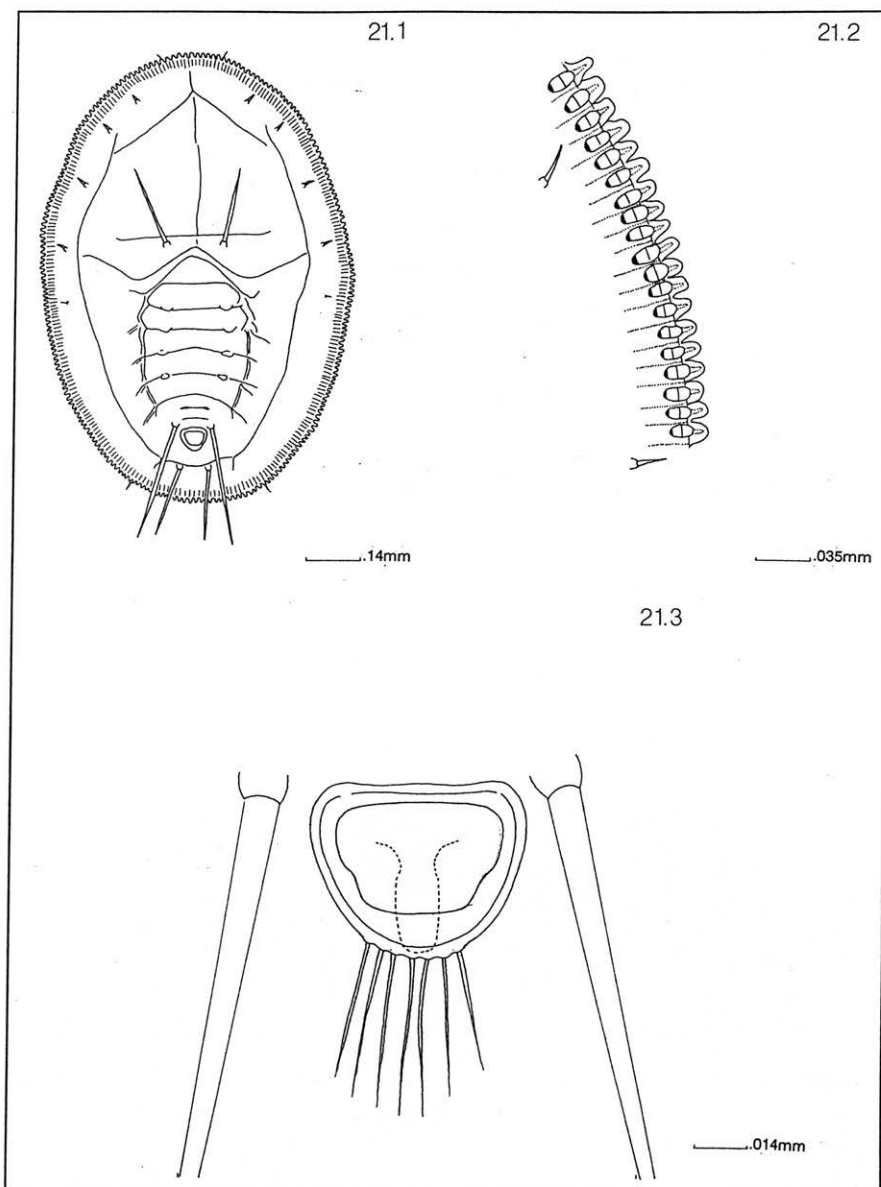


Fig. 21: *Aleurothrixus floccosus* (Maskell)
 21.1. Pupal case; 21.2. Margin of pupal case;
 21.3. Vasiform orifice.

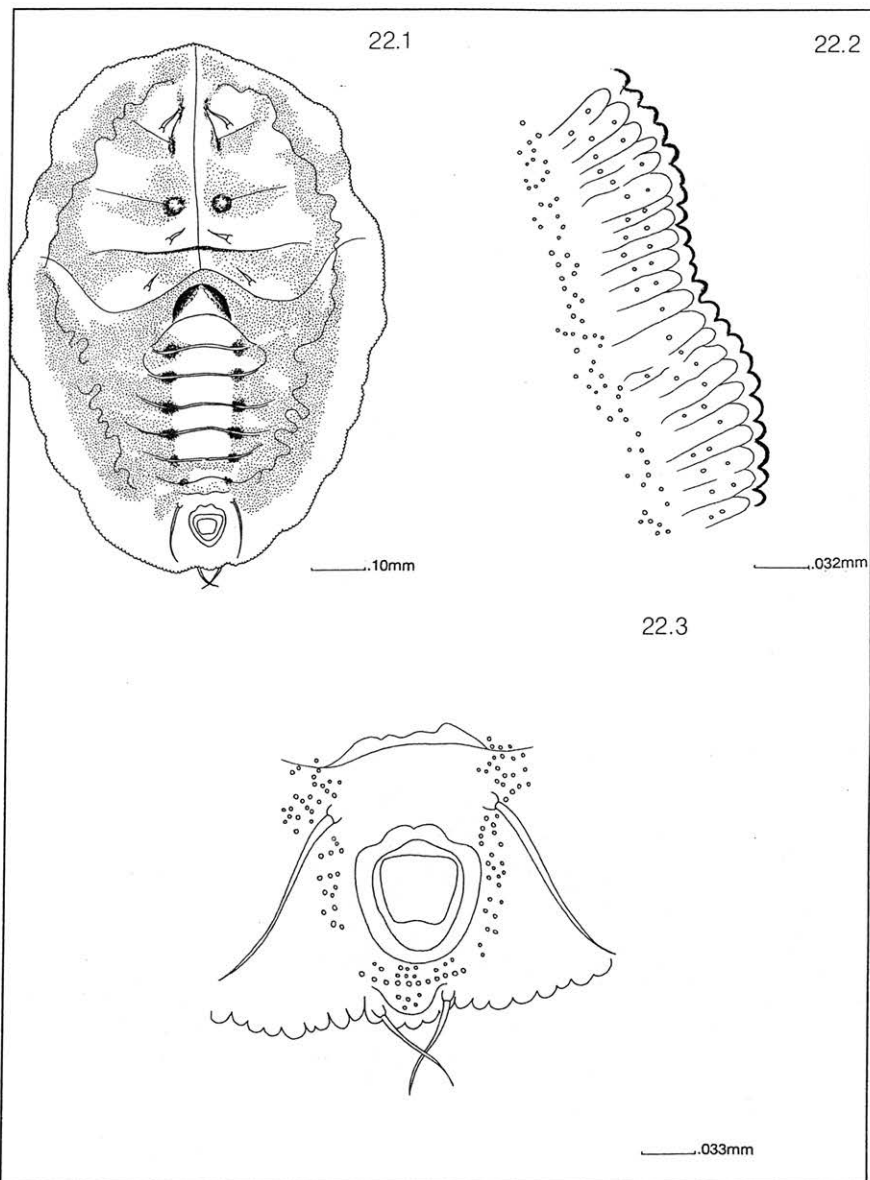


Fig. 22: *Aleuroplatus* sp.
 22.1. Pupal case; 22.2. Margin of pupal case;
 22.3. Vasiform orifice.

