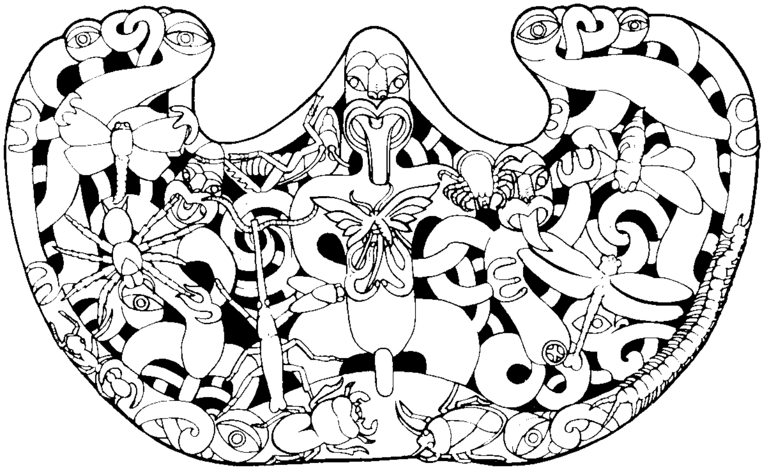

Fauna of New Zealand

Ko te Aitanga Pepeke o Aotearoa

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This series of refereed occasional publications has been established to encourage those with expert knowledge to publish comprehensive accounts of elements in the New Zealand fauna. The series is professional in conception and presentation, yet every effort is made to provide resources for identification and information that are accessible to the non-specialist.

Fauna of New Zealand deals with non-marine invertebrates only, since the vertebrates are well documented, and marine forms are covered by the series *Marine Fauna of New Zealand.*

Contributions are invited from any person with the requisite specialist skills and resources. Material from the New Zealand Arthropod Collection is available for study.

Contributors should discuss their intentions with an appropriate member of the *Fauna* Advisory Group or with the Series Editor before commencing work; all necessary guidance will be given.

(continued on page 3)

HE PAANUI

Kua whakatuuria teenei raarangi pukapuka hei whakahauhau ki nga tohunga whai maatauranga kia whakaatu i nga mea e paa ana ki nga kararehe o Niu Tiireni. He aahua tohunga teenei raarangi pukapuka, engari, ko te hiahia kia maarama ai te tuhituhi, kia moohio ai te maria ki nga tohu o ia ngaarara, o ia ngaarara, aa, kia whakaari i te maatauranga e paa ana ki a ratou.

Ko eenei pukapuka *Fauna of New Zealand* kaaore e paa ana ki nga kararehe, ki nga ika, ki nga maataitai raanei. E tino moohiotia ana nga kararehe. Kei roto i nga pukapuka e kiia ana *Marine Fauna of New Zealand* nga tuhituhi e paa ana ki nga ika me nga maataitai.

Tuhituhinga. Ko te tono ki nga tohunga kia tukua mai aa koutou pukapuka. E waatea ana te kohikohinga kararehe e kiia ana ko te Aitanga Pepeke o Aotearoa hei maatakitaki maau.

Me whaakii oo koutou whakaaro ki te mema o te kaahui tohutohu o *Fauna* e tika ana, ki te Etita raanei, i mua i te tiimatanga tuhituhi.

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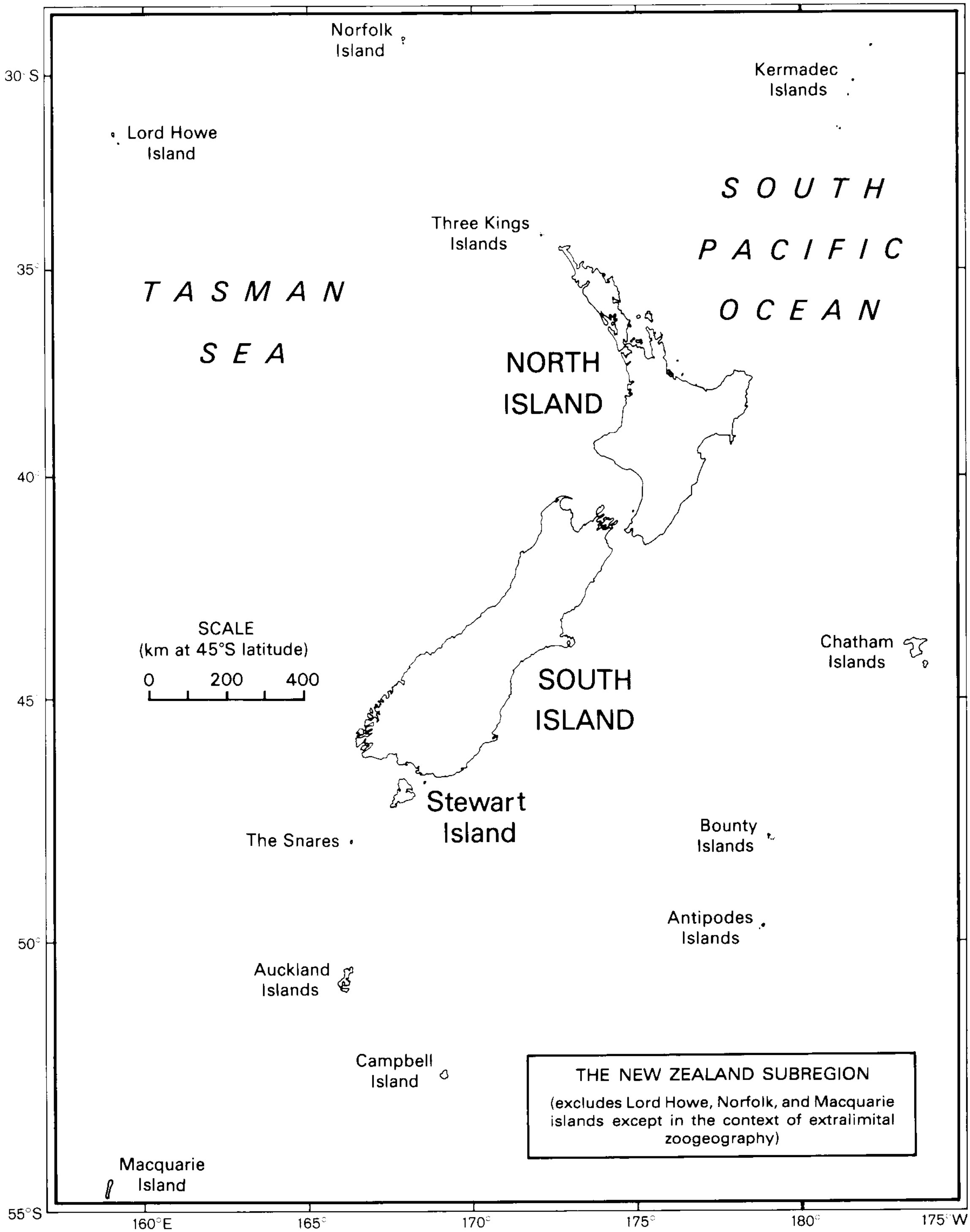
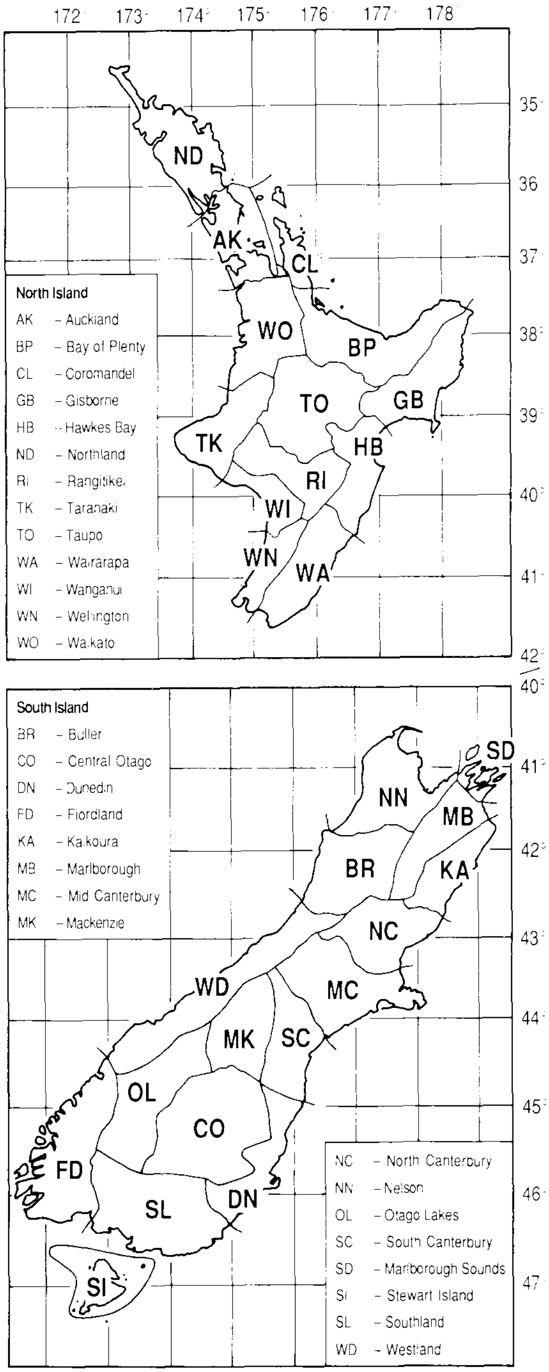
Te utu (tirohia te 'Titles in print' ke runga nei): Ko te koopakitanga me te pane kuini kei roto i te utu. Me utu koutou e noho ana Niu Tiireni me Aahitereiria ki nga taara o Niu Tiireni. Ko i eetahi atu me utu te whakaritenga i nga taara Marikena.

