CONTRIBUTION TO THE KNOWLEDGE OF THE WHITEFLIES (HOMOPTERA: ALEYRODIDAE) FROM MADEIRA ISLAND

By A. M. FRANQUINHO AGUIAR [1] & MARGARIDA T. PITA [2]

With 47 figures and 5 maps

ABSTRACT. Until very recently the aleyrodids were an almost unknown insect group on the island of Madeira - only two references to the presence of introduced species were known: *Aleurothrixus floccosus* (MASKELL) and *Trialeurodes vaporariorum* (WESTWOOD). These pests pose a serious threat to crops and many plants in Madeira. Samples of those species were collected respectively on *Citrus sinensis, Citrus reticulata, Citrus limon, Citrus medica, Poncirus trifoliata, Ocotea foetens, Eugenia uniflora, Persea americana, Coffea arabica* and *Psidium guajava, Carica papaya, Eugenia uniflora, Fragaria ananasse, Phaseolus vulgaris, Cucurbita pepo, Cucumis sativus, Lycopersicum esculentum, Solanum muricatum, Lactuca sativa, Euphorbia pulcherrima, Verbena* sp., *Gerbera* sp., *Ageratina adenophora, Urtica dioica.* Additional collecting on several hosts allow us to add three new records to the Madeiran whitefly fauna: *Aleyrodes proletella* (L.); *Bemisia* sp. near *afer* (PRIESNER & HOSNY) and *Paraleyrodes bondari* PERACCHI respectively on *Brassica oleracea* for the first, *Myrica faya, Marcetella maderensis, Phylis nobla, Clethra arborea, Persea indica, Appolonias barbujana, Hypericum inodorum* for the second and *Citrus sinensis, Citrus reticulata, Citrus limon, Persea americana, Eugenia uniflora, Ocotea foetens* for the third.

Key words: Aleyrodidae, Macaronesia, Madeira Island.

[1] Laboratório Agrícola da Madeira, Estr. Engº. Abel Vieira, 9135 Camacha, Portugal
[2] Dept. de Biologia, Universidade da Madeira, Colégio dos Jesuitas, 9000 Funchal, Portugal

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INTRODUCTION

The whiteflies are a group of sap-sucking insects poorly studied in Madeira, in spite of the economic importance of some introduced species as *Aleurothrixus floccosus* (MASKELL, 1895) and Trialeurodes vaporariorum (WESTWOOD, 1856). The former has been well known citrus pest in the island since 1920 (MOUND & HALSEY, 1978); the latter seems to have been recently introduced (RUSSELL, 1963). These two species were the only ones referenced from Madeira, but three new records can be added now to the island whitefly fauna: *Aleyrodes proletella* (L., 1758); *Bemisia* sp. near *afer* (PRIESNER & HOSNY, 1934) and *Paraleyrodes bondari* PERACCHI, 1971.

These insects have seven life stages, the egg, the first larval (the crawler), the second, third and fourth that are sessile larval instars, the pupa and the adult or imago (PASSOS de CARVALHO, pers. comm.). In most cases the identification of the Aleyrodidae is based primarily on the morphological structure of the fifth larval instar, the so-called "pupal case", rather than on adults (MARTIN, 1987). In spite of this, morphological characters of adults will be used in this work for an alternative detailed identification. The family Aleyrodidae is usually divided into two subfamilies: Aleyrodinae and Aleurodicinae. This one, whose species are mainly from the Neotropics, is represented in Madeira by only one species.

MATERIAL AND METHODS

The samples were collected all around the Island. Parts of the plants with aleyrodids were taken to the laboratory in plastic bags; in some cases an aspirator was used to collect adults. Later, the insects (all stages) were picked from leaves and stored in 70 % ethanol. From each sample, part of the pupal cases were prepared on slide mounts for identification purposes. The mounting method used was that of MARTIN (1987), with a single change on the final stage where Entellan®, a synthetic mounting media, was used instead of Canada Balsam. Whenever necessary the male imagos were mounted after clearing for a couple of months on a medium composed by a mixture of: liquid phenol (4 c.c.), lactic acid (12 c.c.), resorcinol (0.5 gr.), potassium iodide (0.5 gr.), concentrated hydrochloric acid (16 droplets). After the clearing process, slide mounts of the imagos were made using a mounting media composed by a mixture of: gum arabic (5 gr.), sucrose (5 gr.), chloral hydrate cristals (70 gr.), potassium iodide cristals (2 gr.), iodine cristals (2 gr.), 25% formaldehyde (180 droplets). This medium is prone to crystallize in contact with the air after a few years and also lose the contrast given by the iodine coloration. This can be reduced by sealing the glass slides with an airtight varnish. Both the clearing and the mounting mediums are normally used for the microscopic preparation of Acari (CARMONA, pers. comm.).

All the slide mounts and samples in ethanol are on the insect collection of the Laboratório Agrícola da Madeira (ICLAM) and are identified by code numbers begining by

letter "C" (e.g. C46). The figures were made with a Nikon Labophot light microscope and drawing tube. The localization of collecting sites on the distribution maps is based in Universal Transverse Mercator (U.T.M.) coordinates (e.g. CB0417). The maps themselves are a reduction of the 1/25.000 military topographic chart.

RESULTS

Subfamily **ALEYRODINAE**

Aleurothrixus floccosus (MASKELL, 1895)

Aleurodes floccosa MASKELL, 1895
Aleyrodes horridus HEMPEL, 1899
Aleyrodes howardi QUAINTANCE, 1907
Aleurothrixus horridus (HEMPEL) QUAINTANCE & BAKER, 1914
Aleurothrixus howardi (QUAINTANCE) QUAINTANCE & BAKER, 1914

Among the aleyrodids collected the "woolly whitefly" is a relatively important pest, mostly on *Citrus* spp., principally on the south coast of the island (VIEIRA, 1950). Samples of this species were collected from sea-shore to 400 meters, altough we have been able to collect a sample from 650 meters. It appears in dense colonies covered by secreted flocculent wax, generally on lower surfaces of leaves on a vast area of the island (Dist. map 1). Besides Rutaceæ it also attacks some plants of the families Lauraceæ, Rubiaceæ and Myrtaceæ.

The origin of this species is probably Florida (EBELING, 1959 cit. VIEIRA, 1980), although it was first detected in Cuba. The first record from Madeira dates of 1920 (material deposited on the collection of the British Museum), but in Continental Portugal it only appeared in 1977. Today the woolly whitefly is spread all over the Neotropical region, the southwestern Palaearctic and part of the Ethiopian region (MOUND & HALSEY, 1978).

Identification of the pupal case - The puparia (Fig.1) of this species are small with values of length 1050-1175µm and width 600-800µm. Below the wax layers, the colour of the pupal case is almost always pale yellow and more rarely dark brown. The dorsal surface is delimited by a dentate margin (Fig.2). Each dentation is connected with a papilla (gland). The longitudinal moulting suture reaches the margin and the transverse moulting suture reaches the submarginal fold. The submarginal area has various pairs of submarginal microsetae regularly disposed and is separated from the dorsal disc by the submarginal fold interrupted anteriorly. Two pairs of small marginal setae are present, one on the anterior margin and another on the posterior margin. One pair of elongated setae appears on the

metathorax, one pair on the eighth abdominal segment and one pair of caudal setae. The vasiform structure (Fig.3) is elevated and the lingula is completely covered by the operculum. It also has a membrane surrounding the posterior margin of the vasiform orifice that maintains the secreted droplets of honney-dew away from the dorsal surface of the pupal case (PASSOS de CARVALHO, pers. comm.). On the ventral surface besides the easily recognized structures like legs, antennas and rostrum, it can be found one pair of ventral abdominal setae and two pairs of abdominal spiracle, one anterior and another posterior. Also evident are the caudal and thoracic tracheal furrows.

Adult male - On the eighth-tenth abdominal segments (Fig.4) there is the vasiform orifice with the lingula only parcialy covered by the operculum. On the male genitalia the claspers present three subapical teeth before the apical tooth. Between the claspers appears the aedeagus (Fig.5) which is long, slender and shows a constriction at the end. On the material studied we were unable to recognize the dorsal protuberance of the aedeagus mentioned by GILL (1990). The antenna (Fig.6) is typical of the Aleyrodinae, with seven segments. The third is the longest and presents one sensorial cone and two primary sensoria at the extremity (Fig.7). These sensoria are similar to the uncinula and lachneait described by BINK-MOENEN (1983). Primary sensoria are also present on the fifth and seventh (Fig.8) segments and sensorial cones on the sixth and seventh. The upper and lower compound eyes (Fig.9) are linked by four ommatidea and the dimensions of the upper ommatidea are smaller than the lower ones. The existence or absence of this connection between the two compound eyes and the number of ommatidea present on the connection link has taxonomic importance (HULDÉN, 1986 cit. GILL, 1990).