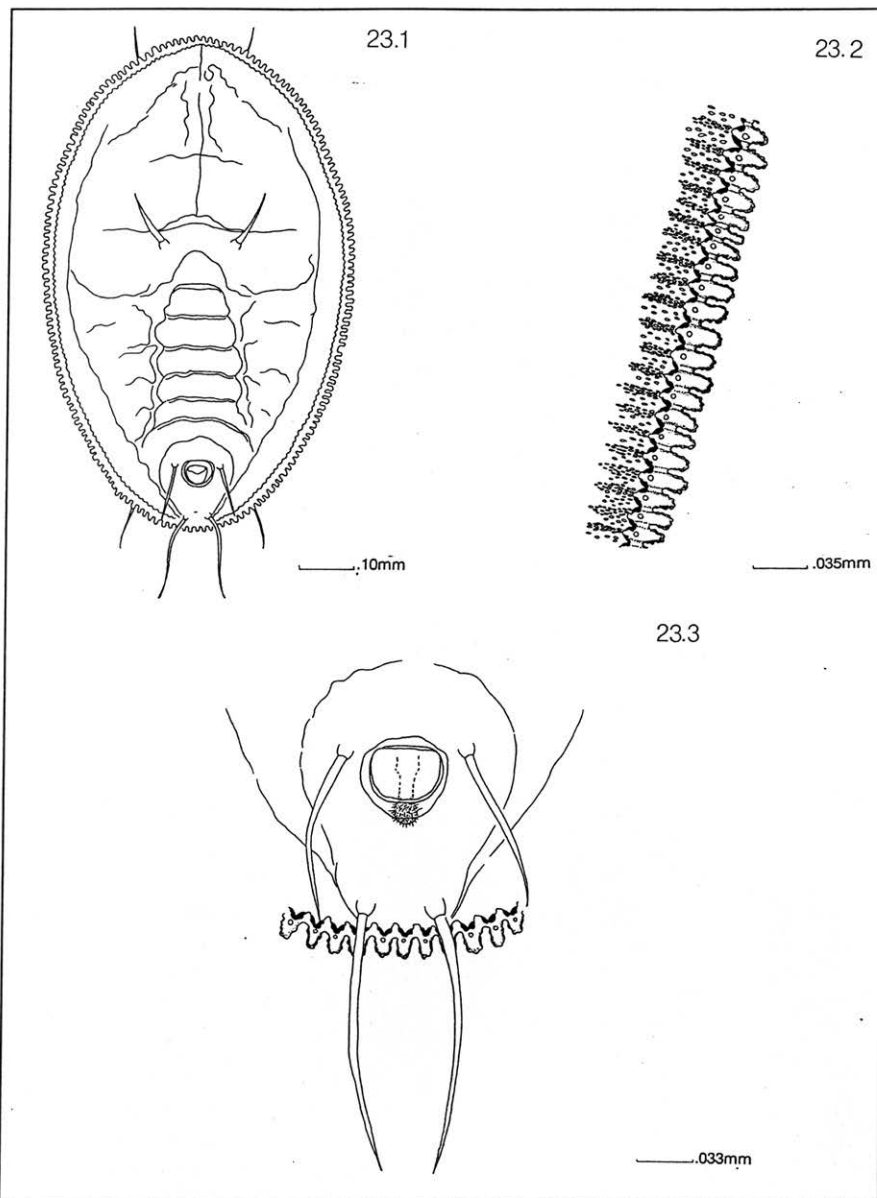


Fig. 23: *Aleurotrachelus socialis* Bondar
 23.1. Pupal case; 23.2. Margin of pupal case;
 23.3. Vasiform orifice.

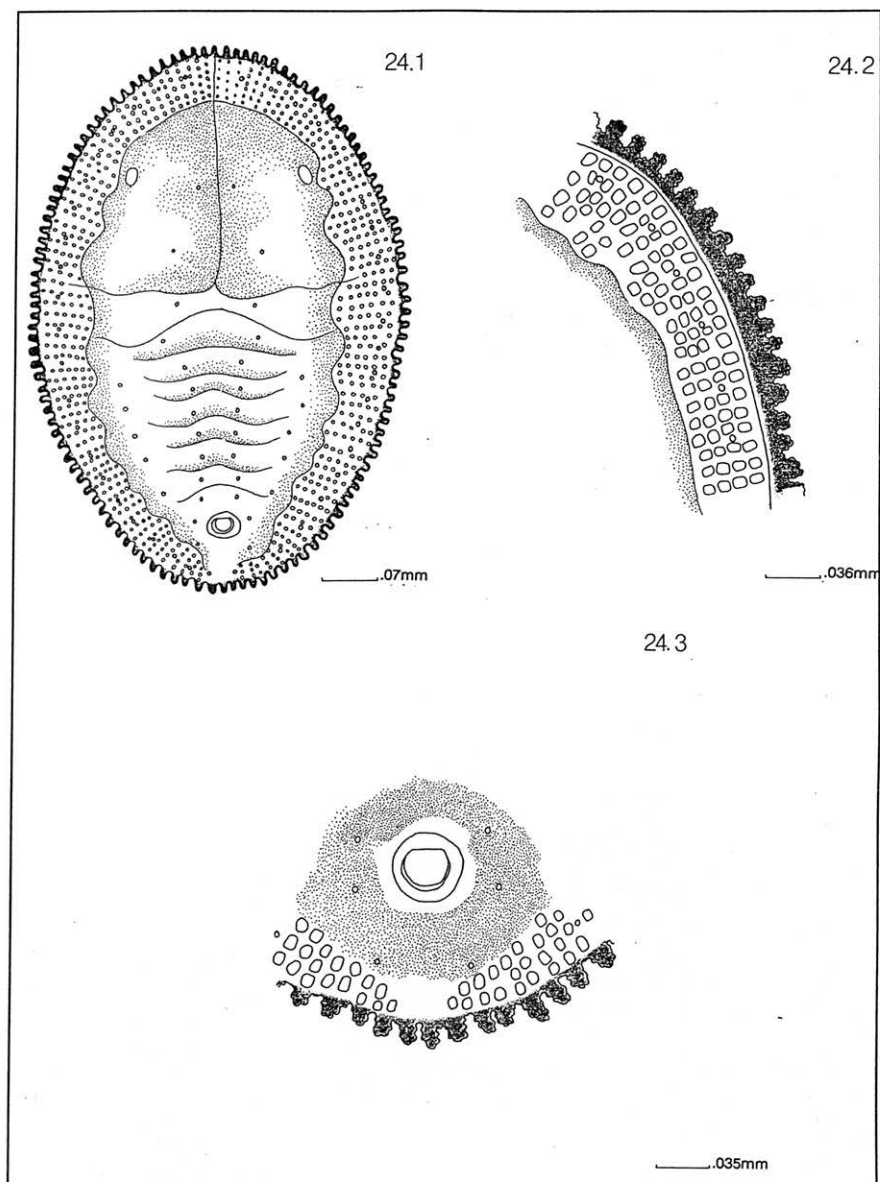


Fig. 24: *Aleurotrachelus cacaorum* Bondar
 24.1. Pupal case; 24.2. Margin of pupal case;
 24.3. Vasiform orifice.

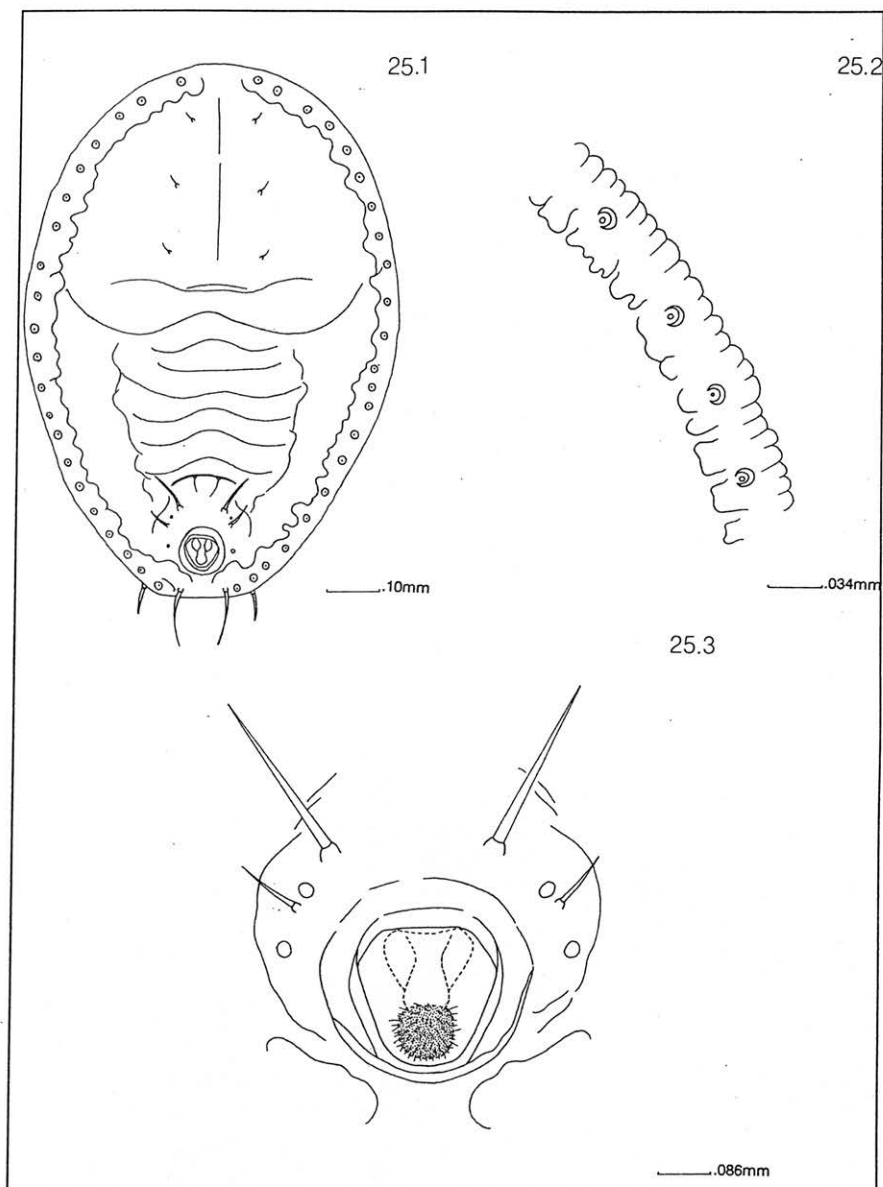


Fig. 25: *Tetraleurodes acaciae* (Quaintance)
 25.1. Pupal case; 25.2. Margin of pupal case;
 25.3. Vasiform orifice.