E toe ana nga pukapuka o mua. Mehemea e hiahia ana koe ki te katoa o nga pukapuka, tonoa mai kia heke iho te utu. E rua pai heneti te heke iho o te utu ki nga toa hoko pukapuka.

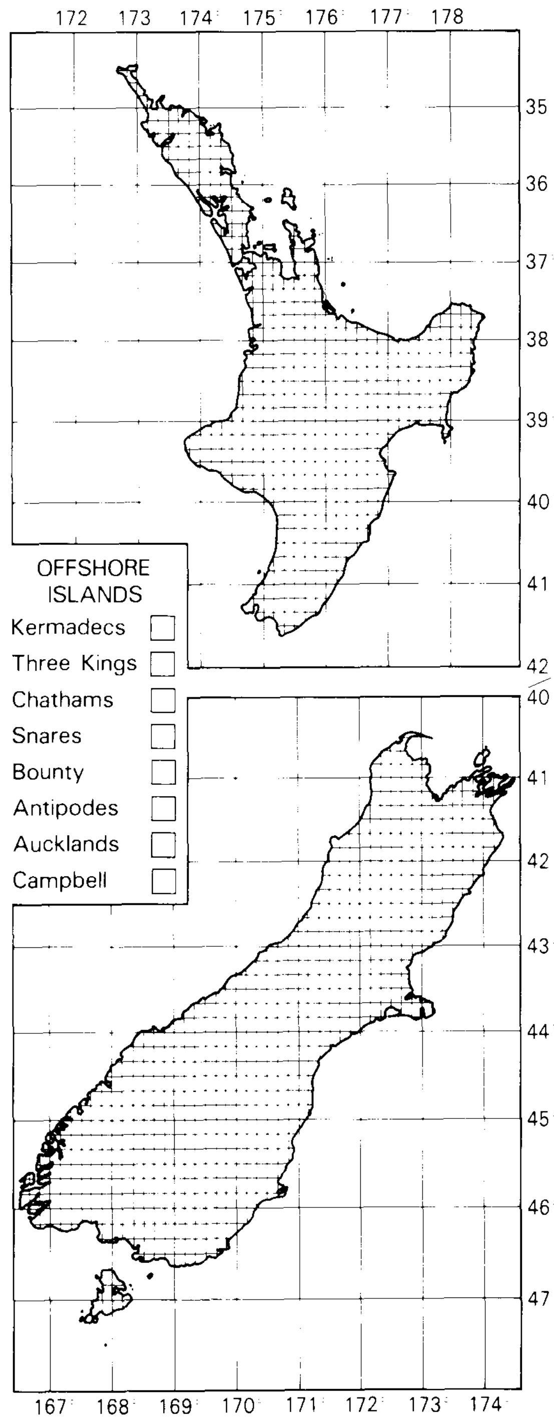


THE NEW ZEALAND SUBREGION

(excludes Lord Howe, Norfolk, and Macquarie islands except in the context of extralimital zoogeography)



Area codes and boundaries used to categorise specimen locality data (after Crosby *et al.* 1976)



Base-map for plotting collection localities; this may be photocopied without copyright release

FOREWORD

On two previous occasions I have contributed a Foreword to the *Fauna* series: first, in no. 1, to mark the launching of the series, and then in no. 13 and 14 to commemorate the twenty-fifth anniversary of Systematics Group. In no. 21 I am again celebrating, for with this issue we introduce some changes that say, very clearly, the *Fauna* has come of age.

The first and most obvious change is to the artwork on the cover and the title page, and I acknowledge the input of Robert Jahnke and Ross Hemara of Waiariki Polytechnic, Rotorua, to its creation. The choice of typography is significant: the font, Plantin, was popular in the 19th century, at a time when European scientific investigation here was in its vigorous infancy. The raranga, or basket-weave motif is Maori in both inspiration and execution. It is a simple theme, but in evoking the legend of Nga Kete e Toru, the three baskets of knowledge, it touches upon beliefs about human experience and endeavour that have a universal context and significance. It therefore expresses particularly well the resolve of DSIR Plant Protection / Te Wāhanga Manaaki Tupu to honour the spirit as well as the letter of the Treaty of Waitangi by ensuring Māori participation in the work of this Division of the Department of Scientific and Industrial Research.

The drawing on the title page is a representation of the pare, or lintel, that now stands over the entrance to the New Zealand Arthropod Collection / Ko te Aitanga Pepeke o Aotearoa. It is no coincidence that the Collection and the *Fauna* bear the same Māori name – the two are inseparably related. The pare, carved by Denis Conway in the style of the Ngāti Whātua, and installed and dedicated in February 1990, is now joined by its printed image as a potent expression of the impetus towards bicultural values.

The inclusion of popular summaries in both English and Māori is a further cross-cultural bridge, from the technical language of the European scientific subculture to the widely understood usage of everyday speech. There are other changes to the presentation of the *Fauna* beginning with no. 21, but these are relatively minor, and are either consequential on the new cover concept or are introduced at the suggestion of the *Fauna* Advisory Group as desirable and timely modifications.

Another major change is that DSIR Plant Protection has taken on those aspects of *Fauna* management that up to now have been handled by DSIR Publishing in Wellington. A core group of staff members has assumed responsibility for printing and promotion, and subscriptions are now looked after by the Library at Mt Albert Research Centre. Handing-over of back issues, client lists, and much associated material has taken place during the latter part of 1990, and all aspects are now in place and operating smoothly. I take this opportunity to warmly acknowledge those staff members of DSIR Publishing who have been instrumental in helping to establish and maintain the *Fauna* as an internationally recognised series.

At this time of creative change it is appropriate for me to reassure you – whether you are a contributor, subscriber, or both – that there has been no change to the guiding philosophy underpinning the *Fauna*, spelled out when the series was conceived some ten years ago. This Division clearly recognises that the *Fauna* series is much more than a house publication. The constitution of the *Fauna* Advisory Group, and the active and sometimes critical participation of the members representing interests outside this Division, guarantee that the *Fauna of New Zealand* will continue to meet the highest standards of scientific documentation and editorial impartiality.