Material studied - S. Martinho, Funchal, CB1814 (3 May 89, *Citrus sinensis* and *C. limon*, col. F. Aguiar); Lugar de Baixo, Pt^a do Sol, CB0417 (23 May 89, *Citrus sinensis* and *C. reticulata*, col. F. Aguiar); Posto Agrário, Santana, CB2330 (31 May 89, *Citrus sinensis* and *C. limon*, col. F. Aguiar); Preces, C^a de Lobos, CB1414 (13 Jun.89, *Citrus sinensis*, col. F. Aguiar); Lombo de S. João, Pt^a do Sol, CB0319 (13 Jun.89, *Citrus limon*, col. F. Aguiar); C^o de Ferro, Funchal, CB2114 (4 Sep.89, *Citrus sinensis*, col. F. Aguiar); 4pup, Bom Sucesso, Funchal, CB2214 (2 Mar.90, C38, *Citrus sinensis*, col. J. Ascensão); S^o da Palmeira, C^a de Lobos, CB1513 (7 Mar.90, *Citrus sinensis*, col. F. Aguiar); S^o dos Moinhos, St^a Cruz, CB2815 (13 Mar.90, *Citrus sinensis*, col. F. Aguiar); 9pup, C^o da Ajuda, Funchal, CB1812 (19 Jun.90, C46, *Citrus reticulata*, col. G. Freitas); Livramento, Funchal, CB2115 (28 Aug.90, *Citrus sinensis*, col. A. Faria); Gaula, St^a Cruz, CB2916 (16 Jan.91, *Citrus sinensis*, col. J. Ascensão); 1 ♂, Lugar de Baixo, Pt^a do Sol, CB0417 (24 Jan.91, C63, *Coffea arabica*, col. F. Aguiar); Lugar de Baixo, Pt^a do Sol, CB0417 (24 Jan.91, *Poncirus trifoliata,* col. F. Aguiar; Caniço de Baixo, St^a Cruz ,CB2813 (7 Feb.91, *Citrus sinensis*, col. F. Aguiar); Choupana, Funchal, CB2316 (7 Mar.91, *Citrus limon*, col. F. Aguiar); S^o de S. Sebastião, St^a Cruz, CB3218 (28 May 91, *Citrus sinensis*, col. J. Ascensão); Maravilhas, Funchal, CB2013

(11 Mar.92, *Citrus sinensis*, col. V. Pereira); Funchal, CB2012 (15 Mar.92, *Citrus reticulata*, col. A. Fernandes); 8 ♀, 2 ♀, S° da Caldeira, C^a de Lobos, CB1215 (8 Jun.92, C152, *Citrus sinensis*, col. F. Aguiar); St° António, Funchal, CB1914 (4 Dec.92, C168, *Eugenia uniflora*, col. F. Aguiar); S. Martinho, Funchal, CB1713 (23 Feb.93, *Citrus sinensis*, col. J. Jesus); 5 ♂, 4 ♀ St^a Luzia, Funchal, CB2114 (28 Apr.93, C192a, *Persea americana*, col. F. Aguiar); Penha de França, Funchal, CB2012 (18 Jun.93, *Eugenia uniflora*, col. M. Pita); 83pup, 1 ♂, S° dos Barreiros, Caniço, CB2814 (2 Jul.93, *Citrus sinensis*, col. F. Aguiar); St^a Maria Maior, Funchal, CB2213 (8 Jul.93, *Citrus sinensis*, col. M. Pita); S. Martinho, Funchal, CB1813 (15 Jul.93, *Citrus sinensis*, col. J. Jesus); 11pup, Rp^a do Deão, Funchal, CB2014 (22 Jul.93, C241, *Citrus limon*, col. F. Aguiar); 11pup, Funchal, CB2113 (25 Aug.93, C254, *Ocotea foetens*, col. F. Aguiar); 4pup, Piornais, Funchal, CB1712 (6 Oct.93, C278, *Citrus limon*, col. J. Ascensão); 9pup, 20 ♀, S° do Saraiva, C^a de Lobos, CB1514 (13 Oct.93, C281, *Citrus limon*, col. F. Aguiar); S. Martinho, Funchal, CB1613 (13 Jan.94, C291, *Citrus medica*, col. F. Aguiar); 20pup, S° da Vargem, Caniço, CB2713 (27 Jan.94, C299, *Citrus sinensis*, col. V. Pereira); 6pup, S° do Porto da Ribeira, Ribeira Brava, CB0916 (27 Jan.94, C301, *Citrus sinensis*, col. A. Fernandes); S° da Igreja, Campanário, CB1016 (9 Feb.94, *Citrus sinensis*, col. F. Aguiar); 9pup, Rosário, S. Vicente, CB1028 (9 Feb.94, C326, *Citrus sinensis*, col. F. Aguiar); S° do Moreno, Ribeira Brava, CB0716 (10 Feb.94, *Citrus sinensis*, col. A. Fernandes); 4pup, S. Gonçalo, Funchal, CB2313 (11 Feb.94, C319, *Citrus sinensis*, col. A. Fernandes); C° do Lombo Segundo, Funchal, CB2016 (16 Feb.94, *Citrus sinensis*, col. H. Henriques); Caniço, St^a Cruz, CB 2714 (24 Feb.94, *Citrus sinensis*, col. F. Aguiar); 11pup, Fonte do Til, Arco da Calheta, BB9820 (24 Feb.94, C341, *Citrus reticulata*, col. A. Fernandes); Loreto, Arco da Calheta, BB9822 (24 Feb.94, *Citrus reticulata*, col. A. Fernandes); 5 ♂, 5 ♀, Bom Sucesso, Funchal, CB2215 (25 Feb.94, C344, *Citrus medica*, col. A. Fernandes); S^a Cruz, CB3217 (28 Feb.94, *Citrus lemon*, Col. A. Fernandes); S. Vicente, CB0830 (3 Mar.94, *Citrus sinensis*, col. A. Fernandes); 10pup, 2 ♂, 1 ♀, S° da Ribeira, St^a Cruz, CB3118 (14 Mar.94, C348, *Citrus sinensis*, col. F. Aguiar); S° do Ribeiro Real, C^a de Lobos, CB1515 (14 Mar.94, *Citrus sinensis*, col. A. Fernandes); Terça de Baixo, St^a Cruz, CB3318 (21 Mar.94, *Citrus sinensis*, col. F. Aguiar); S° da Graça, Machico, CB3421 (21 Mar.94, *Citrus sinensis*, col. F. Aguiar); Machico (vila), CB3420 (21 Mar.94, *Citrus limon*, col. F. Aguiar); Fajã Grande, Faial, CB2425 (7 Apr.94, *Citrus sinensis*, col. H. Guerra); Garajau, Caniço, CB2612 (9 Apr.94, *Citrus limon*, col. A. Fernandes); 16pup, S° da Corujeira, Campanário, CB0917 (13 Apr.94, C377, *Citrus sinensis*, col. A. Fernandes); S° da Igreja, Campanário, CB1115 (28 Apr.94, *Citrus sinensis*, col. F. Aguiar); S° do Pedregal, C^a de Lobos, CB1315 (28 Apr.94, *Citrus limon*, col. F. Aguiar); S° do Caramachão, Machico, CB3222 (3 May.94, *Citrus sinensis*, col. G. Freitas).

Material on British Museum - Funchal, Madeira (1920, *Citrus limon*, col. T. D. A. Cockerell); Funchal, Madeira (1923, *Citrus limon*, col. M. Grabham); Madeira (1925, *Citrus sinensis*, col. E. E. Green); Madeira (Aug. 1929, *Citrus limon*, col. J. Balfour-Browne);

Madeira (Aug. 1929, *Citrus* sp., col. J. Balfour-Browne).

Trialeurodes vaporariorum (WESTWOOD, 1856)

Aleyrodes vaporariorum WESTWOOD, 1856
Asterochiton lecanioides MASKELL, 1879
Aleurodes papillifer MASKELL, 1890
Aleurodes nicotianae MASKELL, 1895
Aleyrodes sonchi KOTINSKY, 1907
Asterochiton sonchi (KOTINSKY) QUAINTANCE & BAKER, 1914
Asterochiton vaporariorum (WESTWOOD) QUAINTANCE & BAKER, 1914
Trialeurodes sonchi (KOTINSKY) QUAINTANCE & BAKER, 1915
Trialeurodes vaporariorum (WESTWOOD) QUAINTANCE & BAKER, 1915
Trialeurodes mossopi CORBETT, 1935
Trialeurodes natalensis CORBETT, 1936
Trialeurodes sesbaniae CORBETT, 1936

The greenhouse whitefly is a cosmopolitan species feeding on a very wide range of host plants belonging to more than eighty families (MOUND & HALSEY, 1978). In Madeira is a common pest both indoors and outside, mostly on vegetable crops and ornamentals (Dist. map 2).

RUSSELL (1948) sustain that the origin of this species is North America and presently constitute a serious widespread pest, the most economically important species of the genus.

Identification of the pupal case - The puparia (Fig.10) of this species has values of length 800-1000μm and width 450-675μm. The colourless pupal case is surrounded by a vertical wax palisade, a marginal fringe of wax filaments and dorsal spine-like wax rays. On the dorsal disc, the margin (Fig.11) is slightly crenate and bears a dense row of different size submarginal papillae and often a small number of larger subdorsal papillae. The presence of these larger papillae seems to be related to the surface of the leaves where the insects develop. Those from hairy leaves are usually smaller and they often have more than four pairs of subdorsal papillae, smaller submarginal papillae and longer eighth abdominal setae. The opposite happens on smooth leaves (RUSSEL, 1948). According to BINK-MOENEN (1983) this apparent correlation between the degree of hairiness of the leaf and the position and number of papillae of the pupal case is not linear but other unknown factors seem to be involved. The longitudinal moulting suture reaches the margin and the transverse moulting suture reaches the submarginal area. On this area it presents a small pair of anterior marginal setae, one pair of posterior marginal setae and one pair of long caudal setae. The thoracic and abdominal tracheal pore areas are evident. The submedian area bears one pair of cephalic setae and the first and eighth abdominal pairs of setae. The subcordate vasiform orifice

(Fig.12), without anterior rim (MOUND,1966), is half open with the head of lingula partly covered by the cordate operculum (BINK-MOENEN, 1983). The lingula tip is three-lobed and present a pair of setae. On the ventral surface, it can be recognized the mouthparts, the legs, the antennas and two pairs of abdominal spiracle, one anterior and one posterior. The ventral eighth abdominal setae are situated between and anteriorly to the posterior abdominal spiracle.