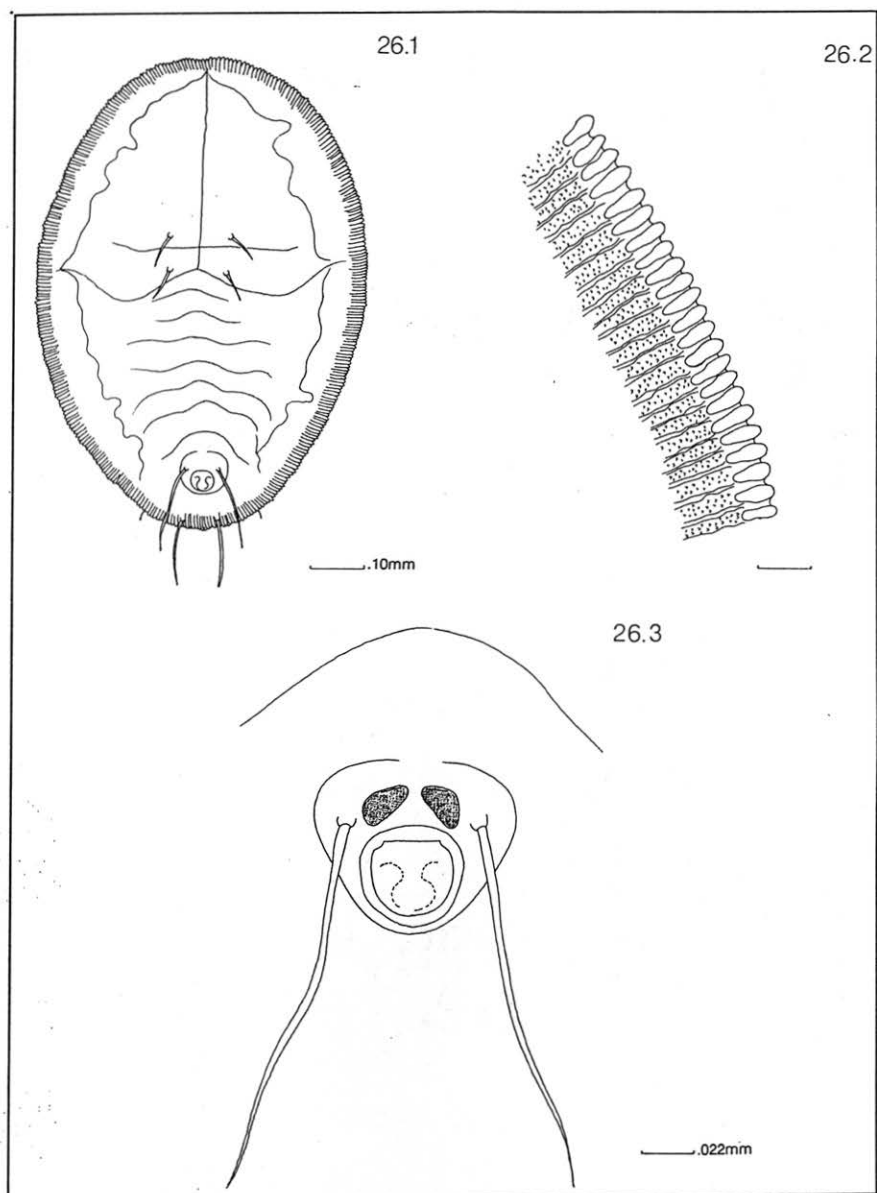


Fig. 26: *Tetraleurodes mori* (Quaintance)
 26.1. Pupal case; 26.2. Margin of pupal case;
 26.3. Vasiform orifice.

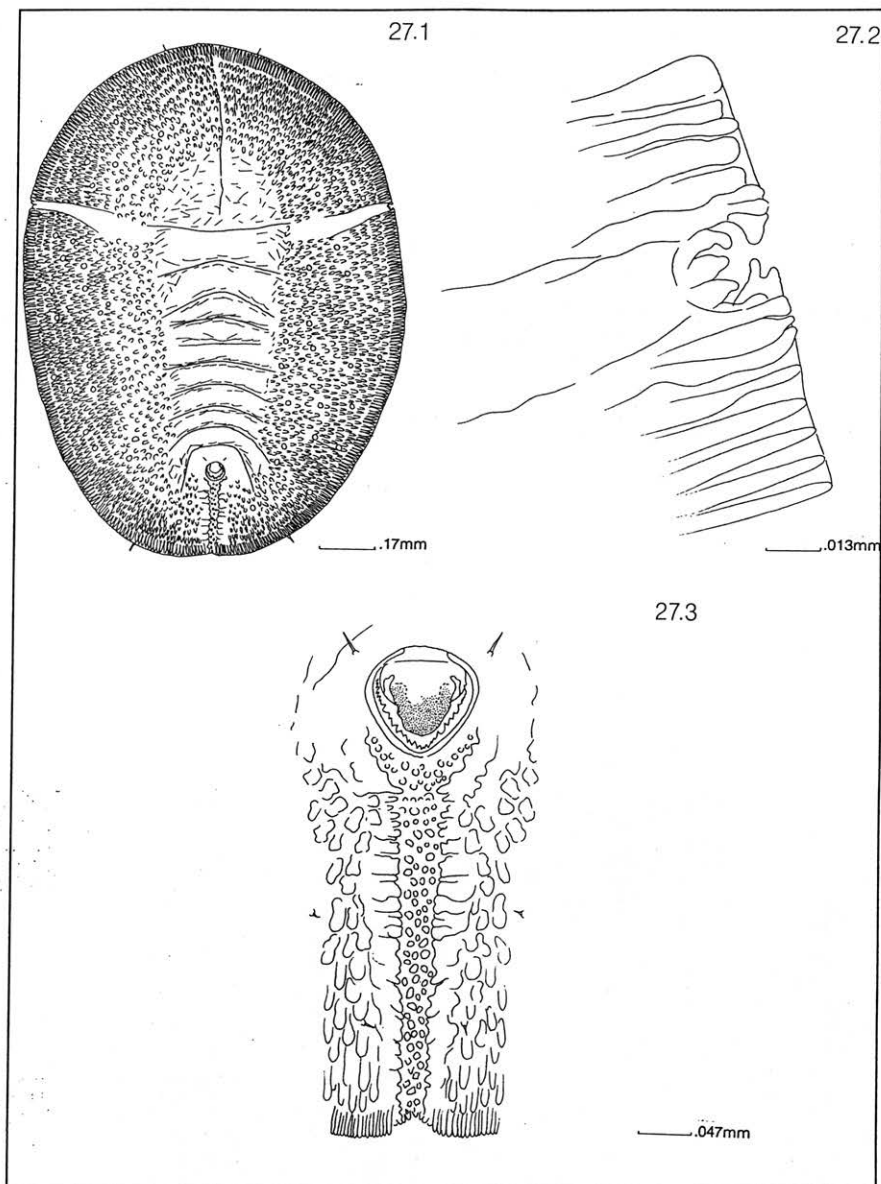


Fig. 27: *Dialeurodes citrifolii* (Morgan)
 27.1. Pupal case; 27.2. Margin of pupal case;
 27.3. Vasiform orifice.