—J.F. Longworth
Director, DSIR Plant Protection

Margarodidae
(Insecta: Hemiptera)

C. F. Morales

DSIR Plant Protection /
Te Wāhanga Manaaki Tupu
Mt Albert Research Centre
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New Zealand

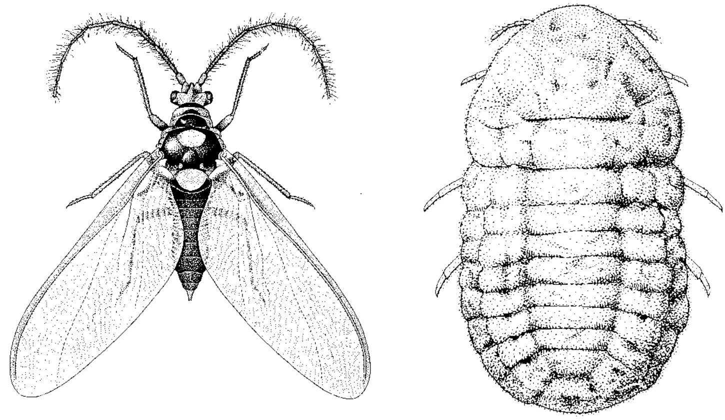

ILLUSTRATION
Coelostomidia wairoensis, adult male, and *C. zealandica*, adult female

Popular summary

The Margarodidae are one of eleven families in New Zealand of the plant-sucking scale insects. Two subfamilies are represented, one by the introduced cottony cushion scale (and, in quarantine only, the Seychelles scale), and the other, the giant scales, by ten native species. These latter are all test-formers, that is, they secrete a protective external coating which varies in texture and appearance from species to species. No Maori names are known for any of these insects.

The cottony cushion scale, which is believed to have originated in Australia, was for a time a serious pest in citrus orchards and gardens. It was brought under control by introducing one of its natural predators, a species of ladybird beetle, and is now a relatively uncommon pest in New Zealand.

The native species of Margarodidae in New Zealand are associated with native trees and shrubs. Most of them are host-specific, and have a long history of evolution in association with their particular host plants. They play a significant role in forest ecology: the sugary secretion produced by the feeding stages is at times sufficiently abundant to provide nourishment for the bacteria and fungi that break down forest-floor litter, for bees, wasps, and other insects, and even for birds. The honeydew produced by one species associated with the trunks of southern beech trees is harvested by foraging bees to make 'forest honey', which has considerable export value.

A sooty mould coating the trunks of host trees such as beech, manuka, and kanuka is often the most obvious indication of the presence of margarodid scales. On closer inspection long, thread-like extrusions – one from the test

He whakapotonga ma te marea

Ko te *Margarodidae* teetahi o te tekau ma tahi whaamere o nga Aitanga-a-peepeke ngote rakau e noho ana i Niu Tiireni nei, aa, e kiia ana he Unahi. E rua nga whaamere-iti e kitea ana ki konei: no teetahi whaamere-iti te Unahi Pera, Aahua Huruhuru hoki me te Unahi Seychelles (kei roto anake teenei i te paauna mo nga kararehe e uru hoou mai ana ki teenei whenua); no teetahi atu whaamere-iti tekau nga tuumomo unahi e kiia ana he Unahi Nui Rawa. He *test-formers* katoa eenei, araa, ka puta mai i a raatou he kiri aupuru; he aahua kee te kiri aupuru o ia tuumomo unahi. Kiihai i kitea he ingoa Maaori no eenei ngaarara.

E ai ki te koorero, no Ahitereiria te tiimatanga mai o te Unahi Pera, Aahua Huruhuru hoki; no teetahi waa he nanakia ia kei roto i nga kaari me nga uru raakau aarani, reemana hoki. Na te mau mai i toona hoariri, he reiri-paate te ingoa Paakehaa, ka mate te nanakia nei. Inaaianei, kaaore e kitea nuitia ana i Niu Tiireni.

Ko nga tuumomo *Margarodidae* tupu o teenei whenua e noho ana kei runga i nga raakau Maaori. Kotahi te raakau kai to teenei tuu ngaarara, kotahi kee atu te raakau kai to teeraa. E hia miriona tau te noho o nga tuupuna o ia ngaarara, o ia ngaarara i toona ake raakau. He take to raatou i te hauora o te ngahere; i a raatou e kai ana, ka puta mai i a raatou he huka, aa, ka nohoia taua miere e nga hekaheka me nga *bacteria* e kai nei i nga otaota i raro i nga raakau o te ngahere; e kainga ana hoki taua honi e nga pii, e nga waapu, e nga aitanga-a-peepeke, e nga manu hoki. Ko te huka i puta mai i teetahi momo unahi e noho ana i runga i nga tawai e tupu ana i Te Wai-pounamu e kohia ana e nga pii hei mahi honi. Ka hokona ana ki nga whenua o taawaahi, aa, he nui te utu.

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Front cover. The insect depicted is *Coelostomidia zealandica*, adult female

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of each immature scale, and with a droplet of honeydew on the end – are also distinctive. Another conspicuous sign of giant scales are the clusters of white cocoons of the male pupae of some species.

The adult males are usually fully winged, dark red, rather fly-like insects lacking mouthparts, and hence short-lived and not easy to find. Their principal purpose in life is to find and mate with the wingless females, which look like large, pink lozenges with legs and may be found crawling on the forest floor or on the bark of trees during summer. Some margarodids have no known male stage.

The life history of margarodid scales is marked by rather dramatic changes in appearance undergone between the various stages, in both sexes. Some of the life stages are very simple in body structure, and offer few readily visible clues to their identity. The study of these scales consequently requires examination of microscope slides.

Differences in the appearance and disposition of minute structures such as pores and hairs may be critical in determining identity from morphology, and this is a task for the specialist. As our understanding of margarodid classification improves, however, some reliance may be placed on biological indicators of identity that can be used by the non-specialist, such as the host plant – or the site on the host plant – from which a specimen was collected.

Ko te mea whakakite i eenei Unahi *Margarodid* ko te puu-hekaheka aahua awe kaapara kei runga i nga tawai, i nga maanuka, i nga maanuka rauriki hoki. Mena ka aata tirohia, ka kitea nga tarete, araa nga miro e puta mai ana i ia unahi, i ia unahi punua. He koopata honi kei nga pitopito tarete nei. Koia anoo te tohu o eenei tuumomo Unahi. Teera anoo teetahi tohu; ko nga raapoi koohanga, aahua maa, o nga riha o eetahi tuu Unahi.

To te pakeke taane he ngaro whai parirau, aahua koo-koowai te kara; he oranga poto toona i te mea kaaore kau toona waha; e uaua hoki te kite. Ko tana mahi, he whaiwhai wahine moona; ko tana wahine he ngaarara parirau-kore, he piki te kara. Kua whai waewae, aa, ka ngoki haere i te whenua, i te kiri raakau raanei, i te raumati. Kaaore anoo kia kitea he taane no eetahi tuumomo unahi.

I toona oranga, ka huri kee te aahua o te Unahi *Margarodid* taane, wahine hoki. I eetahi waa kaaore e rere kee te aahua o teenei, o teenei tuumomo Unahi. Ma te tirohanga maikarakoroapu ka moohio ai.

Teenaa pea, ko te aahua me te takoto o nga huruhuru me nga putaputa kiri nga tohu e moohiotia ai nga tuumomo unahi. He mahi uaua, he mahi tohunga teenei. Ma te piki ake o to taatou maatauranga ki nga tohu o ia tuumomo — ko te raakau, ko te waahi raanei o te raakau e nohoia ana — ka ngawaari ai teenei mahi.

ABSTRACT

The endemic New Zealand coccoid genera *Coelostomidia*, *Platycoelostoma*, and *Ultracoelostoma* are revised. Four new species are described, and six species are redescribed, with designation of lectotypes as necessary. The immature female life stages of all ten species and the male stages of five are described and illustrated. The adult females and first instars of two introduced species of *Icerya* are described. Keys are given to all life stages of the endemic genera. The life histories of *Coelostomidia wairoensis* (Maskell) and *Ultracoelostoma brittini* n.sp. are described and illustrated. Brief summaries are given of the classification of the Margarodidae, their economic importance, biology, life history, host-plant associations, and collection and mounting techniques. Work done on this group in New Zealand is reviewed.