Adult male - The male claspers (Fig.13) present a swelling near the apex, without subapical teeth like those of *A. floccosus*. The aedeagus (Fig.14) is much larger at its base and sharpens to the apex, which doesn't show any constriction. The antenna (Fig.15) have sensorial cones on the extremities of the third (Fig.16), fourth, sixth and seventh (Fig.17) segments, two primary sensoria at the extremity of the third (Fig.16) and one at the extremity of the fifth and seventh (Fig.17). The upper and lower compound eyes (Fig.18) are completely separated.

Material studied - St^a. Cruz, CB3219 (17 Apr.89, *Phaseolus vulgaris*, col. F. Aguiar); 3pup, S^o do Rancho, C^a de Lobos, CB1414 (7 Mar.90, C36, *Psidium guajava*, col. F. Aguiar); 14 ♀, S^o do Rancho, C^a de Lobos, CB1414 (22 May 90, C43, *Phaseolus vulgaris*, col. F. Aguiar); 7pup, S^o do Rancho, C^a de Lobos, CB1414 (18 Jul.90, C49, *Fragaria ananasse*, col. F. Aguiar); 6pup, 2 ♀, Lugar de Baixo, Pt^a. do Sol, CB0417 (24 Jan.91, C62, *Psidium guajava*, col. F. Aguiar); Lugar de Baixo, Pt^a do Sol, CB0417 (24 Jan.91, *Cucurbita pepo*, col. F. Aguiar); Lugar de Baixo, Pt^a. do Sol, CB0417 (24Jan.91, *Gerbera* sp., col. F. Aguiar); Funchal, CB2213 (26 Aug.91, *Carica papaya*, col. M. Rodrigues); 62pup, Caminho Grande e Preces, C^a de Lobos, CB1414 (13 Jan.92, C91, *Carica papaya*, col. F. Aguiar); 97 ♂, 104 ♀, Adegas, Pt^a. do Sol, CB0318 (8 Jun.92. C153, *Phaseolus vulgaris*, col. F. Aguiar); S^o das Lourencinhas, C^a de Lobos, CB1614 (16 Sep.92, *Psidium guajava*, col. F. Aguiar); Campanário, Ribeira Brava, CB1016 (12 Oct.92, *Cucumis sativus*, col. F. Aguiar); S^o dos Salões, Canhas, CB0119 (24 Nov.92, *Cucumis sativus*, col. F. Aguiar); 250pup, S^o das Terças, Pt^a do Sol, CB0318 (17 Dec.92, C177, *Verbena* sp., col. F. Aguiar); 14pup, S^o da Ribeirinha, Camacha, CB2716 (12 Jan.93, C179, *Ageratina adenophora*, col. F. Aguiar); S^o dos Salões, Canhas, CB0119 (25 Mar.93, *Cucumis sativus*, col. F. Aguiar); Fajã dos Padres, C^a de Lobos, CB1014 (4 May 93, *Lycopersicum esculentum*, col. V. Pereira); 6pup, S. Pedro, Funchal, CB 2113 (30 May 93, C208, *Eugenia uniflora*, col. F. Aguiar); 3 ♂, 9 ♀, S^o do Barreiras, Caniço, CB2814 (2 Jul.93, C217, *Lycopersicum esculentum*, col. F. Aguiar); 4pup, 9, 17, S^o do Garachico, C^a de Lobos, CB1315 (2 Jul.93, C218, *Solanum muricatum*, col. F. Aguiar); Serrado e Adega, C^a de Lobos, CB1413 (24 Aug.93, C256, *Cucurbita pepo*, col. F. Aguiar); 21pup, 43 ♂, 85 ♀, S^o das Lourencinhas, C^a de Lobos, CB1614 (2 Sep.93, C257, *Gerbera* sp., col. V. Barros); 51pup, S^o da Morena, St^a Cruz, CB3119 (13 Sep.93, C260, *Gerbera* sp., col. V. Pereira); 20pup, S^o do Saraiva, C^a de Lobos, CB1514 (13 Oct.93, C282, *Solanum muricatum*, col. F. Aguiar); 3 ♂, 13 ♀, S^o do Saraiva, C^a de Lobos, CB1514 (13 Oct.93,

C283, *Carica papaya*, col. F. Aguiar); S° das Lourencinhas, C^a de Lobos, CB1614 (10 Nov.93, C287, *Lycopersicum esculentum*, col. Z. Vasconcelos); S° das Murteiras, Ribeira Brava, CB0717 (19 Jan.94, *Cucumis sativus*, col. V. Pereira); St^a. Luzia, Funchal, CB2115 (27 Jan.94, *Hibbiscus* sp., col. F. Aguiar); 17pup, S° da Madalena, Funchal, CB1914 (30 Jan.94, C302, *Euphorbia pulcherrima*, col. F. Aguiar); 5 ♂, 4 ♀, S° da Igreja, Campanário, CB1016 (9 Feb.94, C313, *Urtica dioica*, col. F. Aguiar); 1 ♂, 1 ♀, S° dos Barreiros, Caniço, CB2813 (10 Feb.94, C334, *Cucumis sativus*, col. F. Aguiar); Lugar de Baixo, Pt^a. do Sol, CB0417 (10 Feb.94, *Euphorbia pulcherrima*, col. F. Aguiar); S° dos Moinhos, Caniço, CB2815 (10 Feb.94, *Phaseolus vulgaris*, col. F. Aguiar); S° dos Moinhos, Caniço, CB2815 (10 Feb.94, *Lycopersicum esculentum*, col. F. Aguiar); 5 ♂, 40 ♀, S° do Tranqual, Campanário, CB1016 (20 Apr.94, *Cucumis sativus*, M. Rodrigues); 23pup, 1, S° da Marinheira, Est° de C^a de Lobos, CB 1416 (31 May 94, C409, *Lactuca sativa*, col. G. Freitas).

Aleyrodes proletella (LINNAEUS, 1758)

Phalaena (Tinea) proletella LINNAEUS, 1758
Phalaena culiciformis GEOFFROY, 1785
Aleyrodes proletella (LINNAEUS) LATREILLE, 1801
Aleyrodes chelidonii LATREILLE, 1807
Aleyrodes brassicae WALKER, 1852
Aleyrodes chelidonii BURMEISTER; KOCH, 1857
Aleurodes brassicae KOCH, 1857
Aleurodes youngi HEMPEL, 1901

This aleyrodid, commonly known as the European cabbage whitefly, feeds on a wide variety of plants, with preference for *Brassica* spp. VAN LENTEREN & NOLDUS (1990) relate this host specificity to a reaction to host plant odour; it seems to be the only species in which a reaction of this type has been found. In Madeira it occurs throughout the year on *Brassica oleracea* where this plant exists (Dist. map 3).

This species is spread all over the Palaearctic Region including the Canary Islands, part of the Ethiopian Region, Brazil (Neotropical Region) and New Zealand (Pacific Region) (MOUND & HALSEY, 1978).

Identification of the pupal case - The almost colourless pupal case (Fig.19) of this species has values of length 1300-1450µm and width 1000-1100µm. It has a weakly crenate margin (Fig.20), rarely with marginal wax (MOUND, 1966). The longitudinal moulting suture reaches the margin and the transverse moulting suture ends on the subdorsal area. On the submarginal area it presents a small pair of anterior marginal setae, one pair of posterior marginal setae and one pair of caudal setae of similar size. MOUND (1966) refers the existence of fourteen pairs of minor dorsal setae, near the margin. On the submedian area of the dorsal

disc we can find three pairs of major setae, on cephalic region and first and eighth abdominal segments. This last pair lay lateral to the anterior margin of the operculum. The tracheal pore areas, thoracic and abdominal, are not differentiated from margin . The dorsum presents an undetermined number of very small pores. The subcordate vasiforme orifice (Fig.21), with smooth inner margins, is less than half occupied by the rectangular operculum, leaving the lingula exposed but included within the orifice. The lingula tip is usually as broad as long and bears a pair of terminal setae that extend beyond the orifice margin. The caudal furrow and ridges are very weakly defined (MOUND, 1966; BINK-MOENEN, 1983). On the ventral surface, besides the already mentioned structures, antennas (extented to the base of the prothoracic leg), legs and rostrum, two pairs of abdominal spiracles are evident, the anterior larger than the posterior. We can also found the ventral eighth abdominal pair of setae on a antero-medial position in relation to the posterior spiracles.