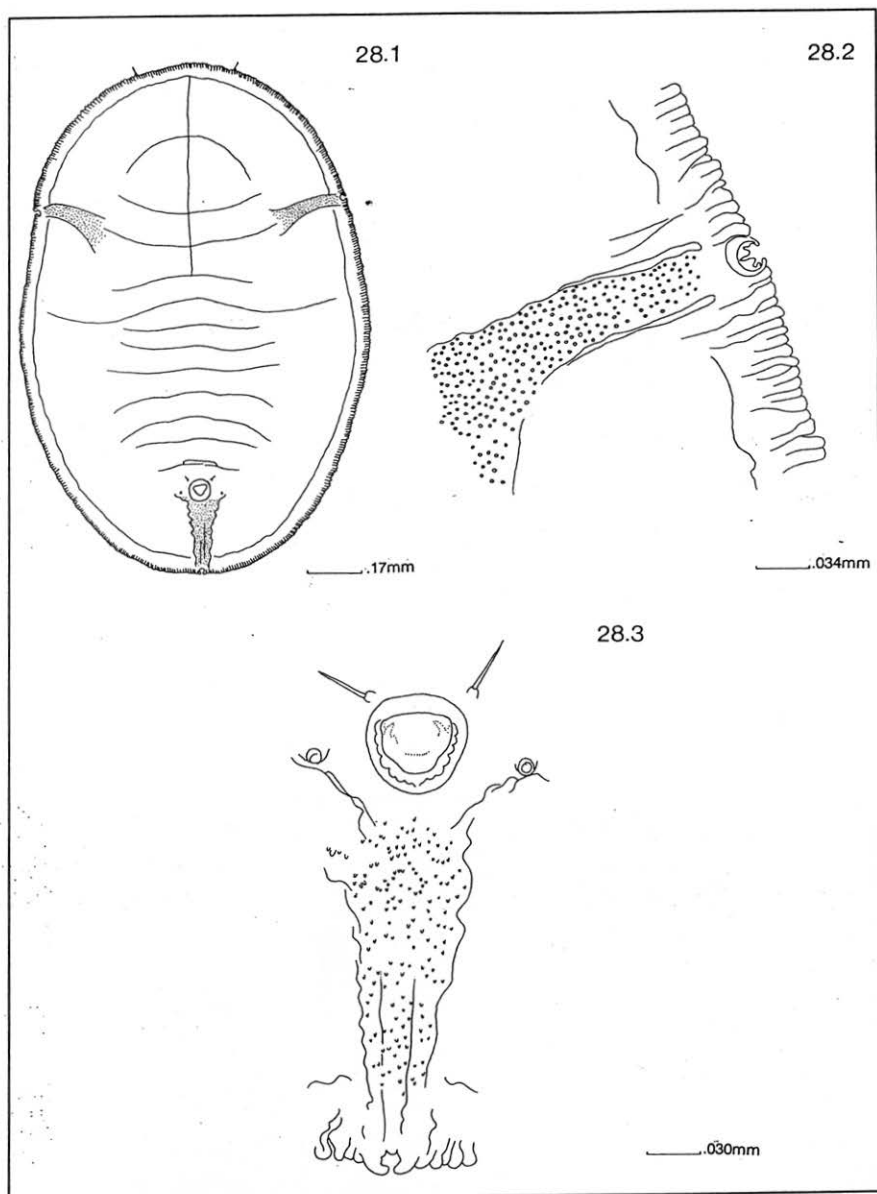


Fig. 28: *Dialeurodes citri* (Ashmead)
 28.1. Pupal case; 28.2. Margin of pupal case at
 thoracic tracheal opening; 28.3. Vasiiform orifice.

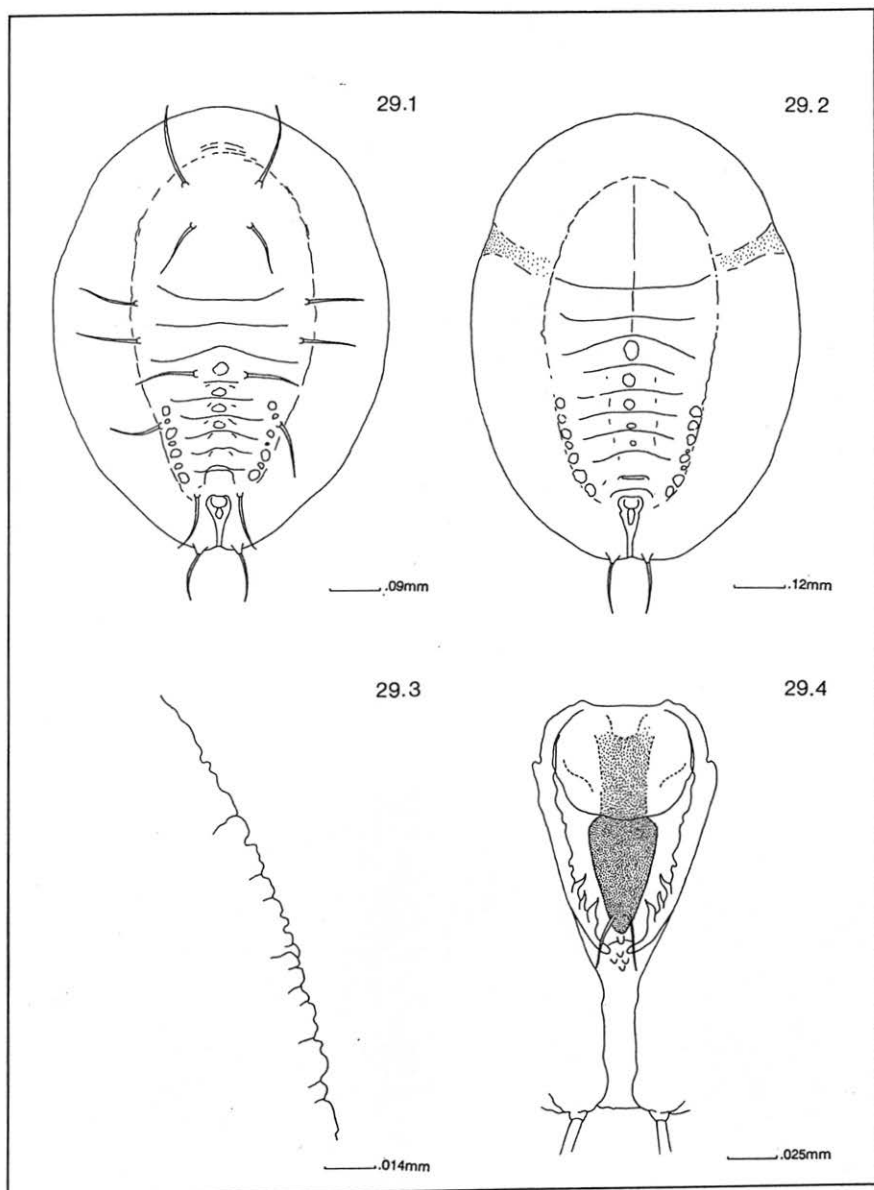


Fig. 29: *Bemisia tabaci* (Gennadius)
 29.1. Pupal case on hairy leaf; 29.2. Pupal case on glabrous leaf; 29.3. Margin of pupal case; 29.4. Vasiform orifice.

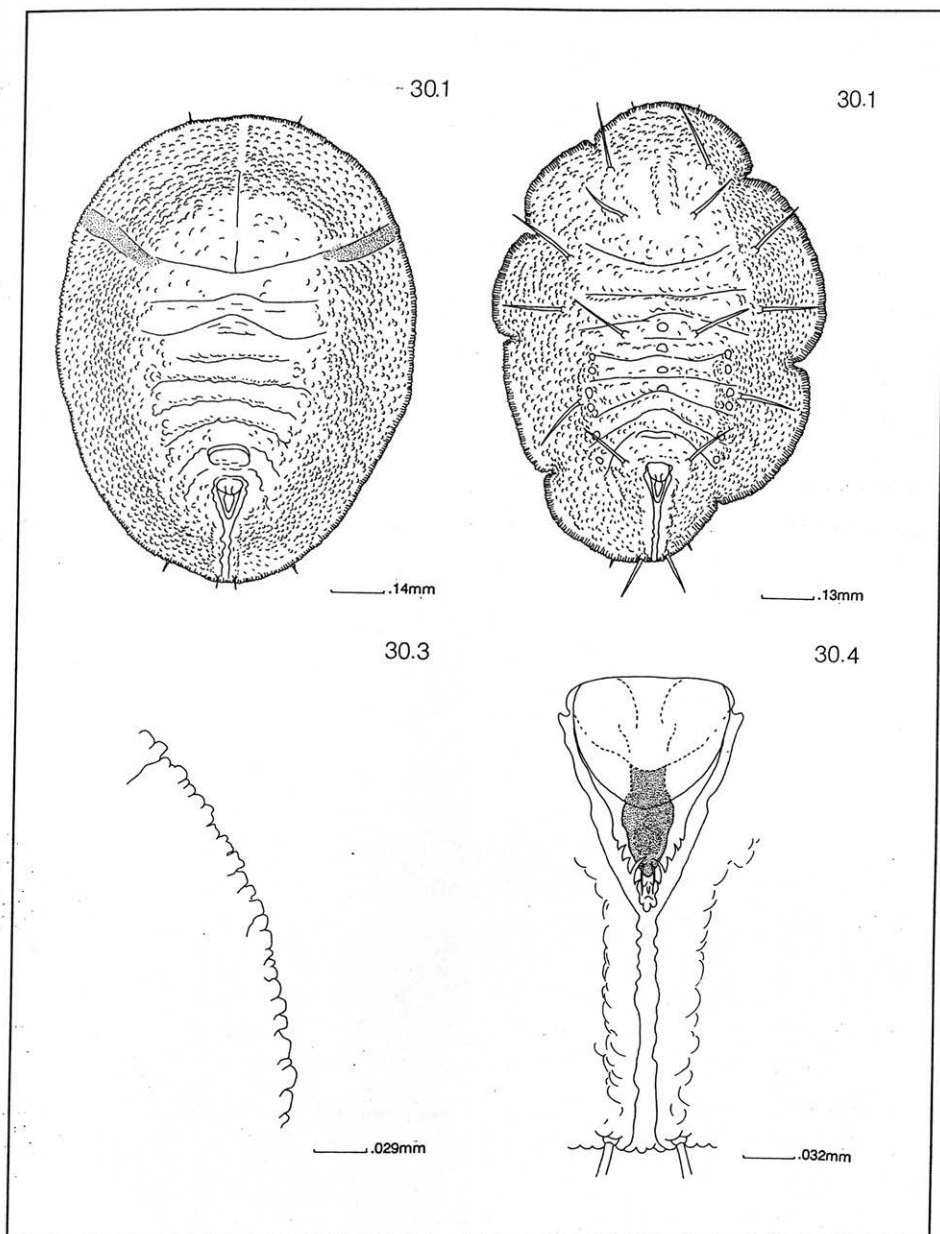


Fig. 30: *Bemisia tuberculata* Bondar

30.1. Pupal case on glabrous leaf; 30.2. Pupal case on hairy leaf; 30.3. Margin of pupal case; 30.4. Vasiiform orifice.

Fig. 31: Central American countries included in the whitefly survey.