CHECKLIST OF TAXA

CONTENTS

ACKNOWLEDGMENTS

This study was made possible by an exchange of scientific staff between DSIR's Entomology Division (now part of DSIR Plant Protection) and the British Museum (Natural History) from October 1985 to September 1986. I am grateful to Mr J.F. Longworth, Director of DSIR Plant Protection, and Dr L.A. Mound, Keeper of Entomology at BMNH, for the opportunity to undertake this work. Mr M. Collins, DSIR Headquarters, authorised a five-month study grant for its completion during 1988.

I thank Dr J.M. Cox (BMNH), Dr D.J. Williams (CAB International Institute of Entomology), and Dr C. Hodgson (Wye College, Kent) for advice and help freely given during the study; Dr D.R. Miller (Systematics Laboratory, U.S. Department of Agriculture) for loans of material; Dr K.M. Harris (CAB International Institute of Entomology) for identification of *Lestodiplosis* sp.; Mr J.S. Dugdale and Dr R.C. Craw (DSIR Plant Protection) for identification of Lepidoptera and Coleoptera respectively; and Dr C. Hodgson for criticism of the manuscript.

My co-workers and co-authors in the sooty beech scale project, Dr M.G. Hill and Ms A.K. Walker, have kindly permitted my use of extensive joint research results.

INTRODUCTION

There are eleven families of Coccoidea in New Zealand. The earliest work on this group was done by W.M. Maskell, who between 1879 and 1898 described over 300 new species of Homoptera from around the world, mostly scale insects from New Zealand. In their catalogue of Maskell's Homoptera, Deitz & Tocker (1980) listed the localities of the Maskell type specimens and gave details of his species-group names as well as including biographical details. Maskell's interest in the then new science of microscopy meant that he was well ahead of his contemporaries in describing species from slide mounts of specimens. Although they were not stained and had other deficiencies in mounting techniques (Ferris 1957), many of them can still be used today. Fortunately Maskell also preserved dry material, but it must be remembered by coccidologists who use this unmounted material that he was less than methodical about keeping specimens collected on separate days or from different localities in different boxes. However, Maskell was before his time in recognising that immature and male stages were also important to the taxonomy of the coccoids.

Since Maskell, the few taxonomic treatments of the New Zealand scale insect fauna include Hoy's (1962) revision of the Eriococcidae, Beardsley's (1964) paper on the Phenacoleachiidae, Green's (1929) comments on the Ortheziidae, Williams & De Boer's (1973) contribution on the Pseudococcidae, Emms's (1985) thesis on the Leucaspidinae, Brittin's (1935) paper on Margarodidae, Dumbleton's (1967) paper on *Ultracoelostoma*, De Boer & Valentine's (1977) taxonomic treatment of some diaspidid species, Lambin & Kosztarab's (1976) paper on *Solenophora*, and most recently Cox's (1987) extensive revision of the Pseudococcidae. Other systematic work on New Zealand coccoids has often been included in treatments of world genera, such as Morrison's (1928) revision of the Margarodidae, which included the then known fauna from New Zealand, Morrison & Morrison's (1922, 1923, 1927) redescriptions of coccoid and asterolecanoid species described by Maskell, and Russell's (1941) revision of the Asterolecaniidae.

A checklist (Wise 1977) of some of the Hexapoda of New Zealand included the Coccoidea, and a summary of the literature pertaining to the New Zealand members of this superfamily was given by Deitz (1979).

Apart from the introduced monophlebine species *Icerya purchasi* Maskell and *I. seychellarum* (Westwood) (the latter recorded as occurring in New Zealand, but so far only intercepted in quarantine), all species of Margarodidae found in New Zealand are test-formers belonging to the subfamily Coelostomidiinae.

Native margarodids are frequently encountered on a variety of trees, especially *Nothofagus* and Podocarpaceae. Adult females, which are wingless and look like large, pink mealybugs, may be found crawling on the forest floor or on the bark of trees during the summer months. The winged males are large, have dark red bodies, and are often caught in Malaise traps. More obvious, however, are the festoons of white cocoons of the male pupae on *Leptospermum* and *Kunzea* (*Coelostomidia wairoensis*) and *Nothofagus* spp. (*Ultracoelostoma assimile* and *U. brittini*). The waxy white tests of the second and third instars of several species are to be found throughout the year on or under bark, in amongst the moss layer on trees, or in the axils of branches and twigs of a variety of trees. Large amounts of sooty mould on the trunks and branches of *Kunzea ericoides* can indicate the presence of immature stages of *C. wairoensis*, just as a characteristic covering of sooty mould on the trunks of beech trees (*Nothofagus*) is caused by secretion of honeydew by the immature stages of *U. brittini*.

In the New Zealand fauna, the females of *Ultracoelostoma*, *Coelostomidia*, and *Platycoelostoma* have four stages. Males have not been found in *Platycoelostoma*, but in the other two genera there are five male stages. The first instars have well developed legs and antennae, but the second- and third-instar females and the second-instar males occur inside a test and have reduced legs and antennae. However, the numbers of setae, spines, pores, and hairs increase after each moult, and in *Ultracoelostoma* the anal end becomes more sclerotised with the advancing age of each immature test-inhabiting instar.

The texture of the test varies from thick and resinous in *Ultracoelostoma* spp. and *Coelostomidia zealandica* to thin and powdery in *C. pilosa*, and elastic and papery in *Platycoelostoma*. The adult female of *Ultracoelostoma* species remains inside the test with reduced legs, mouthparts, and antennae, whereas the adult females of *Coelostomidia* and *Platycoelostoma* emerge from the test of the previous stage with well developed legs and antennae, but without functional mouthparts. The prepupal or third-instar males of *Coelostomidia* and *Ultracoelostoma* are superficially similar to adult females of *Coelostomidia* spp., but are smaller and have fewer antennal segments. On slide-mounted specimens there are two pairs of outpushings of the derm near the second pair of legs which later develop into the wing and hamulohaltere buds of the pupa. Adult males are usually fully winged.

Except for *Ultracoelostoma brittini*, which is important for the honey industry, the endemic species of New Zealand Margarodidae are of no economic importance. Since the 1960s *U. brittini* has been of interest to New Zealand beekeepers because the honeydew that it secretes is harvested by bees to make 'forest honey'. This honeydew also is an important component in the ecology of southern beech forests (Moller & Tilley 1987).

Earlier literature on the New Zealand Margarodidae is patchy, comprising Maskell's descriptions, Morrison & Morrison's (1922, 1923) redescriptions of the Maskell type-species, and Morrison's (1927, 1928) broader work dealing with Margarodidae, plus papers by Myers (1922), Green (1929), Brittin (1935, 1936), and Dumbleton (1967).

The first margarodid to be described from New Zealand was *Icerya purchasi* (Maskell 1879). Fernald's world catalogue of Coccidae (1903) listed *Icerya seychellarum* as occurring in New Zealand on the basis of a paper by Maskell (1897) in which he identified some coccoids sent to him by Koebele from China and Formosa. From 1881 to the 1920s there was a flood of literature relating to *I. purchasi* as a citrus pest and the search for and discovery in Australia of its biological control agent *Rodolia cardinalis* Mulsant.

An endemic New Zealand margarodid was described for the first time when Maskell (1880) erected the genus *Coelostoma* for the single species *zealandica*. The name *Coelostomidia* was proposed by Cockerell (1900), as Maskell's proposed generic name was preoccupied. Morrison & Morrison (1922) redescribed *C. zealandica*, and provided a diagnosis of genus *Coelostomidia*. In a later detailed revision of the Margarodidae, Morrison (1928) listed two more species in this genus, *pilosa* Maskell (1891) and *wairoensis* Maskell (1884). Cockerell (1902) and Fernald (1903) had earlier listed these three species, Fernald adding host records. Another species, *C. montana*, was added to *Coelostomidia* by Green (1929). Detailed descriptions of the immature stages of these four species and notes on their life history were given by Brittin (1935), but no keys or detailed diagrams were included.