Adult male - The male claspers (Fig.22) are stout and arch-shaped, bearing strong setae near the apex which are sharply pointed. The aedeagus (Fig.23) has a very peculiar shape, being upturned on its median region by almost ninety degrees. The ventral side of this region has a swollen appearance. The seven segmented antenna (Fig.24) presents one sensorial cone on the extremities of the third (Fig.25) and sixth segments, and two on the extremity of the seventh (Fig.26), two primary sensoria at the extremity of the third (Fig.25) and one at the extremities of the fifth and seventh (Fig.26). The upper and lower compound eyes (Fig.27) are completely separated.

Material studied - 1 ♀, Mantilha de Baixo, Pt[a] do Sol, CB0218 (11 Feb.92, C92, *Brassica oleracea*, col. F. Aguiar); 6pup, 1 ♀, S° das Terças, Pt[a] do Sol, CB0318 (11 Feb.92, C93, *B. oleracea*, col. F. Aguiar); 5pup, 3 ♀, S° das Lourencinhas, C[a] de Lobos, CB1614 (13 Feb.92, C104, *B. oleracea*, col. F. Aguiar); 1 ♀, Álamos, Funchal, CB1915 (13 Feb.92, C110, *B. oleracea*, col. F. Aguiar); 29pup, C° dos Saltos, Funchal, CB2115 (4 Mar.92, C113, *B. oleracea*, col. F. Aguiar); 16 ♀, S° dos Barreiros, Caniço, CB2814 (2 Jul.93, C216, *B. oleracea*, col. F. Aguiar); 11pup, 6 ♂, 2 ♀, S° das Lourencinhas, C[a] de Lobos, CB1614 (24 Aug.93, C248, *B. oleracea*, col. F. Aguiar); S° da Caldeira, C[a] de Lobos, CB1215 (27 Jan.94, C298, *B. oleracea*, col. M. Rodrigues); Gaula, St[a] Cruz, CB2916 (13 May 94, C401, *B. oleracea*, col. Z. Vasconcelos).

Bemisia sp. near ***afer*** (PRIESNER & HOSNY,1934)

Like *B. afer* this species shows a great variation in the dorsal morphological characters of the pupal case, which probably are also related to the presence or absence of hairiness on the host plant leaves. Pupal case on Fig.28 is from *Myrica faya* and that on Fig.29 is from *Clethra arborea*. So far this species has been mainly collected on plants characteristic of the macaronesia flora on the center and north of the island, from 100 to 1100 meters (Dist.

map 4).

B. afer is widespread in Africa and probably indigenous to this region. It also exists in southern Europe, Asia and Madagascar.

Identification of the pupal case - The pupal case (Figs.28 and 29), with a length of 1000-1450µm and width of 625-1025µm, is normally pale with an irregularly undulate or crenate margin (Fig.32), with submarginal ridges irregular and short. The longitudinal moulting suture reaches the margin and the transverse moulting suture ends on the subdorsal area. On the submarginal area we can observe the anterior and posterior marginal pairs of setae and one pair of caudal setae, all of them small. The thoracic and abdominal tracheal pore areas are differentiated from margin as a comb. On the subdorsal area of the dorsal disc there are ten or more pairs of very small setae. An undetermined number of submarginal setae and pores are scattered along the submarginal area. The submedian area presents three pairs of small setae, one cephalic, the first and the eighth abdominal. It also presents thoracic and abdominal depressions. Some forms like that of Fig.28 shows tubercle clusters that are variable on number and size. Scattered all over the dorsal disc an undetermined number of pores can be observed (Fig.29). On Fig.28 the submarginal and subdorsal areas are simplified, lacking the majority of pores and some microsetae. The vasiforme orifice (Fig.30) like *B. afer* is open, elongate-triangular, with the operculum filling about half of it, leaving the lingula tip exposed and with a pair of long setae that extend beyond the posterior margin of the orifice. The floor of the vasiform orifice (Fig.31) is covered by a heavy pattern of ridges. The caudal furrow and caudal ridges are distinct. On the ventral surface the thoracic tracheal folds are very well defined and covered by stipples which density decreases from the margin. The caudal tracheal fold is less defined but easily recognized. The ventral eighth abdominal setae are long, the anterior and posterior abdominal spiracles are similar in size and the antennas are extented to the base of the prothoracic leg.

Adult male - The claspers, (Fig.33) strongly curved at its distal third are also sharply pointed at the apex. Between the inflatable sac and the apex a pointed spine can be observed. The aedeagus (Fig.34) is long and slender almost straight. The antenna (Fig.36) presents sensorial cones on the extremities of the third (Fig.37) and sixth segments, and one on the the middle of the seventh (Fig.38), two primary sensoria at the extremity of the third, (Fig.37) one at the extremity of the fifth and one at the middle of the seventh (Fig.38). The upper and lower compound eyes (Fig.35) are linked by one pair of ommatidea.

Material studied - 3pup, Chão da Ribeira, Seixal, CB0332 (21 Feb.92, C109, *Myrica faya*, col. F. Aguiar); 6 ♂, Seixal, CB0332 (6 Mar.92, C118, *Myrica faya*, col. F. Aguiar); 9pup, 6 ♂, Fajã do Penedo, Pt^{a} Delgada, CB1533 (20 Mar.92, C136, *Marcetella maderensis*, col. F. Aguiar); 1pup, Caniçal, CB3523 (28 May 92, C258, *Phylis nobla*, col. F. Aguiar); Fajã da Nogueira, Santana, CB2223 (18 Nov.92, C198, *Myrica faya*, col. F. Aguiar); 4pup, Caniçal, CB3523 (18 Nov.92, C199, *Myrica faya*, col. F. Aguiar); 8pup, 1♂, Fajã da Nogueira,

Santana, CB2223 (15 Dec.92, C197, *Myrica faya*, col. F. Aguiar); 2pup, Caniçal, CB3523 (15 Dec.92, C201, *Myrica faya*, col. F. Aguiar); 4pup, Fajã da Nogueira, Santana, CB2223 (5 Jan.93, C200, *Myrica faya*, col. F. Aguiar); 6 ♂, 2R, Fajã da Nogueira, Santana, CB2223 (17 Jun.93, C211, *Myrica faya*, col. F. Aguiar); 11pup, 13 ♂, 23R, Bica da Cana, S. Vicente, CB0825 (27 Jan.94, C337, *Clethra arborea*, M. Carvalho); 1pup, Encumeada, CB1125 (3 Feb.94, C375, *Persea indica*, M. Carvalho); 2pup, Fanal, S. Vicente, BB9932 (3 Feb.94, C381, *Apollonias barbujana*, M. Carvalho); 1pup, Fajã da Nogueira, Santana, CB2124 (7 Feb.94, C382, *Hypericum inodorum*, F. Aguiar).

Subfamily **ALEURODICINAE**

Paraleyrodes bondari PERACCHI, 1971

This species was described from *Citrus* sp. collected in Brazil (Rio de Janeiro). Its recent introduction in Madeira was probably done via *Citrus* material, from that origin. Its hosts in Madeira are mainly *Citrus* spp. and other subtropical fruit trees mostly avocado. Its occurrence in the island is closely associated to those hosts on the south coast of the island, below 400 meters (Dist. map 5).

The genus *Paraleyrodes* has ten species almost all from the Neotropical Region and mainly from Brazil (MOUND & HALSEY, 1978). More recently another species was described by IACCARINO (1989) from Syria.

Identification of the pupal case - The elliptical pupal case (Fig.39), with a length of 1050-1260µm and width of 550-780µm, is normally pale yellow. The slightly undulate margin (Fig.40) bears a pair of small anterior marginal setae and one pair of longer posterior marginal setae. On the submarginal area there are fourteen pairs of setae being three anterior, ten laterals and one caudal. On the dorsal disc, subdorsal area we can observe seven pairs of compound wax pores, one cephalic and six abdominal. The first two of the later are smaller and different in structure with 8-9 loculae. The other ones including the cephalic pair have 11-13 loculae (Fig.41). These compound pores produce very long cylindrical wax rods often longer than the pupal case. Between the transverse moulting suture and the cephalic compound pore we can observe vestige of the third instar's compound pores. On the submedian region the longitudinal moulting suture reaches the margin and the transverse moulting suture reaches the submarginal area. Also on the submedian region the following pairs of small setae are present: the cephalic pair and the first and eighth abdominal. Several pairs of submedian depressions are present, mostly on the abdominal segments. The subtriangular vasiform orifice (Fig.42) has a large and tongue-shaped lingula that extends beyond its posterior margin. The lingula itself is densely covered by spinules and has two pairs of long and stout setae. The operculum which has a sinuous anterior margin with a pair of opercular setae, covers only half of the orifice. On the dorsal disc an undetermined number of discoidal pores are

present, mainly on the abdominal segments. On the ventral surface there are three pairs of setae, two thoracic pairs and one ventral abdominal and four pairs of spiracles,two thoracic and two abdominal. Besides the rostrum and the tree pairs of legs, all of them with tarsal claws, the antenna are long reaching (on the male) the basal segment of the metathoracic leg. The pupal case described by PERACCHI (1971) is that of a female whose antennas don't exceed the basal segment of the mesothoracic leg.

Adult male - The claspers (Fig.43) are robust with an internal subapical tooth. The apex is curved but not sharply pointed. In *Paraleyrodes* the distal end of the aedeagus display complex forms that are specifically unique. The shape of *P. bondari* aedeagus (Fig.44) has its apex characteristically bifurcated in two subapical processes (dorsal view) and two spines, one dorsal and one ventral (side view). The antenna of the male *Paraleyrodes* (Fig.46) has apparently only three segments because the terminal four are fused into one long and thick structure (GILL, 1990), which has a great number of primary sensoria randomly scattered (Fig.47). The upper and lower compound eyes (Fig.45) are linked by one pair of ommatidea.