Fig. 32: South American countries included in the whitefly survey.



Fig. 34: Departments of Honduras included in the whitefly survey.



Fig. 36: Departments of Colombia included in the whitefly survey.

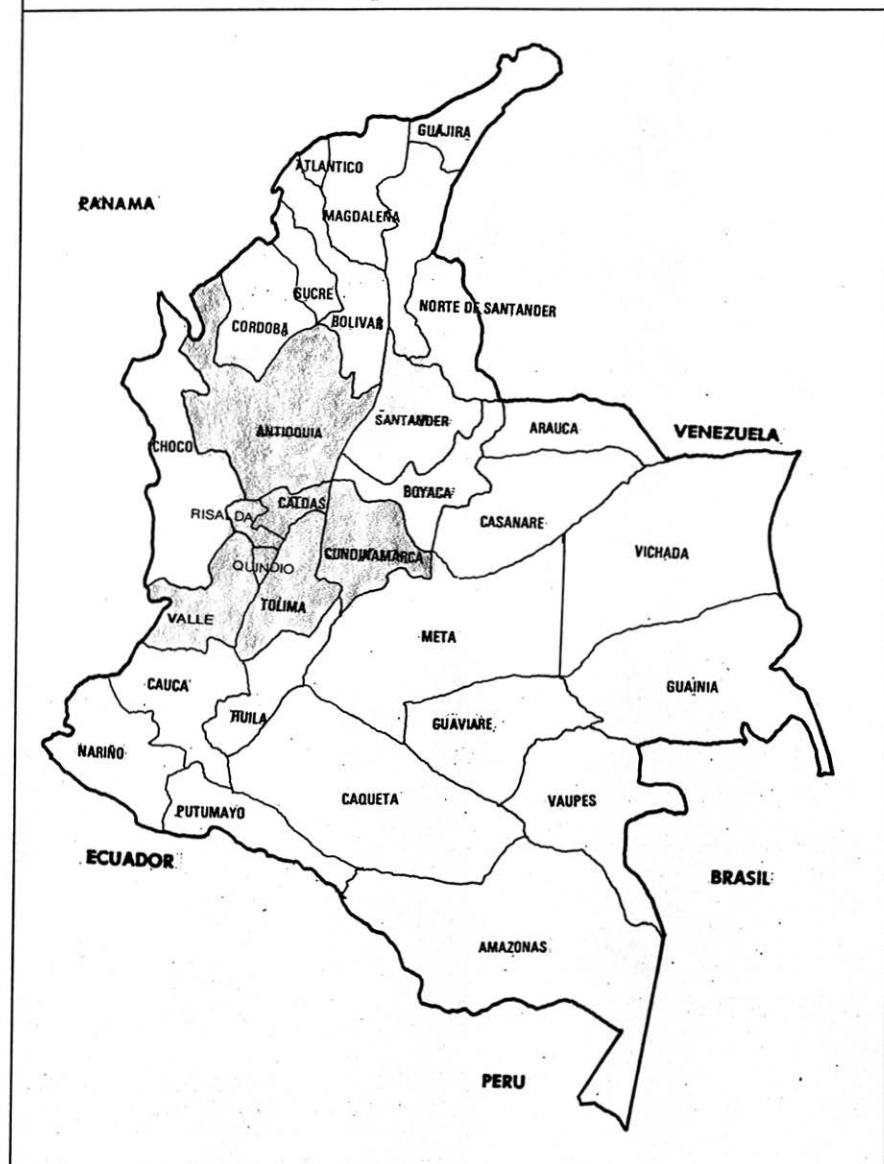


PLATE I



a. *Leonardius lahillei*



b. *Leonardius lahillei*



c. *Leonardius lahillei*



d. *Aleurodicus cocois*

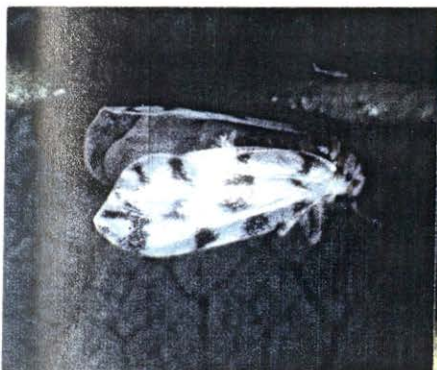


e. *Aleurodicus cocois*



f. *Aleurodicus cocois*

PLATE II



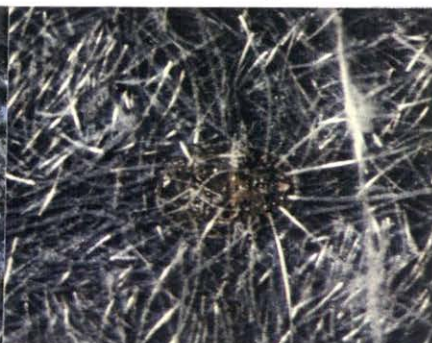
a. *Aleurodicus dugesii*



b. *Aleurodicus dugesii*



c. *Paraleyrodes* sp.



d. *Paraleyrodes* sp.



e. *Paraleyrodes* sp.



e. Undescribed species #4

PLATE III



a. Undescribed species #4



b. Undescribed species #1



c. Undescribed species #1



d. Undescribed species #1



e. *Dialeurodicus* sp.

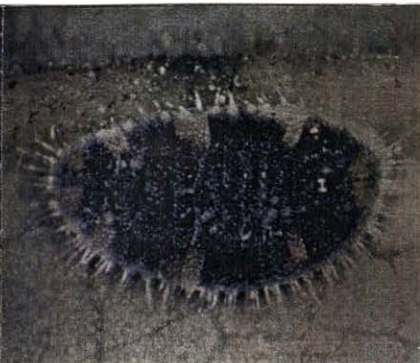


f. *Dialeurodicus* sp.

PLATE IV



a. *Dialeurodicus* sp.