The genus *Ultracoelostoma* was first described by Maskell (1890) from "Fagus" in the Reefton district of the South Island, as *Coelostoma assimile*. Cockerell (1902) established the subgenus *Ultracoelostoma* on the basis of the absence of legs and reduction of antennae in the adult female, and this was supported by Morrison & Morrison (1922). Brittin (1935) considered that *U. assimile* should be retained in *Coelostomidia* because of the presence of leg rudiments in the adult female, the great similarity between the intermediate stages and adult males of *Coelostomidia* and *Ultracoelostoma*, and because the tests of *U. assimile* and *C. zealandica* are almost indistinguishable. The great variation in the degree of atrophy of legs and mouthparts in different populations of *U. assimile* confirmed Brittin's (1935) opinion that the criteria of presence or absence of legs used by Cockerell and Morrison to establish a separate genus was insubstantial, but that there were probably distinct 'varieties' within this genus. Dumbleton (1967) suggested that these varieties may indicate the presence of one or more species on *Nothofagus*, and he recorded for the first time a species of *Ultracoelostoma* on *Dracophyllum*. The only differences he could find to separate this species from the populations on *Nothofagus* were in the length of the tarsal claw and, in life, the smaller and more elongate tests. A study of the morphology of *U. assimile* supported Brittin's assertions (Oliver 1975).

There is undoubtedly much variation in the degree of atrophy of legs, mouthparts, and antennae as well as in the numbers and distribution of pores and setae on the dermal vestiture in *Ultracoelostoma* and *Coelostomidia*, but on the basis of the characters exhibited in the anal region of these insects, as well as other characters, it is my opinion that these two genera should be maintained.

The genus *Platycoelostoma* was established by Morrison & Morrison (1923) for one species, *compressa*, first described as *Coelostoma compressum* by Maskell (1892).

A major purpose of this work is to redescribe the species known from New Zealand, including their immature and male stages, and to provide life history information for two representative species in different genera.

MORPHOLOGY

Adult female (Fig. 1)
Body shape varies according to where the females live. *Coelostomidia*, *Platycoelostoma*, and *Icerya* are mobile, and their body outline is more or less elongate to oval and elliptical in cross-section. *Ultracoelostoma*, owing to its enclosure in a test, has a globular shape. Margarodids are giants among the Coccoidea, 1.5–35 mm in length (Morrison 1928). The New Zealand species vary between 1.6 mm and 15 mm in the adult female.

The antennae are much shorter than the body, and vary from ten or eleven well defined cylindrical segments to a conical form comprising five or six segments. The apical segment is usually longest, and bears a number of thickened hairs; other segments may also bear one or two such hairs. There is usually a large pore on the second segment.

Legs or their vestiges are usually present. When fully developed they are large, but shorter than the body. The coxa and trochanter are quadrate or triangular; the trochanter bears from four to ten pores on each face and a long seta on its lower edge, or may lack both pores and seta. The femur is usually elongate, stout or slender, with fine hairs dorsally and sometimes spine-like hairs ventrally. The tibia is usually longer than the femur and has many stout, spine-like setae on the lower face. The long, one-segmented tarsus has a single claw at the apex; this is curved and tapered, often with a denticle near the tip and with a variable number of digitules arising from the base. The digitules may be knobbed and extend beyond the claw apex or blunt or pointed and not reach the claw apex. *Ultracoelostoma* species have the legs reduced to cones, though retaining all segmentation, and the claw and digitules variably reduced.

The cone-shaped beak, or labium, has three segments; it varies in shape from short and stout with a blunt tip to elongate with an acute tip, and in the number and shape of hairs at its apex. When the beak is absent, its position is indicated by a thickened area in the cuticle, a sclerotised vestige, or a group of hairs.

There are two pairs of thoracic spiracles, with the opening surrounded by a round or oval chitinised rim. The spiracle opening often has a cluster of complex disc pores and minute pores, and the atrium sometimes has a group or band of complex disc pores, and sometimes minute pores, at its inner opening. A chitinised plate or bar extends inwards from the rim. The abdominal spiracles are smaller and simpler, and occur on the venter or margin of the body. The number of abdominal spiracles varies from two to eight, with or without associated complex disc pores and minute pores.

The derm is mostly membranous and without sclerotisation in the New Zealand species, but bears pores, setae, cicatrices, spines, and hairs of various types and arrangements. These are mostly distributed randomly on the head and thorax and in rows on the abdomen, but in *Icerya* pores also occur in the form of an ovisac band in mature females. Derm pores secrete wax and other substances; they vary in shape and number between species, but are of five main types, as follows. Simple pores have a sclerotised rim of varying thickness and a clear or granular interior, and have a regular outline. Complex disc pores are flat, circular pores made up of from two to six internal loculi surrounded by a ring of smaller loculi, in turn surrounded by a chitinised ring. Simple disc pores are similar to the complex disc pores and have from two to five loculi, but lack the rim of outer loculi. Open-centred pores have an outer ring of loculi, and are flat in *Platycoelostoma* but deep and cylindrical in *Icerya*. Minute pores do not have a chitinised rim nor regular loculi, but have irregular internal slits. Cicatrices appear as large, simple pores usually with an irregular outline, mostly on the ventral surface. Setae are cuticular structures with a definite articulated, chitinised collar, which varies from flat and circular to high, tapering, and cylindrical. The setae vary in shape from thin with a pointed tip to short and thick with a tapered, blunt, or expanded tip. Derm hairs are attached directly to the derm, without a basal collar. They may be fine or thick, tapered or clavate at the tip, and vary in length. Spines are like derm hairs in having no basal collar, but are stout and cylindrical with tapered or clavate tips.

The anal tube shows much variation in its shape, lobes, pores, hairs, and setae. It is usually apical to subapical, but in *Icerya* it is dorsal. Even if it is simple in structure, an inner chitinised ring is present.

Intermediate stages (2nd and 3rd instars) (Fig. 2)

Second- and third-instar females of *Icerya* resemble adults, but lack an ovisac band. In all other New Zealand species they are immobile and enclosed in a test which is variable in structure and shape, usually globular, ovoid, or elongate.

Icerya has fully developed legs, *Coelostomidia* and *Ultracoelostoma* have reduced legs retaining all segments, and in *Platycoelostoma* the legs are small dermal protuberances with pores, setae, and reduced claws and digitules. In *Icerya, Coelostomidia,* and *Ultracoelostoma* the trochanter has a long seta on the posterior edge and from three to five sets of pores on each face. The claws and digitules are fully developed in *Icerya* but reduced to varying degrees in *Coelostomidia* and *Ultracoelostoma.* Antennae are fully developed in *Icerya* but reduced to varying degrees in the other three genera. Thoracic and abdominal spiracles are associated with various numbers of complex pores, and minute pores which increase from the second to the third instar. The beak and its chitinous supports are present, but show little variation. Pores, setae, spines, modified spines, cicatrices, and derm hairs are present. The derm shows various degrees of sclerotisation, mostly on the last abdominal segment, which bears distinctive sets of pores, setae, cicatrices, and derm hairs.

The anal tube is well developed, and varies in the number and type of derm hairs and pores within it and the presence or absence of lobes and thickened areas.

First instar (Fig. 3)

The body is usually elongate to oval and the derm membranous; *Ultracoelostoma* species have chitinisation on the last abdominal segment. The six- or seven-segmented antennae are usually stout, with a pore on the second segment and thick setae on the last, sometimes also on the penultimate segment or on others, as in *Platycoelostoma.*

The legs are well developed. The trochanter has from two to four pores and a long seta on each face, and the claw has a varying number of knobbed digitules and sometimes a denticle. The setae on the legs are usually fine with pointed tips. The beak may have two or three segments; it is conical with a blunt or acute tip, and bears various numbers and types of hairs. There are two pairs of thoracic spiracles and from two to eight pairs of abdominal spiracles, all with or without pores.

Setae, derm hairs, and spines are present in varying numbers, shapes, and sizes; there is usually a pair of long caudal setae, and *Icerya* has many long marginal setae as well.