Material studied - 2pup, 1 ♂, 2 ♀, S. Martinho, Funchal, CB1613 (15 Feb.90, C41, *Citrus sinensis*, col. F. Aguiar); Livramento, Funchal, CB2115 (28 Aug.90, *Citrus sinensis*, col. A. Faria); 5pup, C° da Ajuda, Funchal, CB1812 (3 Feb.91, C67, *Citrus reticulata*, col. G. Freitas); Caniço, CB2813 (7 Feb.91, *Citrus sinensis*, col. F. Aguiar); Maravilhas, Funchal, CB2013 (11 Mar.92, *Citrus sinensis*, col. V. Pereira); 6pup, Funchal, CB2012 (15 Mar.92, C132, *Citrus reticulata*, col. A. Fernandes); 7pup, C° da Ajuda, Funchal, CB1812 (10 Apr.92, C145, *Persea americana*, col. G. Freitas); 6pup, 4 ♂, Lb° da Boa Vista, Funchal, CB2214 (8 Dec.92, C169, *Citrus sinensis*, col. F. Aguiar); 1pup, Lb° da Boa Vista, Funchal, CB2214 (8 Dec.92, C171, *Citrus reticulata*, col. F. Aguiar); 4pup, 1 ♂, Lb° da Boa Vista, Funchal, CB2214 (8 Dec.92, C172, *Eugenia uniflora*, col. F. Aguiar); 6pup, 8 ♂, C° da Ajuda, Funchal, CB1812 (12 Jan.93, C181, *Persea americana*, col. G. Freitas); C° da Ajuda, Funchal, CB1812 (12 Jan.93, *Citrus reticulata*, col. G. Freitas); 6pup, S. Martinho, Funchal, CB1713 (23 Feb.93, C184, *Citrus sinensis*, col. J. Jesus); 5pup, 6 ♂, St^a Luzia, Funchal, CB2114 (28 Apr.93, C193, *Persea americana*, col. F. Aguiar); 6 ♂, St^a Luzia, Funchal, CB2114 (28 Apr.93, C193, *Persea americana*, col. F. Aguiar); 7 ♂, St^a Luzia, Funchal, CB2114 (28 Apr.93, C195, *Citrus sinensis*, col. F. Aguiar); Lb° da Boa Vista, Funchal, CB2214 (3 Jul.93, C220, *Persea americana*, col. C. Aguiar); St^a Maria Maior, Funchal, CB2213 (8 Jul.93, C224, *Citrus sinensis*, col. M. Pita); St^a Maria Maior, Funchal, CB2213 (8 Jul.93, C237, *Persea americana*, col. M. Pita); S° do Amparo, Funchal, CB1813 (15 Jul.93, C233, *Citrus sinensis*, col. J. Jesus); Funchal, CB2013 (1 Aug.93, *Persea americana*, col. F. Aguiar); 5pup, Funchal, CB2113 (25 Aug.93, C252, *Ocotea foetens*, col. F. Aguiar); Lugar de Baixo, Pt^a do Sol, CB0417 (8 Oct.93, C274, *Persea americana*, col. F. Aguiar); 4pup, S° do Saraiva, C^a de Lobos, CB1514 (19 Jan.94, C295, *Citrus limon*, col. J. Ascenção); 8pup, St^a Luzia, Funchal, CB2114 (24 Jan.94, C304, *Citrus sinensis*, col. B. Alves); 8pup, St^a Luzia, Funchal,

CB2115 (27 Jan.94, C309, *Citrus limon*, col. L. Ferreira); 11pup, S. Gonçalo, Funchal, CB2313 (11 Feb.94, C320, *Citrus limon*, A. Fernandes); 13pup, 1 ♂, Stª Cruz, CB3219 (28 Feb.94, C340, *Persea americana*, col. A. Fernandes); 13pup, Sº do Ribº Real, Cª de Lobos, CB1515 (14 Mar.94, C366, *Citrus sinensis*, col. A. Fernandes); 16pup, 3 ♂, Pte dos Frades, Cª de Lobos, CB1514 (14 Mar.94, C368, *Citrus sinensis*, col. A. Fernandes); 6pup, Pte dos Frades, Cª de Lobos, CB1514 (14 Mar.94, C369, *Citrus limon*, col. A. Fernandes); 10pup, 2 ♀, Terça de Baixo, Stª Cruz, CB3318 (21 Mar.94, C362, *Citrus sinensis*, col. F. Aguiar); 2pup, Garajau, Caniço, CB2612 (9 Apr.94, C370, *Citrus limon*, col. A. Fernandes); 6pup, Preces, Cª de Lobos, CB1414 (24 Apr.94, C388, *Citrus limon*, col. F. Aguiar).

FINAL CONSIDERATIONS

The five species treated in this study have probably all been introduced to Madeira. On the basis of available information it appears that *Aleurothrixus floccosus* and *Trialeurodes vaporariorum* are Nearctic species, *Aleyrodes proletella* seems to be Palaearctic and the *Bemisia* sp. if it is *afer* is probably of Ethiopian origin. In relation to *Paraleyrodes bondari*, evidence points to a Neotropical origin.

It is known that whiteflies are very poor fliers and no evidence exists that they routinely migrate long distances, unless they are carried by the wind. The first two species are highly dispersed pests throughout the world and could be considered examples of the transportation by wind. This can explain the colonization of the entire Algarve region in two years by *A. floccosus*. Many other species probably moved out of their natural environs with the help of man. Concerning Madeira and besides the wind action, we could consider the commercial transactions of plants with Continental Europe, the return of emigrants and deficient phytossanitary inspection measures as an explanation for the presence of these species on the island.