b. *Ceraleurodicus ingae*



c. *Ceraleurodicus ingae*



d. *Ceraleurodicus altissimus*

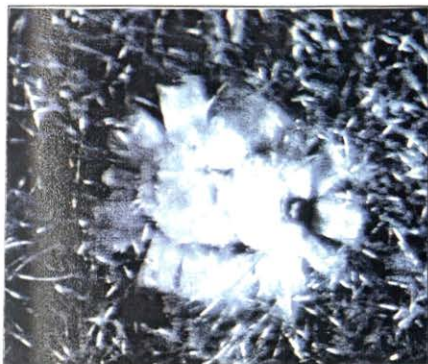


e. *Ceraleurodicus altissimus*



f. *Ceraleurodicus altissimus*

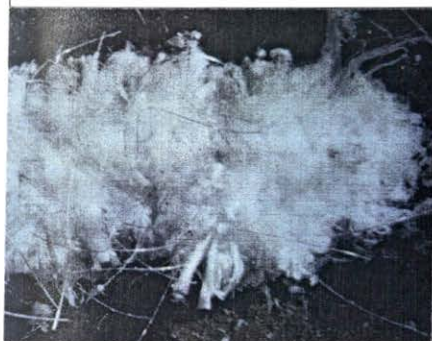
PLATE V



a. Undescribed species #3



b. *Lecanoideus giganteus*



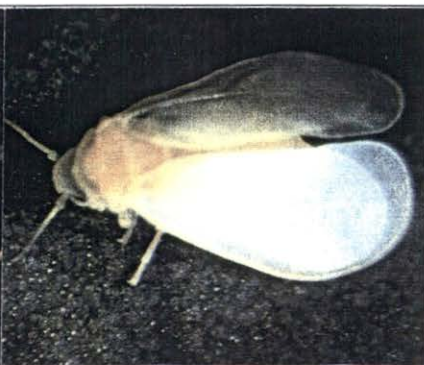
c. *Lecanoideus giganteus*



d. *Lecanoideus giganteus*



e. *Aleurodicus dispersus*



f. *Aleuroglandulus malangae*

PLATE VI



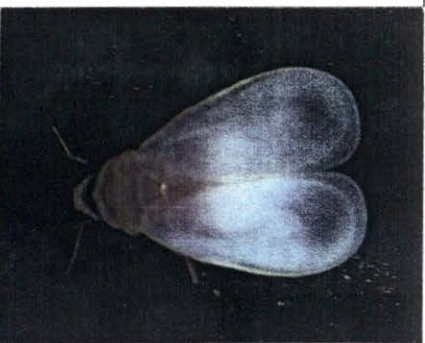
a. *Aleuroglandulus malangae*



b. *Aleuroglandulus malangae*



c. *Dialeurodes citrifolii*



d. *Dialeurodes citrifolii*



e. *Bemisia tuberculata*



f. *Bemisia tuberculata*

PLATE VII



a. *Bemisia tuberculata*



b. *Bemisia tabaci*



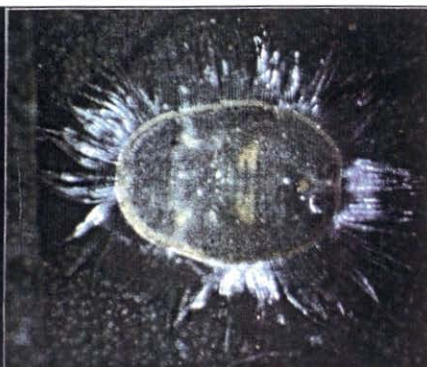
c. *Bemisia tabaci*



d. *Bemisia tabaci*

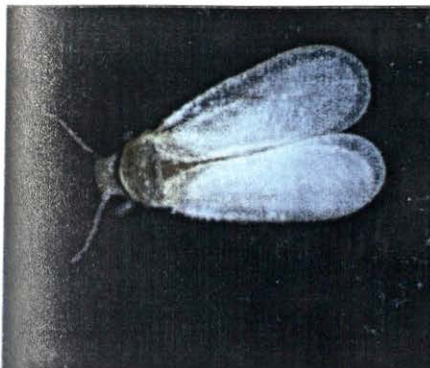


e. *Bemisia tabaci*

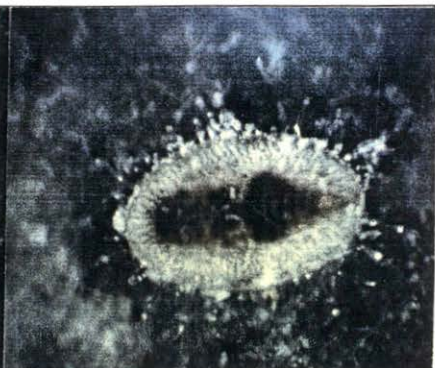


f. *Trialeurodes floridensis*

PLATE VIII



a. *Trialeurodes floridensis*



b. *Trialeurodes abutiloneus*



c. *Trialeurodes abutiloneus*



d. *Trialeurodes abutiloneus*



e. *Trialeurodes vaporariorum*



f. *Trialeurodes vaporariorum*

PLATE IX



a. *Trialeurodes vaporariorum*



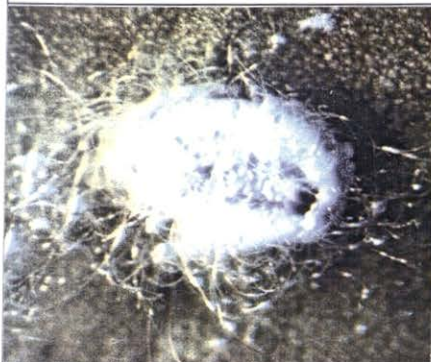
b. *Trialeurodes variabilis*



c. *Trialeurodes variabilis*



d. *Trialeurodes variabilis*



e. *Aleurothrixus floccosus*



f. *Aleurothrixus floccosus*

Fig. 35. Departments of Nicaragua included in the whitefly survey.

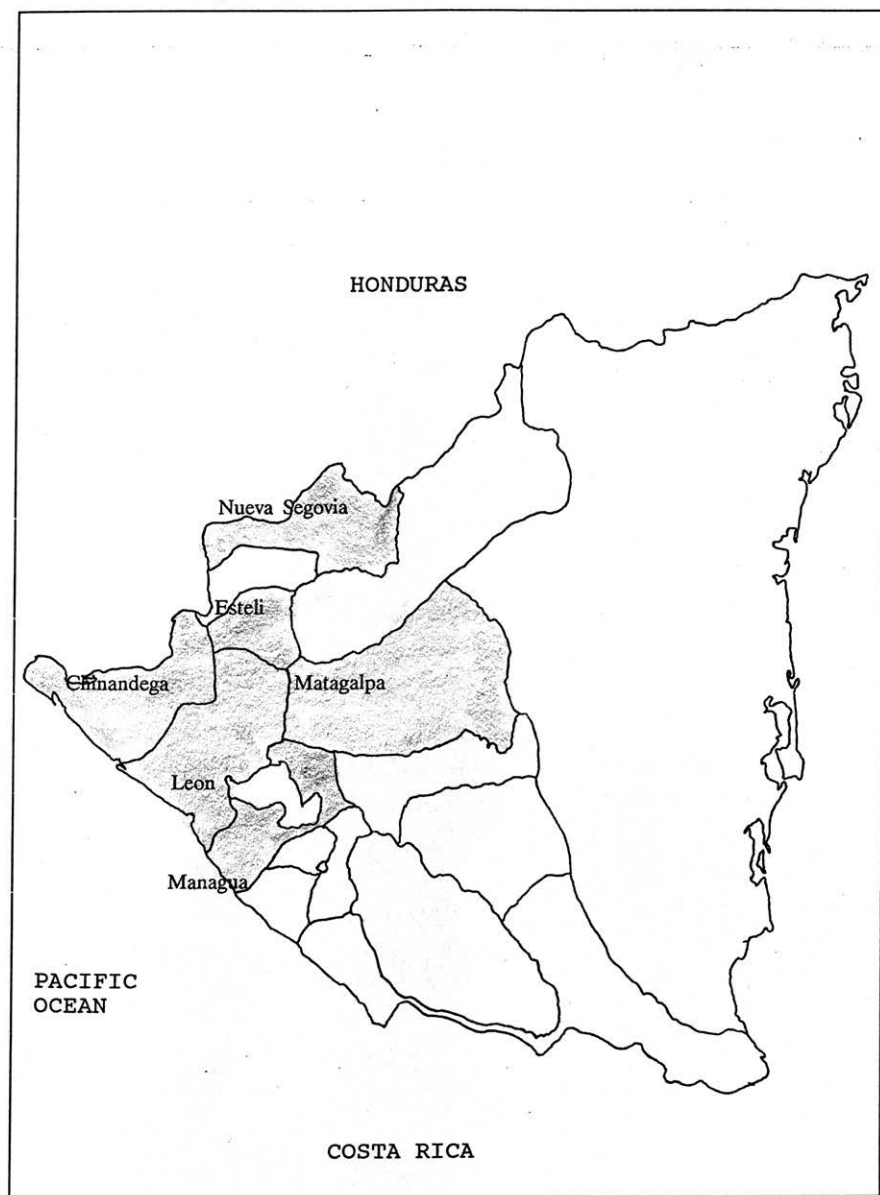
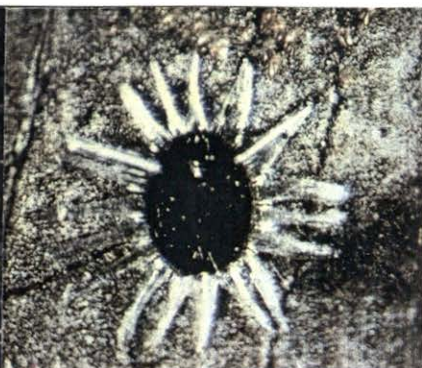


PLATE X



a. *Aleurothrixus floccosus*



b. *Aleuroplatus* sp.



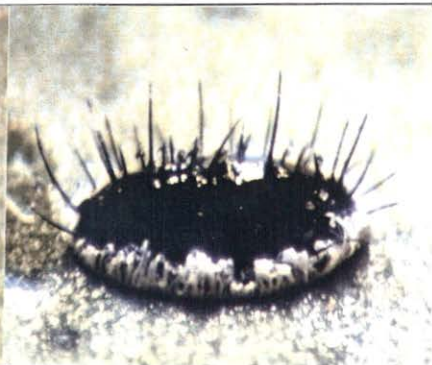
c. *Aleuroplatus* sp.



d. *Aleuroplatus* sp.



e. *Aleurocanthus woglumi*



f. *Aleurocanthus woglumi*

Fig. 33: Departments of Guatemala included in the whitefly survey.



PLATE XI



a. *Aleurocanthus woglumi*



b. *Tetraleurodes acaciae*



c. *Tetraleurodes acaciae*



d. *Tetraleurodes mori*



e. *Tetraleurodes mori*

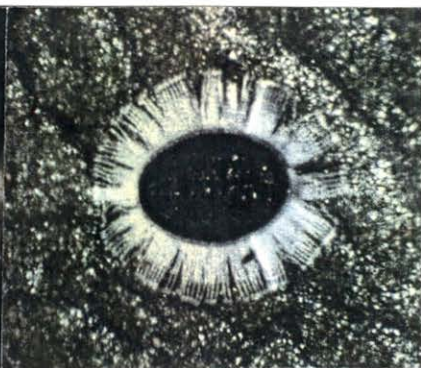


f. *Tetraleurodes mori*

PLATE XII



a. *Tetraleurodes mori*



b. *Aleurotrachelus cacaorum*



c. *Aleurotrachelus cacaorum*



d. *Aleurotrachelus socialis*



e. *Aleurotrachelus socialis*



f. *Aleurotrachelus socialis*

APPENDIX I

DATA COLLECTING SHEET TROPICAL WHITEFLIES (HOMOPTERA: Aleyrodidae)

Loc of Reference: _____ COUNTRY: _____

DEPARTMENT/PROVINCE: _____

MUNICIPALITY/LOCALITY: _____

HEIGHT ABOVE SEA LEVEL (If known): _____

COLLECTING DATE: _____ COLLECTOR: _____

HOST: Common Name: _____

Scientific Name: _____

LOCALIZATION IN THE HOST: Stems _____, Branches _____, Twigs _____

Leaves _____, Buds _____, Flowers _____, Fruits _____

OBSERVATIONS: _____

COLLECTING INSTRUCTIONS:

1. Immatures (nymphs and "pupae") should be collected together with its substrate (bark, leaves, buds, etc.). DO NOT detach them from the substrate (important appendages used in identification are broken).
2. Place immatures in 70% alcohol.
3. Adults can be collected by cutting their substrate and placing them directly in 70% alcohol. In order to do so, adults should not be disturbed. Adults can be also collected by using an aspirator and then transferred to vials. If possible, send adults without alcohol in order to study wing patterns and body color.
4. If specimens are sent by mail it is recommended that plastic vials be used to prevent crushing. It is also important to seal the vial stoppers with adhesive tape to avoid alcohol leakage.