The last abdominal segment is most distinctive in its distribution and type of setae, spines, modified spines, pores, and derm hairs in *Coelostomidia* and *Ultracoelostoma*. From one to three cicatrices are present. The anal tube may be simple or complex; if complex, it bears bands of pores.

Adult male (Fig. 4, 5)

Terminology in this section follows Theron (1958). Male Margarodidae are large and robust in comparison with males of other families of Coccoidea. They have an elongate body, no mouthparts, an expanded thorax with much heavy chitinisation, wings with a strong anterior costal complex and one or two smaller faint veins, and a well developed penis sheath as in other coccoid families. Males of *Ultracoelostoma* and *Coelostomidia* lack the fleshy lateral projections on the abdomen found in other tribes, such as Iceryini.

Venter. The head is membranous except for a mid-cranial ridge which joins the pre-ocular ridge and the pre-oral ridge. Pores, setae, and hairs are sparse. The non-functional mouth is a simple ring. The antennae are almost as long as the body and usually ten-segmented, with the first two segments stout and the rest cylindrical or (*Icerya*) bilobed, with either short, stout or long, slender setae arranged in no particular order, except in *Icerya* where they are in whorls on each lobe. Thickened setae are present on the terminal segment and sometimes on the other segments. There are compound eyes with facets in various shapes and numbers, and a pair of ocelli.

The prothorax has a long, medial sclerotised ridge (the remains of the prosternum) and a long, sclerotised lateral ridge (the cervical sclerite) joining the pleural ridge, to which the first coxae are attached. The mesothorax has the foremost spiracle anterior to the episternum, which appears as a sclerotised bulge laterally. The mesothorax consists of the basisternum, which has marginal ridges not fused to one another in the middle, and a sclerotised internal furca. The precoxal ridges of the second pair of legs form the posterior boundary of the mesothorax. The metathorax has pleural ridges, to which the third pair of legs are attached. The posterior thoracic spiracle is situated anterior to the coxae of these legs. Setae, hairs, and pores are sparse. The legs are long and slender, the coxa is triangulate, the trochanter has three or four pores on each face and a long hair, and the femur, tibia, and tarsus have many stout, bifurcate, short hairs. The tarsus is distinctly two-segmented, and the claw may have a denticle and varying numbers of knobbed digitules at its base.

The abdomen in *Ultracoelostoma* and *Coelostomidia* (unlike *Icerya*) has no areas of sclerotisation except for the penis sheath. Mostly there are seven bands of pores and setae; cylindrical tubercles are absent. There are two or three pairs of spiracles in *Icerya*, but *Coelostomidia* and *Ultracoelostoma* have seven pairs. The penis sheath usually has a broad base and a rounded apex, which is often bifid. Ventrally there is a broad slit for extrusion of the penis.

Dorsum. The head is membranous except at the beginning of the mid-cranial ridge and the postoccipital suture separating the head from the thorax. Pores, setae, and hairs are present though sparse on the head.

The prothorax is membranous except for the pair of longitudinal sclerotised ridges representing the post-tergite. The mesothorax has the prescutum, scutum, prealares, scutellum, postnotum, and mesopostnotum sclerotised, with membranous areas between prescutum and scutum. The scutellum is separated from the scutum by an invaginated, V-shaped ridge which has two membranous areas. There is a large membranous area between the scutellum and mesopostnotum, and laterally are the tegulae and axillary sclerotisation of the wing articulation and extensions of the postnotum. There are very few pores and setae except at the edges, and even there they are sparse. The metathorax has a small sclerite to which the hamulohalteres are attached and small sclerotisations representing the metapostnotum. Sparse pores and setae are present.

The wings, a single pair, are lightly infuscate in *Coelostomidia* and *Ultracoelostoma* but darker in *Icerya*. Venation is reduced to a thickened anterior band – the costal complex – and a faint diagonal vein which fades out before it reaches the wing margin. There are also two folds which appear as uncoloured lines. The hamulohalteres are well developed, leaf-like, broad, and have from two to six curved, knobbed setae at the apex.

The abdomen has no sclerotisation except for the penis sheath. Cylindrical tubercles are present or absent; pores with from three to six obscure internal loculi, minute pores, derm hairs, and setae of various sizes and shapes are present on some segments and absent from others.

In general, the males of both *Coelostomidia* and *Ultracoelostoma* are closer in their degree and form of sclerotisation to males of the tribe Monophlebini than to those of Margarodinae or Steingeliinae as studied by Theron (1958).

Pupa (Fig. 6)

Information is available for *Coelostomidia* and *Ultracoelostoma* only.

The body is broadly elongate. Antennae are indistinctly ten-segmented. The legs have obscure segmentation and short, stout setae. Thoracic and abdominal spiracles are present, but lack associated pores. The wing and hamulohaltere buds are dorsad.

Setae may be elongate, fine, and pointed, but on the abdomen, especially on the last ventral segment, they are stout, slender, and knobbed. Derm hairs may be fine and slender or stout and blunt. Complex disc pores occur in varying numbers, mostly on the venter, and simple pores of two sizes are present. An outpushing of the derm on the tenth segment forms the penis sheath. Caudal setae of various lengths are present.

Prepupa (Fig. 7)

Information is available for *Coelostomidia* and *Ultracoelostoma* only.

The body is broadly elongate. The antennae are nine-segmented; a pore is sometimes present on the second segment, and thickened setae are present on the terminal segment and sometimes on others.

The legs are well developed, with the coxa and trochanter triangulate. The trochanter has pores and a long seta on the ventral side, and there are some spine-like setae on the lower edge of the tibia and tarsus. The claw either has or lacks a denticle, and there are one or two pairs of digitules which are knobbed or acute and either extend beyond the claw apex or do not reach it. Well developed mouthparts are absent, but there is often a sclerotised vestige of the beak and its hairs remaining. The wing and hamulohaltere pads on the margin of the dorsum appear, on slide-mounted specimens, as outpushings of derm which lack setae or pores. The thoracic spiracles have two or three associated pores, but the abdominal spiracles have none. Complex and simple disc pores, simple pores, cicatrices, and minute pores are present.

Setae are fine and slender; derm hairs are mostly fine, pointed, and of two sizes, some thick and blunt. The anal tube is only lightly sclerotised, often with pores and hairs.

CLASSIFICATION OF SCALE INSECTS

The classification of scale insects is controversial at present, and this is reflected in the nominal status of both the group and its divisions. The scale insects are regarded by some authorities as a superfamily – the Coccoidea – within the Homoptera (Morrison 1928, Balachowsky 1942, Boratynski 1970, Miller 1984), but by others as a suborder, the Coccinea (Borchsenius 1950, 1958, Pesson 1951, Bodenheimer 1952, Obenburger 1957, Koteja 1974, Quayoom & Khan 1974, Danzig 1984, 1986, Kosztarab *et al.* 1990). The former view is followed here.

The superfamily Coccoidea (scale insects) comprises about 6000 species in some 800 genera (Kosztarab & Kozár 1988) and 15–22 families, depending on the classification system followed. Aphids and scales are generally regarded as being sister groups in a monophyletic group – the Aphidiformes (Schlee 1969) or Aphidomorpha (Hennig 1981) – based on seven synapomorphic characters of coccoid and aphid wings. More recent comparisons of additional morphological characters of coccoids and aphids (e.g., Theron 1958, Beardsley 1968, Boratynski & Davis 1971) have strengthened this sister-group concept.

The systems of coccoid classification used before cladistic concepts became generally accepted were based on degrees of specialisation and on the possession of primitive characters by different groups of scale insects. Often the classification has been quite arbitrary, and has caused confusion in the study of taxonomy, phylogeny, and evolution of scale insects and the interpretation of their relationships with other insect groups.

Hennig's (1981) methods of phylogenetic analysis made a huge impact on the classification of scale insects and the interpretation of their phylogeny and evolution. These methods attempted to identify both primitive and derived characters within and between insect groups and to analyse them in an objective way, often with the aid of computer packages.