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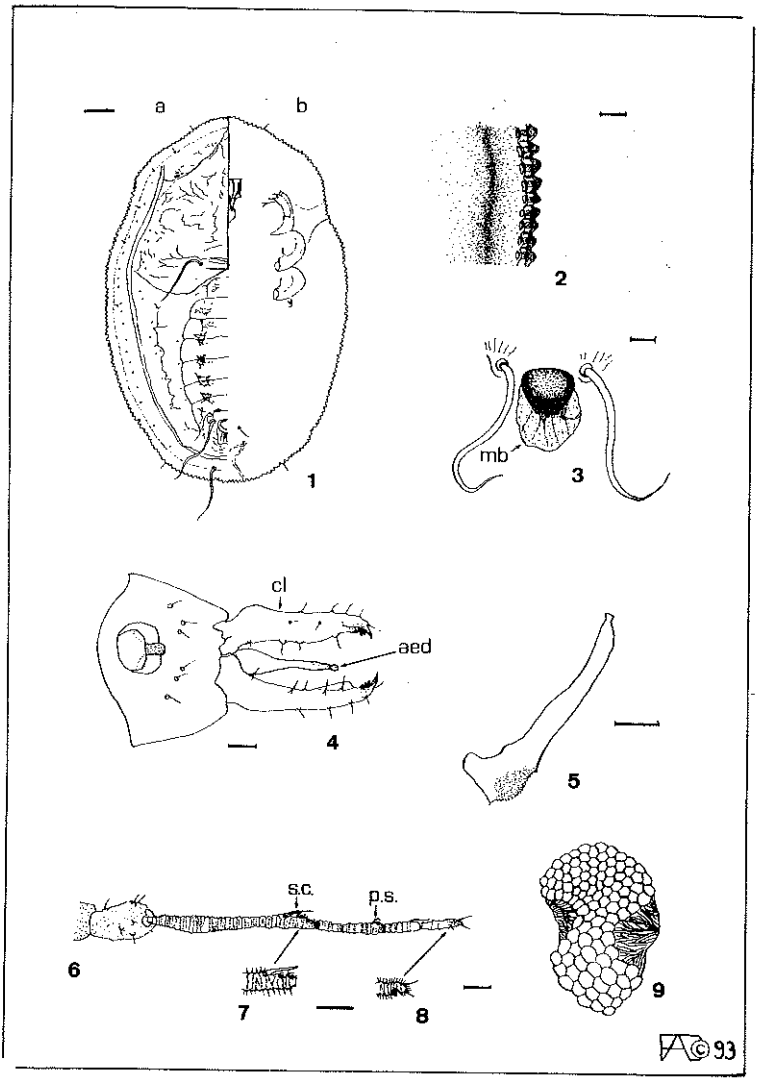
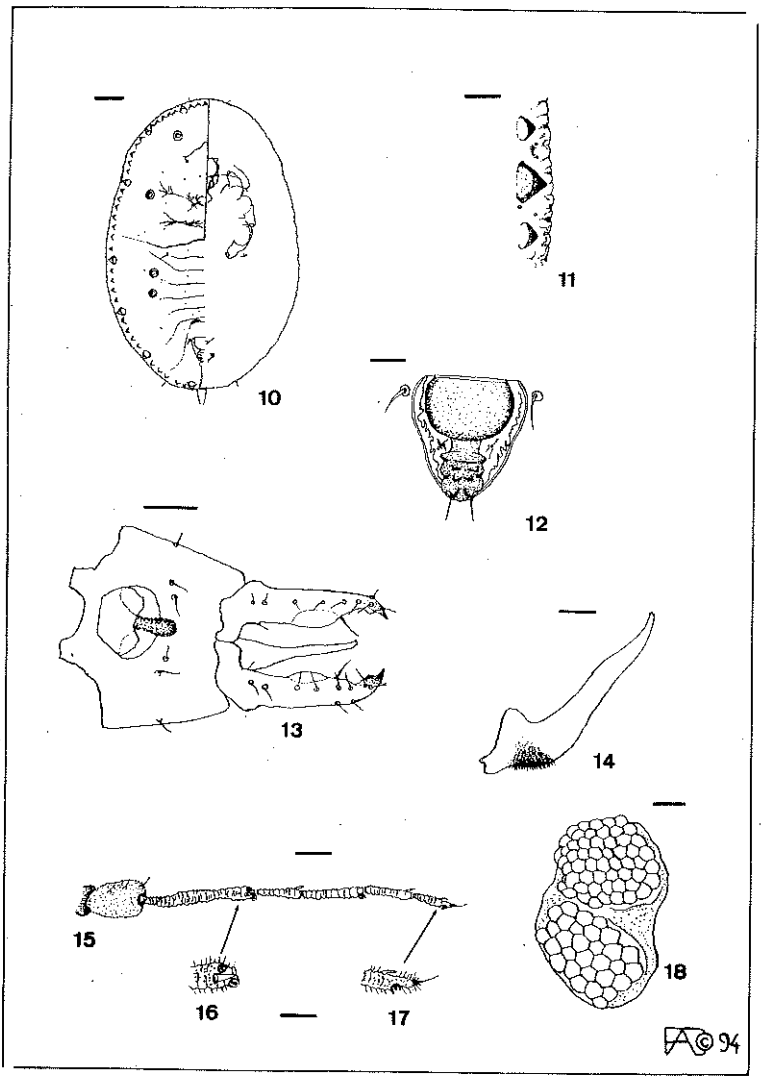
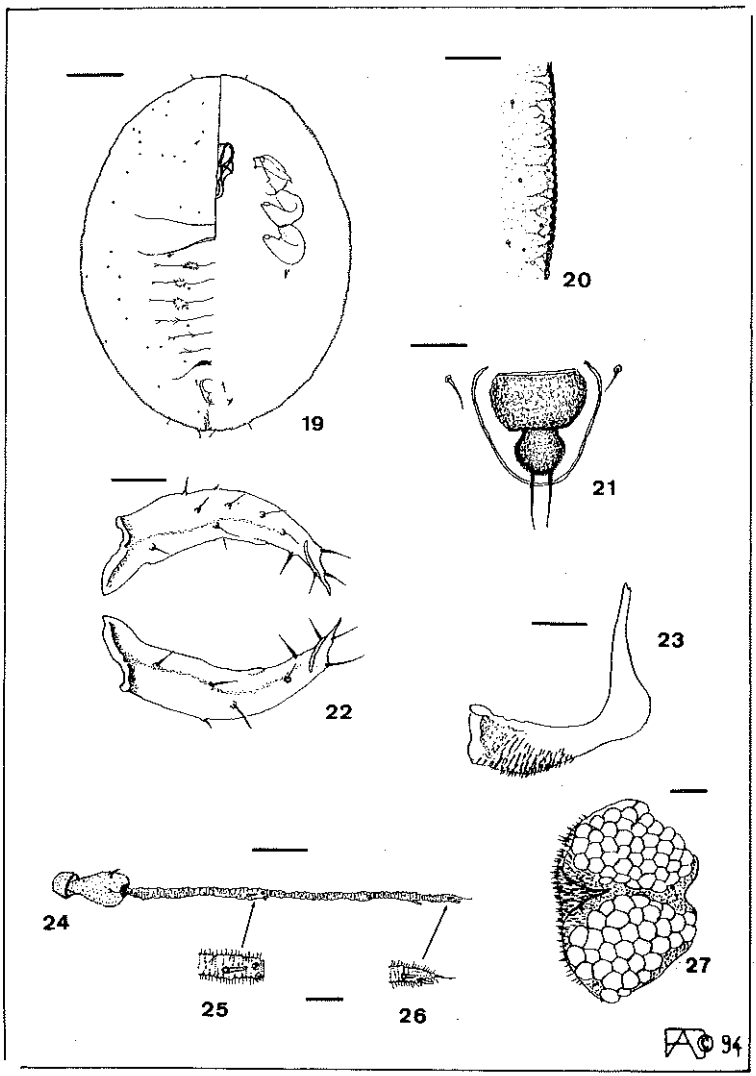


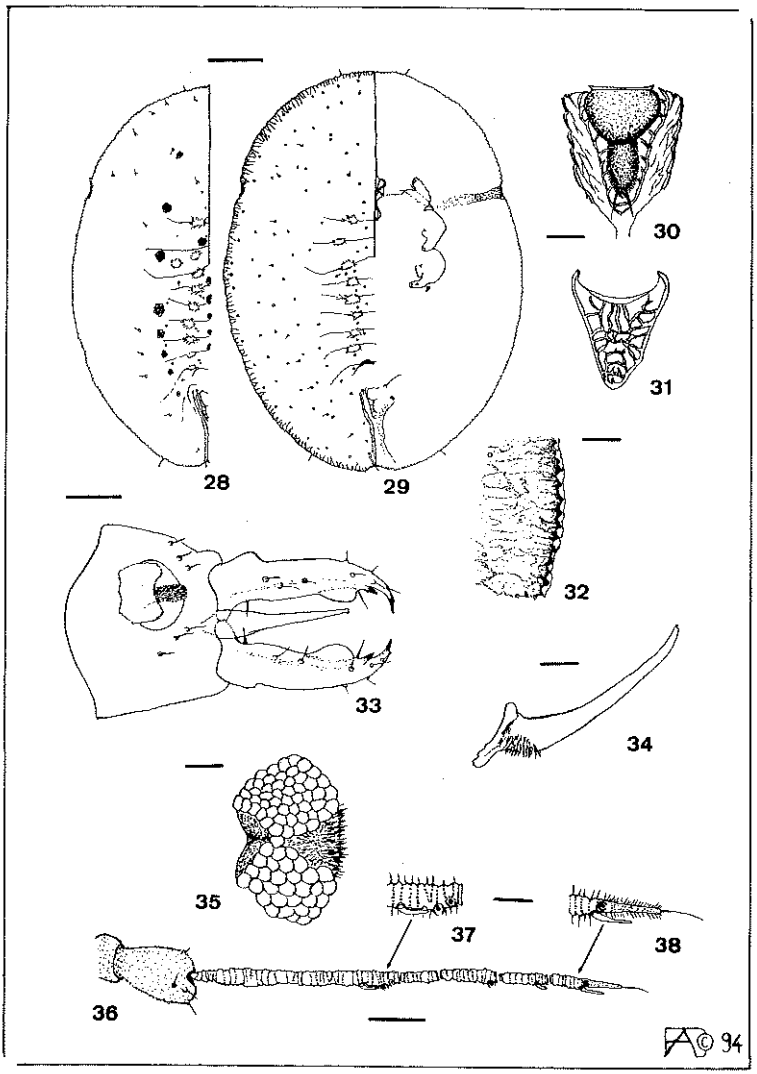
Figs. 1-9 - *Aleurothrixus floc·· sus:* 1. Pupal case, a - dorsal surface, b - ventral surface (bar = 97µm); 2. Margin (bar = 25µm); 3. V siform structure and eighth abdominal setae, mb - membrane (bar = 25µm); 4. Male 8th to 10th ab..om al segments and genitalia, cl - claspers, aed - aedeagus, dorsal view (bar = 25µm); 5. Aedeagus, si.. view (bar = 25µm); 6. Antenna, sc - sensorial cone, ps - primary sensoria (bar = 25µm); 7. tail of the antenna third seg. (bar = 27.8µm); 8. Detail of the apex of the seventh seg.(bar = 27.8µm 9. Upper and lower left side compound eyes (bar = 25µm).