APPENDIX II

Slide-mounting technique

1. Transfer from alcohol or plant material to a 10% potassium hydroxide (KOH) solution in a watch glass.
2. Leave material in KOH overnight or 12 to 24 hours. Or, heat it for 1-3 hours at 20-40°C, depending upon the consistency of the material. KOH macerates body contents of adults in formation. Do not place empty pupal cases in KOH or just for a short time. When pupal cases are transparent and the KOH leaves residues in the cavity, a small tear should be made with a thin needle in a ventral extreme to remove visible material; otherwise, it will take up stain along with the cuticle of the pupal case.
3. Decant KOH and add several drops of glacial acetic acid to neutralize the alkali and decant.
4. Add a little liquid carbol-xylol (xylene with 10% phenol) to the specimens and heat gently for a few minutes. This step eliminates the waxy coating that interferes with the staining process. Decant carbol-xylol.
5. a) Black pupae:
 - Rinse briefly in alcohol 70%.
 - Immerse in a cold mixture (88:2) of ammonia with hydrogen peroxide (H_2O_2). When pupal cuticle turns pale brown and transparent go to step 6.
 - If color does not change, place pupae in a 5% chloral solution; the bleaching usually is rapid. Then decant.b) Pale pupae:
 - Rinse briefly in glacial acetic acid.
 - Immerse pupae in acid fuchsin stain for a few minutes. Then decant.
6. Rinse in glacial acetic acid, then decant.
7. Add fresh glacial acetic acid and allow to soak and dehydrate for a few minutes before decanting.
8. Add a little clove oil or xylene to the dehydrated pupal cases and leave until cleared.
9. Mount in Canada balsam or Hoyer's. Canada balsam works better for pupae and Hoyer's for adults.
10. Dry in an oven at 40°C for 30-45 days.

APPENDIX III

List of families including number of species and records of whitefly hosts from Central America and Colombia.

<u>FAMILY</u>	<u>SPECIES</u>	<u>RECORDS</u>
Anacardiaceae	2	7
2Annonaceae	1	3
Araceae	2	6
Balsaminaceae	1	1
Boraginaceae	2	9
Caricaceae	1	7
Compositae	8	17
Compretaceae	1	4
Cucurbitaceae	5	16
Euphorbiaceae	7	24
Geranaceae	1	3
Heliconiaceae	1	3
Lauraceae	1	7
Lauranthaceae	1	1
Leguminosae	12	43
Malvaceae	5	20
Meliaceae	1	2
Moraceae	3	7
Musaceae	3	16
Myrtaceae	3	16
Palmae	2	10
Rosaceae	1	2
Rubiaceae	1	1
Rutaceae	6	39
Sapotaceae	1	2
Solanaceae	8	43
Sterculiaceae	2	7
Urticaceae	1	1
Verbenaceae	1	1
Undetermined	—	13
TOTAL: 29	84	331

APPENDIX IV

List of species including families and records of whitefly hosts from Central America and Colombia

<u>SCIENTIFIC NAME</u>	<u>FAMILY</u>	<u>RECORDS</u>
<u>Ageratum conizoides</u>	Compositae	4
<u>Anacardium occidentale</u>	Anacardiaceae	1
<u>Annona diversifolia</u>	Annonaceae	3
<u>Baccharis trinervis</u>	Compositae	5
<u>Bauhinia decora</u>	Leguminosae	1
<u>Bidens pilosa</u>	Compositae	1
<u>Caladium sp.</u>	Araceae	1
<u>Capsicum annum</u>	Solanaceae	3
<u>Capsicum frutescens</u>	Solanaceae	2
<u>Carica papaya</u>	Caricaceae	7
<u>Cassia javanica</u>	Leguminosae	1
<u>Cassia siamea</u>	Leguminosae	8
<u>Cecropia peltata</u>	Urticaceae	1
<u>Chrysalidocarpus lutescens</u>	Palmae	5
<u>Citrullus lanatus</u>	Cucurbitaceae	4
<u>Citrus aurantifolia</u>	Rutaceae	8
<u>Citrus aurantium</u>	Rutaceae	1
<u>Citrus limetta</u>	Rutaceae	1
<u>Citrus reticulata</u>	Rutaceae	5
<u>Citrus sinensis</u>	Rutaceae	23
<u>Citrus sp.</u>	Rutaceae	4
<u>Cocos nucifera</u>	Palmae	5
<u>Colocasia esculenta</u>	Araceae	5
<u>Cordia dentata</u>	Boraginaceae	8
<u>Cucumis melo</u>	Cucurbitaceae	5
<u>Cucumis sativus</u>	Cucurbitaceae	3
<u>Cucurbita moschata</u>	Cucurbitaceae	1
<u>Cucurbita sp.</u>	Cucurbitaceae	3

APPENDIX IV (CONT)

SCIENTIFIC NAME	FAMILY	RECORDS
<u>Cyphomandra bitacea</u>	Solanaceae	1
<u>Datura stramonium</u>	Solanaceae	1
<u>Eclipta alba</u>	Compositae	3
<u>Elephantopus spicatus</u>	Compositae	1
<u>Eucalyptus</u> sp.	Myrtaceae	1
<u>Eupatorium</u> sp.	Compositae	1
<u>Euphorbia cotinifolia</u>	Euphorbiaceae	1
<u>Euphorbia graminea</u>	Euphorbiaceae	2
<u>Euphorbia heterophylla</u>	Euphorbiaceae	2
<u>Euphorbia hirta</u>	Euphorbiaceae	2
<u>Euphorbia pulcherrima</u>	Euphorbiaceae	3
<u>Ficus benamina</u>	Moraceae	1
<u>Ficus golmanii</u>	Moraceae	1
<u>Ficus</u> sp.	Moraceae	5
<u>Gardenia augusta</u>	Rubiaceae	1
<u>Geranium grandiflorum</u>	Geraniaceae	3
<u>Gliricidia sepium</u>	Leguminosae	3
<u>Glycine max</u>	Leguminosae	3
<u>Gossypium hirsutum</u>	Malvaceae	10
<u>Heliconia</u> sp.	Heliconiaceae	2
<u>Heliotropium indicum</u>	Boraginaceae	1
<u>Hibiscus rosasinensis</u>	Malvaceae	2
<u>Inga spuria</u>	Leguminosae	2
<u>Inga</u> sp.	Leguminosae	3
<u>Impatiens balsamina</u>	Balsaminaceae	1
<u>Leucaena leucocephala</u>	Leguminosae	5
<u>Lycopersicum lycopersicum</u>	Solanaceae	28
<u>Manihot esculenta</u>	Euphorbiaceae	13
<u>Manilkara zapota</u>	Sapotaceae	2
<u>Melia azedarach</u>	Meliaceae	2
<u>Musa paradisiaca</u>	Musaceae	3

APPENDIX IV (CONT)

SCIENTIFIC NAME	FAMILY	RECORDS
<u>Musa sapientum</u>	Musaceae	4
<u>Musa</u> sp.	Musaceae	9
<u>Nicandra physalodes</u>	Solanaceae	1
<u>Oryctanthus occidentalis</u>	Lauranthaceae	1
<u>Persea americana</u>	Lauraceae	7
<u>Phaseolus</u> sp.	Leguminosae	2
<u>Phaseolus vulgaris</u>	Leguminosae	17
<u>Pithecellobium dulce</u>	Leguminosae	2
<u>Psidium fridrichsthalianum</u>	Myrtaceae	3
<u>Psidium guajava</u>	Myrtaceae	27
<u>Rosa sinensis</u>	Rosaceae	2
<u>Sclerocarpus phyllocephalus</u>	Compositae	1
<u>Sida acuta</u>	Malvaceae	6
<u>Sida rombifolia</u>	Malvaceae	1
<u>Simarouba glauca</u>	Leguminosae	1
<u>Solanum melongena</u>	Solanaceae	3
<u>Solanum tuberosum</u>	Solanaceae	4
<u>Sonchus oleraceus</u>	Compositae	1
<u>Spondias</u> sp.	Anacardiaceae	6
<u>Tectona grandis</u>	Verbenaceae	1
<u>Terminalia catappa</u>	Compretaceae	4
<u>Theobroma cacao</u>	Sterculiaceae	6
<u>Walteria indica</u>	Sterculiaceae	1
Undetermined	Malvaceae	1
Undetermined	Euphorbiaceae	1
Undetermined	Undetermined	12
TOTAL: 84	29	331

APPENDIX V

GLOSSARY

Abdomen: In immature whiteflies, the second or posterior division of the insect body; consists of eight apparent segments; bears no legs in any stage.