Early workers, and some of their more recent followers (MacGillivray 1921, Silvestri 1939, Bodenheimer 1952, Borchsenius 1958, Koteja 1974, Danzig 1986) divide the scale insects into two groups, one containing the Margarodidae, Ortheziidae, and Phenacoleachiidae, and the other all remaining families. The former group was named Archaeococcoidea (= Palaeococcoidea; Borchsenius 1950) by Bodenheimer (1952) and Borchsenius (1950). Koteja (1974) and Danzig (1986), who regard the scale insects as a suborder (see above), gave these two groupings the taxonomically valid names Orthezioidea (= Archaeococcoidea in the sense of Borchsenius) and Coccoidea (= Neococcoidea of Borchsenius) respectively. To avoid confusion, I will be following Miller (1984) in using the informal terminology 'archaeococcoids' and 'neococcoids' for these groups.

Bodenheimer (1952) and Borchsenius (1958) treated each of these two divisions of the scale insects as monophyletic. However, on the evidence of a numerical analysis of morphological features of the males, Boratynski & Davis (1971) concluded that the archaeococcoids are paraphyletic and the neococcoids polyphyletic. Koteja (1974) rejected a polyphyletic origin for the neococcoids on the grounds of female mouthpart morphology. Miller & Kosztarab (1979) constructed a phylogram based on Boratynski & Davis (1971) which showed the neococcoids to be diphyletic. A polyphyletic origin for the neococcoids was postulated by Brown (1977) on the basis of coccoid chromosome systems, but this was questioned by Nur (1980), who

NOTE. Representative examples of dermal structures and anal tubes are illustrated in Fig. 8.

on similarly derived evidence proposed strongly that they are monophyletic. Danzig (1984, 1986) also propose a monophyletic origin for the neococcoids.

Morrison (1928) divided the Coccoidea into two groups. One included the families Ortheziidae and Margarodidae, and was based on the presence of abdominal spiracles and compound eyes in the male, both primitive conditions. The second group included all other coccoids.

The presence of abdominal spiracles, although useful for the easy recognition of certain families, is not an appropriate character for the diagnosis of a major scale taxon in accordance with the principles of Hennig (1966), and Miller (1984) considers that this has caused problems in the interpretation of the basal portion of the phylogenetic tree for the Coccoidea.

A cladistic analysis of the Margarodidae and related groups by Miller (1984) uses other features, such as characteristics of the anal region, mouthparts, life history, first instar, adult morphology, sperm, symbionts, and gender determination mechanisms. The resulting cladogram is compatible with the classification systems accepted by most coccidologists today, including myself.

In Miller's interpretation the scale insects have two divisions, the family Margarodidae and its sister-group containing all the other families. Miller refers to this latter, more derived group as 'neococcoids' (which include the Phenacoleachiidae and Ortheziidae), and divides them into lecanoids and diaspidoids. The Margarodidae thus remain as the only family in Miller's archaeococcoid group.

Evolution of the scale insects

Margarodidae have the greatest assemblage of primitive characters of any of the Coccoidea, and are therefore of considerable significance in the interpretation of the age and evolution of the group.

Before the discovery of many of the coccoid fossils now known, Borchsenius (1958) postulated that scale insects must be very ancient, perhaps originating in the Devonian and separating into eleven groups from the Carboniferous to the Permian. On the basis of their specialised morphology, association with gymnosperms, predominantly tropical distribution, and presence of many primitive groups in all areas of the globe he suggested that they were present before the break-up of the major land masses in the Jurassic.

In his phylogenetic analysis of the Insecta, Hennig (1981) reviewed the existing coccoid fossils. He refuted Borchsenius's (1958) concept of a very ancient origin for the coccids because fossils belonging to the stem group Aphidina + Coccina (in the sense of Hennig) have been found from the Upper Permian, before the evolution of the scale insects.

Other coccidologists have associated the origin of the scale insects with the angiosperms and the Cretaceous (Hoy 1962, Danzig 1986). The recent discovery in Lower Cretaceous deposits of fossil Margarodidae which are morphologically very close to the extant genus *Matsucoccus* (Koteja 1988) suggests an earlier origin of the scale insects.

CLASSIFICATION OF THE MARGARODIDAE

Margarodidae are the largest of all the Coccoidea, varying in length from 1.5 mm to 35 mm. The family name Margarodidae was first proposed by Morrison (1927), who based it on the genus erected by Guilding (1829). This genus fitted Morrison's concept of the group which he characterised by the presence of abdominal spiracles and compound eyes in the male.

Miller's (1984) cladistic analysis shows that the Margarodidae are monophyletic, except for *Pityococcus* (which may belong to the neococcoids), and is essentially consistent with classifications accepted by most coccidologists. It conforms with Morrison's (1928) naming of five units of the Margarodidae – the subfamilies Margarodinae, Monophlebinae, Coelostomidiinae, Xylococcinae, and Steingeliinae – but differs in details of placement of certain genera to other subfamilies.

A preliminary cladistic analysis (Morales, in press) has also shown the Margarodidae to be monophyletic.

Subfamily Coelostomidiinae

Morrison (1928) considered the Marchalinini to be the tribe most similar to the Monophlebinae and to provide a link between them and the Coelostomidiinae. Koteja (1974) stated, on the basis of mouthpart morphology, that the Coelostomidiinae could be a link between Monophlebidae and Porphyrophoridae (i.e., the family including *Neosteingelia*, Matsucoccidae, Xylococcidae, Kuwaniidae, and Porphyrophoridae). He regarded the Monophlebinae as being more primitive than the Coelostomidiinae, which in turn are more primitive than the remaining groups in the archaeococcoids excluding *Phenacoleachia*.

Miller's (1984) analysis shows that the subfamily Coelostomidiinae is not monophyletic, and suggests that the Margarodidae could be divided according to the distribution of the genera, i.e., a Gondwanan group comprising *Coelostomidia*, *Ultracoelostoma*, and Monophlebinae, and a Laurasian group comprising Xylococcini, *Neosteingelia*, *Kuwania*, Steingeliinae, *Matsucoccus*, and Margarodinae. Miller shows the Neotropical genera *Mimosicerya* and *Paracoelostoma* each forming a separate branch. Morales (in press) agrees in general with this grouping.

TAXONOMIC CHARACTERS

Most coccoid taxonomy in the past has been based on the adult female alone, as this is the stage most commonly encountered. However, this is not the case with margarodids, since the immatures are frequently found without associated females and the adult males are large and conspicuous.

One of the difficulties in relying on adult or preadult females to identify scale insects is that in some groups the older stages become so sclerotised that diagnostic features are difficult to see, or the taxonomic characters of these stages are so specialised and convergent that taxa are difficult to separate from one another. The importance to phylogeny and systematics of previously overlooked characters such as the anal ring of the coccoids has recently been recognised by Danzig (1984) and Miller (1984).

The trend in recent revisions of coccoids is to include descriptions of the morphology of life stages other than the adult female, and knowledge of these has been important in studies of the higher classification and phylogeny of the scale insects. Lack of knowledge of the life history of Margarodidae has resulted in one instance in the male prepupa of a species - *Coelostomidia wairoensis* (Maskell) – being described as the adult female (Brittin 1935).

First instars often show less modification, and have been used increasingly in taxonomic and phylogenetic studies, as reviewed by Howell (1984). Characters of the first instars were used to provide keys to species and to construct a classification system for the Diaspididae by Takagi (1969). Male coccoids show less specialisation than the neotenic adult female, and although they are rarely found, the morphology and cytology of those available from several different families have been used in phylogenetic studies (Hughes-Schrader 1948, Theron 1958, Ghauri 1962, Giliomee 1967, 1968). Not all male coccoids are well developed; for instance, after passing through two pupal instars the males of *Stomacoccus platani* Ferris remain degenerate, membranous, and wingless (Ferris 1917). In Diaspididae, characters of the immature males have been used to separate species (Stoetzel & Davidson 1974).