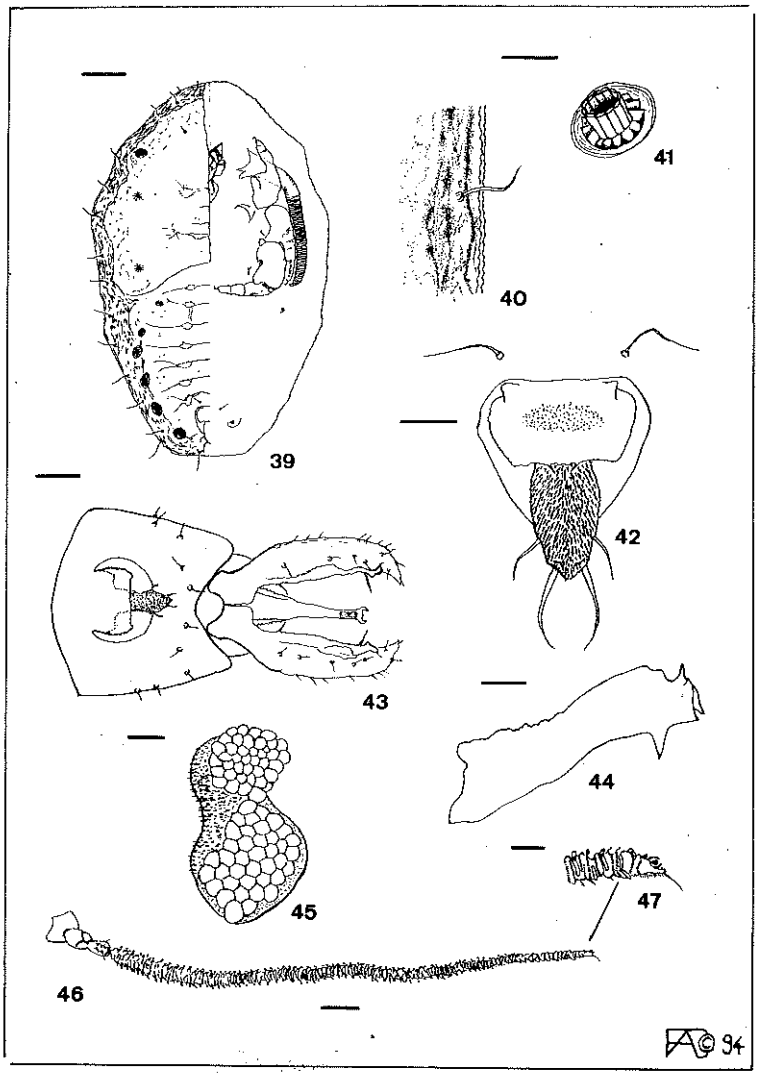
Figs. 10-18 - *Trialeurodes vaporariorum* : 10. Pupal case (bar = 97µm); 11. Margin (bar = 25µm); 12. Vasiform orifice and eighth abdominal setae (bar = 25µm); 13. Male 8th to 10th abdominal segments and genitalia (bar = 50µm); 14. Aedeagus, side view (bar = 25µm); 15. Antenna (bar = 51µm); 16. Detail of the antenna third seg. (bar = 25µm); 17. Detail of the apex of the seventh seg.(bar = 25µm); 18. Upper and lower left side compound eyes (bar = 51µm).



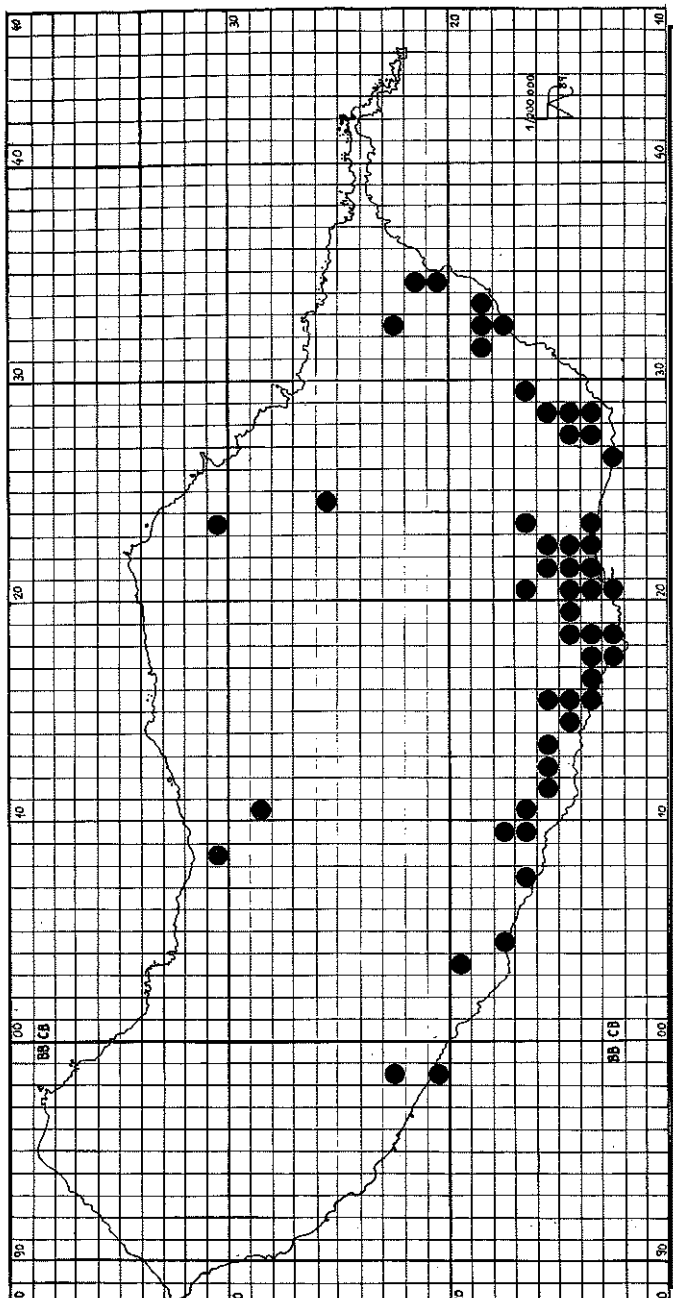
Figs. 19-27 - *Aleyrodes proletella*: 19. Pupal case (bar = 182μm); 20. Margin (bar = 50μm); 21. Vasiform orifice and eighth abdominal setae (bar = 37.5μm); 22. Male claspers (bar = 27.8μm); 23. Aedeagus, side view (bar = 27.8μm); 24. Antenna (bar = 90μm); 25. Detail of the antenna third seg. (bar = 27.8μm); 26. Detail of the apex of the seventh seg.(bar = 27.8μm); 27. Upper and lower right side compound eyes (bar = 27.8μm).



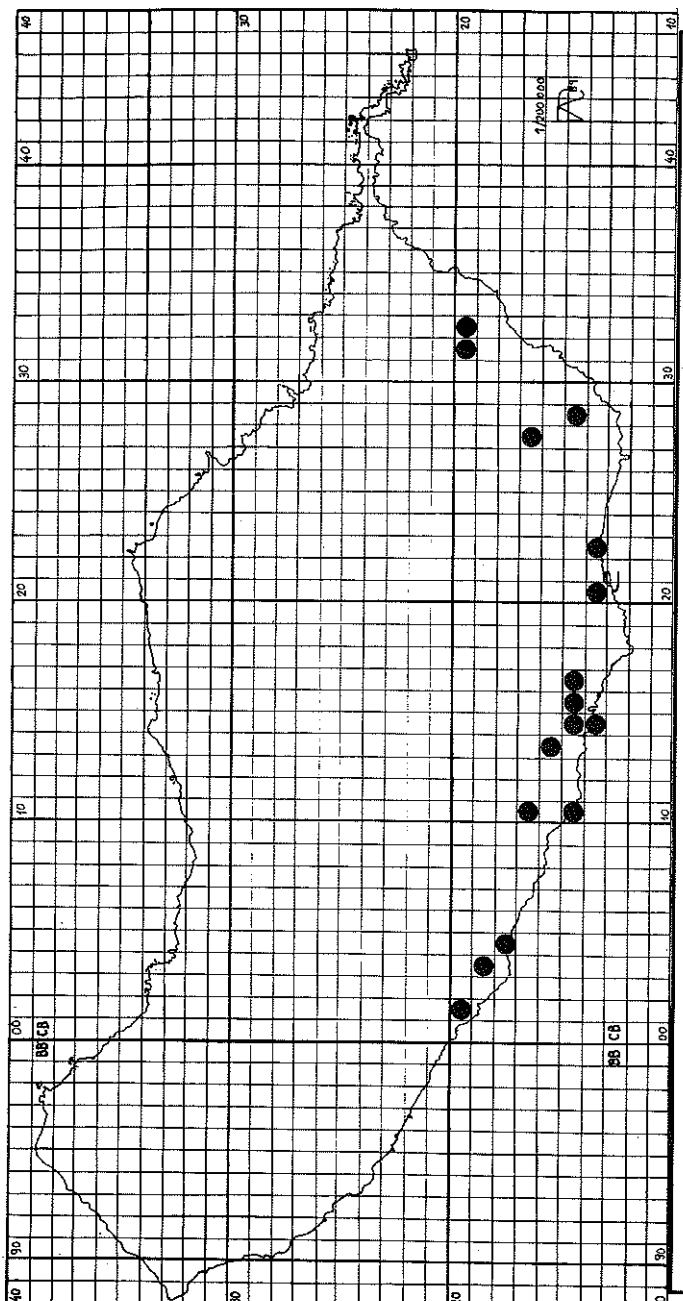
Figs. 28-38 - *Bemisia* sp. near *afer*: 28. Pupal case from *Myrica faya* (bar = 194μm); 29. Pupal case from *Clethra arborea* (bar = 194μm); 30.Vasiform orifice and eighth abdominal setae (bar = 33.3μm); 31. Vasiform orifice floor (bar = 33.3μm); 32. Margin (bar = 31μm); 33. Male 8th to 10th abdominal segments and genitalia (bar = 50μm); 34. Aedeagus, side view (bar = 27.8μm); 35. Upper and lower left side compound eyes (bar = 31μm); 36. Antenna (bar = 50μm); 37. Detail of the antenna third seg. (bar = 20.8μm); 38. Detail of the apex of the seventh seg.(bar = 20.8μm).