Abdominal tracheal fold: The single median furrow which extends caudad from a depressed area adjoining the posterior abdominal spiracles to the body margin.

- (01) **Abdominal tracheal pore:** Tracheal opening reaching caudal margin of abdomen.

Agglomerate pore: Simple pore arranged in a restricted circle, giving the appearance of a compound pore; there is a large, chitinous process in the center of some of them.

Anterior: Toward the head; opposed to posterior.

- (02) **Anterior marginal setae:** Pair of setae, usually very short, located on the anterior-submedian margin of pupal case.

Bifid sac: Male organ.

Caudal: Of or pertaining to the anal end of the body.

- (03) **Caudal furrow:** Longitudinal depression located between vasiform orifice and caudal end of body.

- (04) **Caudal setae:** Pair of setae, usually medium to large, located meso-caudally.

Cephalic segment: The anterior segment of the cephalothorax.

- (05) **Cephalic setae:** Pair of setae located on the submedian area of the cephalic portion, anterior to the cephalothoracic suture.

- (06) **Cephalothoracic suture:** Suture located between the head and thorax.

Cephalothorax: The fused head and thorax.

APPENDIX V (CONT)

- (07) **Compound pore:** Comparatively large gland, conspicuously invaginated, having several to many distinct loculi at the bottom, arranged in a circle around the base of a central process that arises above the top of the pore; cylindrical or cylindrical and thimble-shaped, occurring in seven or fewer subdorsal pairs.

- (08) **Crenulate margin:** Margin with small scallops, evenly rounded and rather deeply curved.

- (09) **Dentate margin:** Toothed margin.

Disk pore: minute, circular, nonloculate pore of the dorsal surface; designated as submarginal, subdorsal, and submedian, depending upon its position.

Dorsal Disk: The entire area within the subdorsal furrow.

Dorsal setae: Named from the body segments on which they occur, cephalic, first abdominal, and eighth abdominal.

Dorsum: The entire upper surface; includes areas such as margin, submargin, subdorsal furrow, and dorsal disk.

Double-rimmed simple pore: Circular, slightly concave, and usually located in the submargin; consists of a light, porous- like central portion encircled by a dark rim which in turn is encircled by another light, porous-like area ringed with a lighter rim; there is a minute opening in the proximal portion of the circumference of the darker rim.

- (10) **Eight abdominal setae:** Pair of setae, variable in length, located dorsally on the submedian area of the eighth abdominal segment; near, usually above, vasiform orifice.

Eight-shaped simple pore: Oval and divided at midlength by a slender bar, usually located near body margin and usually seen in side view because it is directed outward.

- (11) **First abdominal setae:** Pair of setae, usually short to medium in size, located dorsally on submedian area of the first abdominal segment.

- (12) **Identate margin:** Margin fairly smooth with indentations, dents, or dimples.

- (13) **Lingula:** A more or less slender tongue or strap-shaped organ, attached cephalad within the vasiform orifice.

APPENDIX V (CONT)

- (14) **Lingular setae:** One or two pairs of subterminal, usually conspicuous, setae of lingula, may be absent.
- (15) **Longitudinal molting suture:** Suture extending meso-dorsally on cephalothorax; involved in molting process; with the transverse molting suture forms the inverted "T" at molting.

Margin: The narrow distal portion of the dorsum.

Marginal furrow: Extends from marginal teeth to the submargin.

- (16) **Marginal lines:** Transverse lines on the submarginal area.

Marginal ridge: Extends from marginal teeth to the submargin.

Marginal teeth: Dentate margin distally.

- (17) **Mesothoracic setae:** Pair of setae on the submedian area of the second segment of thorax.
- (18) **Metathoracic depression:** Flattened area on metathorax; may occur on other areas.
- (19) **Metathoracic setae:** Pair of setae on submedian area of the third segment of thorax.
- (20) **Minute simple pore:** Some are minuscule and obscure while others are readily visible; some appear as clear areas with indistinct margins.

Minute wide-rimmed simple pore: Similar to the wide-rimmed pores but smaller, located in the submargin and subdorsum proximad to the wide-rimmed pores.

- (21) **Operculum:** A lid-like structure covering the vasiform orifice.
- (22) **Opercular setae:** Pair of usually short, caudally located setae of operculum.
- (23) **Pocket:** A pair of invaginations extending cephalad from the submedian part of the seventh abdominal suture.

Porette: Minute structure resembling and associated with the disk pores. Designated as submarginal, subdorsal, and submedian, depending upon their position.

APPENDIX V (CONT)

Posterior: Hind or hindmost; opposed to anterior.

- (24) **Posterior marginal setae:** Pair of short to medium setae located laterad to caudal setae, on posterior end of pupal case.
- (25) **Prothoracic setae:** Pair of setae on submedian area of the prothorax.

Rachis: A median ridge on the abdomen.

- (26) **Sclerotized spine:** Heavily chitinized spine produced by pupal case skin.
- (27) **Septate simple pore:** Circular or subcircular, slightly tuberculate, faintly porous, the rim is much darker than the center; each has an opening in the rim, from which a canal-like line extends partially or entirely across the pore; located proximad of the minute wide-rimmed pores.

Simple pore: Opening on the body surface, variable in size, shape, and structure.

- (28) **Smooth margin:** Margin conspicuously smooth.
- (29) **Spinule:** Varies from minute needlelike point to relatively large, blunt or pointed structure.

Subdorsal area: The area between imaginary curved lines projected cephalad and caudad to the subdorsal furrow from the outermost points of the rachis.

Subdorsal furrow: A depressed area that separates the submargin from the dorsal disk.

Submarginal area: Area extending from the margin to the subdorsal furrow.

- (30) **Submarginal papillae:** Modified glands located, usually, on the submarginal area.
- (31) **Submarginal pore:** Simple pore, variable in shape and size, located on the submarginal area; may occur on other areas.
- (32) **Submarginal setae:** Setae present on the submarginal area.
- (33) **Submarginal teeth:** Row of tooth-like glands located below margin of pupal case, or submargin.

APPENDIX V (CONT)

Submedian area: The longitudinal center section of the dorsal disk.

- (34) **Thoracic tracheal comb:** Toothed or dentate margin at thoracic tracheal openings.
- (35) **Thoracic tracheal fold:** A pair of furrow-like depressions extending from the anterior thoracic spiracles to the body margin.
- (36) **Thoracic tracheal pore:** Tracheal opening reaching margin of thorax.
- (37) **Transverse molting suture:** Suture located between cephalothorax and abdomen; together with the longitudinal molting suture form the inverted "T" at molting.
- (38) **Tubercle:** A little solid pimple or small button.
- (39) **Vasiform orifice:** Anal orifice situated dorsally on the last abdominal segment; contains the operculum and lingula.

Venter: The belly; the entire undersurface of the abdomen.

- (40) **Ventral abdominal setae:** Pair of setae located at each side, and usually at anterior half, of vasiform orifice; somewhat anterior to the posterior abdominal spiracles.

Wide-rimmed simple pore: Circular or subcircular, located in the submargin around, and proximad of, the double-rimmed pores; the rim is as wide or wider than the diameter of the center, which is porous in appearance and has a suggestion of a minute, central opening.

WHITEFLIES (HOMOPTERA: Aleyrodidae) FROM
CENTRAL AMERICA AND COLOMBIA INCLUDING
SLIDE-MOUNTED PUPAL AND FIELD KEYS FOR IDENTIFICATION,
FIELD CHARACTERISTICS, HOSTS, DISTRIBUTION,
NATURAL ENEMIES, AND ECONOMIC IMPORTANCE

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AN ABSTRACT OF A THESIS

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ABSTRACT

A recent identification guide for the 30 most economically important and common species of whiteflies occurring in agricultural and natural systems from Central America and Colombia is provided. The key for slide-mounted specimens is illustrated and the field keys for immatures and adults include color pictures. Characteristics of the family, subfamily and genus are listed. The worldwide species of each treated genus are included. Each species is described both from slide-mounted immatures and from field observations of immatures and adults. The economic importance of each species is discussed. Whitefly species are recorded from 84 host species belonging to 29 families of plants from 10 countries. Sixteen records of predators in the orders Hemiptera, Neuroptera, Coleoptera, and Diptera; and 37 of parasitoids in the order Hymenoptera are reported. The material collected and the ecological information gathered regarding host plants, geographical distribution, and natural enemies were incorporated into the collection and database system of the Agroecological Inventory Center, Plant Protection Department, at the Escuela Agrícola Panamericana, El Zamorano, Honduras, Central America. Duplicates of the collected material were deposited at the Insect Identification Branch, California Department of Food and Agriculture, Sacramento, California, U. S. A.