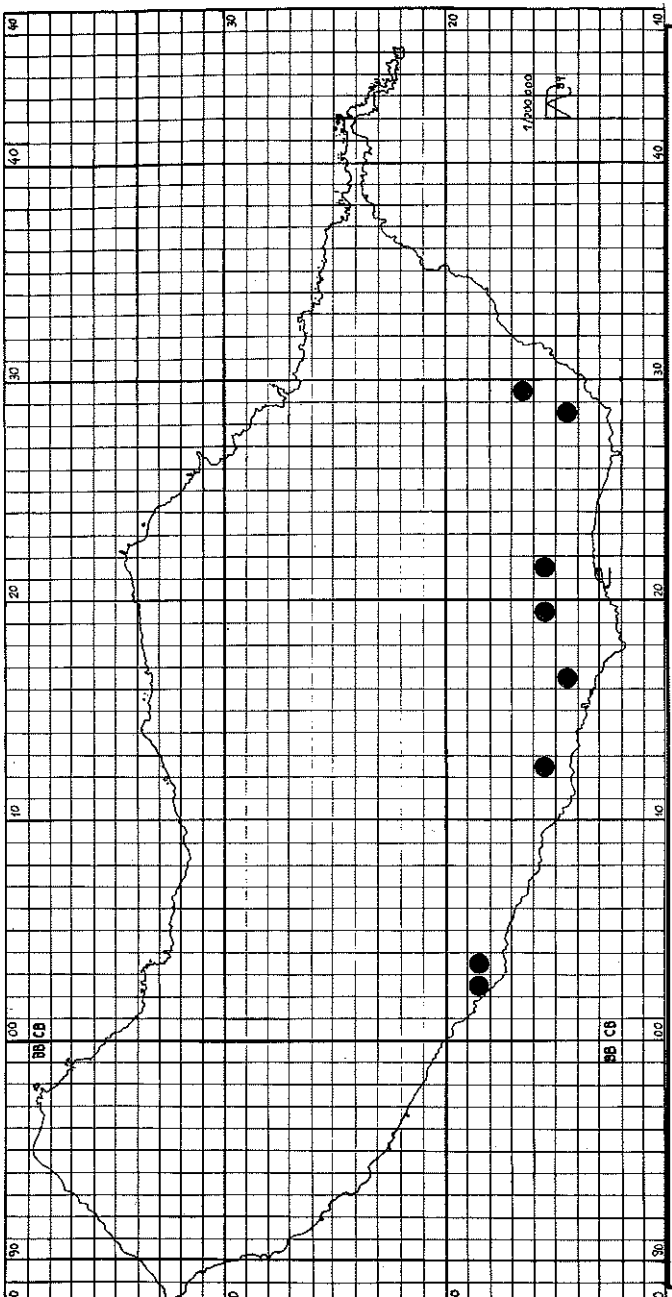
Figs. 39-47 - *Paraleyrodes bondari* : 39. Pupal case (bar = 137μm); 40. Margin (bar = 25μm); 41. Cephalic compound wax pore (bar = 25μm); 42. Vasiform orifice and eighth abdominal setae (bar = 34μm); 43. Male 8th to 10th abdominal segments and genitalia (bar = 51μm); 44. Aedeagus, side view (bar = 25μm); 45. Upper and lower right side compound eyes (bar = 33.3μm); 46. Antenna (bar = 97μm); 47. Detail of the apex of the antenna (bar = 29.4μm).



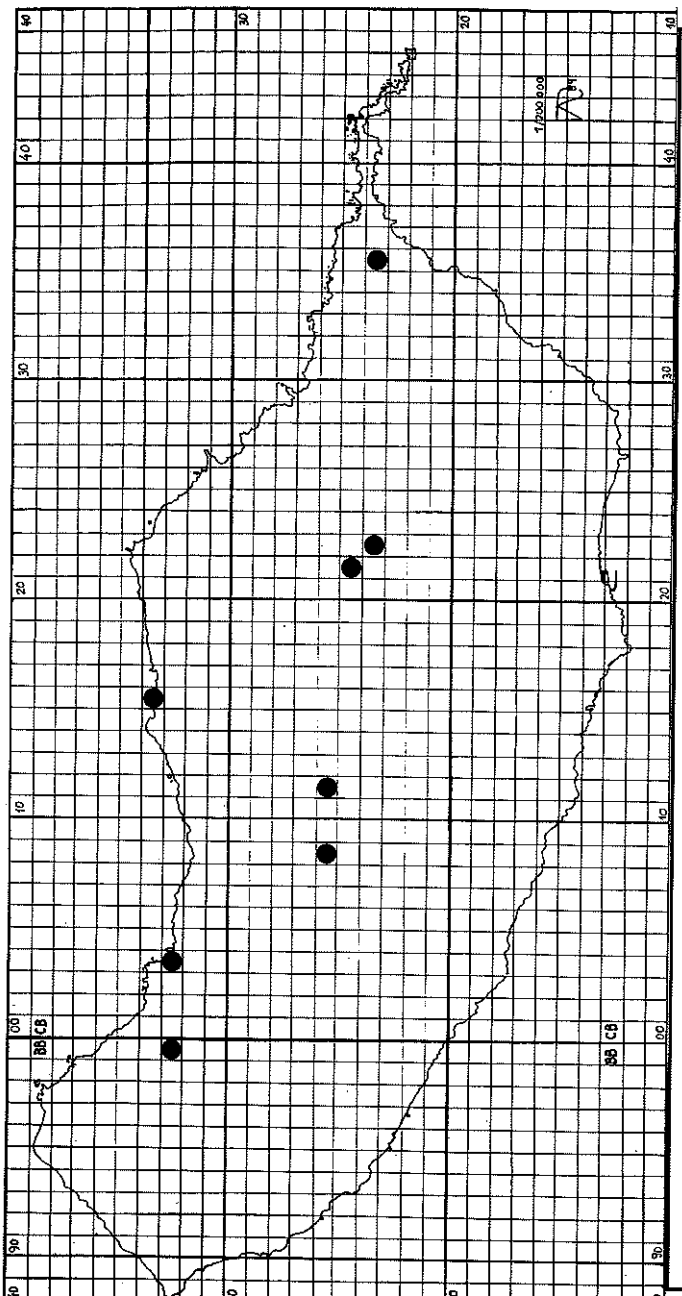
Distribution map 1 - *Aleurothrixus floccosus*



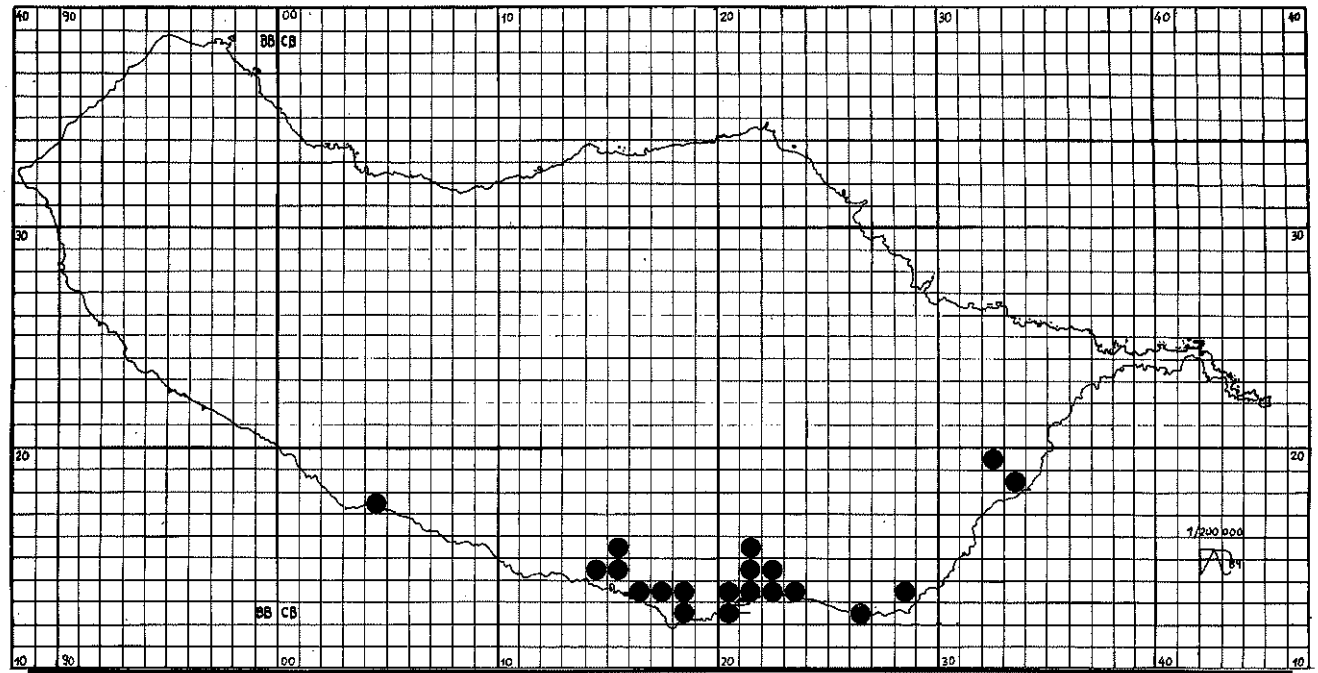
Distribution map 2 - *Trialeurodes vaporariorum*



Distribution map 3 - *Aleyrodes proletella*



Distribution map 4 - *Bemisia* sp. near *afer*



Distribution map 5 - *Paraleyrodes bondari*