Different host plants of scales can also influence morphological features to such an extent that taxonomists have mistakenly named a new species, as in *Parthenolecanium corni* (Bouché), a polyphagous coccid whose form on *Robinia pseudoacacia* was named *Lecanium robinarium* Douglas (Cooper & Oetting 1986). Seasonal differences in numbers and measurements of certain morphological structures such as numbers and sizes of multilocular pores and cicatrices, and length of setae and appendages, have been reported for *Matsucoccus pini* (Boratynski 1952) and *M. josephi* (Ben Dov 1981). Cox (1983) found that the number of trilocular and multilocular pores and ventral tubular ducts varied with temperature in pseudococcids.

This variation emphasises the need for taxonomic revisions not only to include immature and male specimens when they are available but also, at times, to use non-morphological information for defining closely related taxa. Such information from the examination of non-morphological characters of scale insects – including chromosome systems (Nur 1980), endosymbionts (Buchner 1965), secondary chemicals such as dyes, waxes, terpenoids, and pheromones (Robison 1977), details of sperm bundles (Robison 1977), and susceptibilty to parasitism (Saakyan-Baranova & Dergunova 1978) – can be of great use to help resolve these sorts of problems, with the aid of modern techniques such as electron microscopy, electrophoresis, molecular biology, and serology.

Taxonomy of the Margarodidae

The characters of the adult female that have commonly been used are the degree of reduction of the legs, abdominal spiracles, and antennae; the kind, number, and distribution of hairs, setae, pores, and cicatrices; and the features of the anal tube and surrounding area. However, the neotenic adult females are often difficult to identify morphologically because of close similarities in these features. Similarly, identification of intermediate females involves the number, kind, and distribution of the various hairs, spines, setae, pores, and cicatrices, but the features of the anal tube and surrounding area are often the most important taxonomic characters. In most instances the antennae and legs are so reduced as to be of little use in separating taxa.

In the first instar the legs are usually uniform within a group, but features of the antennae such as the distribution of sensory setae and the number of segments have been used in separating taxa. However, as in the second- and third-instar females, the anal area and details of the derm vestiture provide the most characters. Unfortunately in most taxa adult males are not well known, but those that have been studied are identified on the characters of the legs, such as the number of digitules on the claw, the dermal vestiture of the abdomen and the number of abdominal projections, and the details of the male genitalia.

BIOLOGY AND LIFE HISTORY

Coelostomidia wairoensis

Introduction. My study (Morales 1990) of the life history of *C. wairoensis* was carried out at Karamatura Valley, Huia, 16 km west of Auckland, from January 1987 to April 1988 inclusive. On the study site of approximately 0.25 ha *Kunzea ericoides* was the host plant of *C. wairoensis*.

Leptospermum scoparium (manuka) and *Kunzea ericoides* (kanuka) in New Zealand are both tall shrubs, kanuka reaching 15 m and manuka 4 m in height. They occur in predominantly lowland areas throughout, often in the interface between open ground and forest. *C. wairoensis* is a familiar sight on kanuka, mostly in the North Island and northern part of the South Island. In autumn and winter the masses of white pupal cocoons are noticeable on kanuka branches, which are blackened by sooty mould growing on the sugary secretions of the scale insect. During summer, when the feeding stages of *C. wairoensis* are most active, the kanuka becomes covered in bees and wasps harvesting honeydew, which no doubt contributes to 'manuka' and 'kanuka' honey. Many nectar-feeding birds such as white-eyes (*Zosterops lateralis*), bellbirds (*Anthornis melanura*), and tui (*Prosthemadera novaeseelandiae*) probably also feed on this honeydew. Yellow-fronted parakeets (*Cyanorhamphus auriceps*), transferred to Little Barrier Island for conservation purposes, are reported to break open the tests and feed on their contents (Prof. E.C. Young, pers. comm).

Contrary to previous records, *C. wairoensis* has not been found feeding on manuka in Auckland. This plant is the host for a felted scale, *Eriococcus orariensis* Hoy, which was self-introduced from Australia to New Zealand and was used by farmers against manuka (Hoy 1962). Wandering male prepupae of *C. wairoensis* are sometimes found on manuka branches and trunks seeking pupation sites, however. Some species of rata (*Metrosideros* spp.) are occasional hosts of this margarodid. Both *K. ericoides* and *L. scoparium* occur in New Zealand and Australia (W. Harris, pers. comm.), but no margarodids have been recorded from either species in Australia.

Descriptions of life history stages. The cast skins of each instar are left inside the test, enabling ready determination of the number of moults. The four female stages consist of a mobile crawler, two non-mobile feeding stages, and a fully legged, mobile, non-feeding adult female. The five male stages consist of a mobile crawler, a non-mobile feeding stage, and three other non-feeding stages – the mobile prepupa, the sessile pupa, and the fully winged adult male (Fig. 9).

The crawlers are about 0.8 mm long by 0.5 mm wide, bright pink, with well developed legs and antennae. They settle in the small cracks on the young branch tips, insert their mouthparts, and produce a long, waxy anal tube to void the sugary waste products of their feeding. Their bodies become covered in white, fluffy wax which later becomes a pale brown, rather papery test.

The crawler moults to produce the second instar, which is bright red, 1.4–2.5 mm long by 1.0–1.8 mm wide, has reduced legs and antennae, and is enclosed inside a test.

The third instar is 3.2–4.5 mm long by 2.7–3.2 mm wide, and is similar to the previous instar in appearance and habit.

The adult female is 5.6–6.1 mm long by 2.7–3.2 mm wide. It has well developed eyes and antennae and, as with the previous instars, there are no sclerotised patches on the body. The female rotates 180° from her pre-ovipositional orientation and lays up to 110 eggs in the end of the test opposite to the anal filament aperture. Often the female dies inside the test. Very few adult females were seen walking about on the host plant, and it may be that some never leave the test despite their apparent mobility.

The eggs are about 0.80 mm long by 0.60 mm wide, bright pink, with a dusting of white wax. The crawlers hatch inside the test and emerge through the anal filament aperture.

The first and second male instars are indistinguishable from those of the female, but the third-instar male is the prepupa. These were observed emerging from second-instar tests by pushing themselves out of the anal filament aperture and in the process rupturing the sides of the relatively flimsy test.

The male prepupa is brick-red, mobile, and 3.3–4.3 mm long by 1.5–1.7 mm wide. During March and April it can be seen in large numbers crawling on the trunks and branches of its host plant, and also often on surrounding shrubs. It is similar in appearance to the prepupa of *U. brittini.*

The prepupae settle in great numbers on the trunk, at the trunk base, and on the branches of the host plant to spin cocoons about 5.0 mm long and pupate. In the field the prepupa takes more than a month to moult into a pupa and a further month to develop into an adult male. The pupa or fourth male instar is similar in appearance to that of *U. brittini.*

The adult male has well developed wings, antennae, legs, and compound eyes. The body is a dark pinkish purple with clear purplish wings. Body length is 3.7–4.5 mm, and wingspan about 9.0 mm. Mating was observed in the field in May and June. The adult female is often halfway out of her test, and before copulation she raises her abdomen. Males seem to find the females by searching the substrate with their antennae, and can mate several times with the same female or with one that has already mated. Coupling lasts about 20 minutes.

Parasites and predators. There appear to be no previous records of parasitism or predation on *C. wairoensis.* A cecidomyiid fly larva was found sucking the contents out of eggs, and a lepidopterous larva – *Stathmopoda coracoides* Meyrick – was found feeding on live eggs and immature stages of the scale. Coleoptera associated with the scale insect/sooty mould complex are fungus feeders (R. Craw, pers. comm.).

The role of mortality factors can only be elucidated with more detailed knowledge of the biology of the scale insect and with accumulated population data for several generations. Although the cecidomyiid and lepidopteran larvae are predators of *C. wairoensis* they probably occur at densities too low to affect the population growth of the scale. As for the red pine scale (McClure 1983), further analysis could reveal that survival and settlement of crawlers may be the most important factors affecting population growth in *C. wairoensis*.

Ultracoelostoma brittini

Introduction. The sooty beech scales, *Ultracoelostoma assimile* (Maskell) and *U. brittini*, are found throughout the North and South islands, but population densities tend to be highest around the northern half of the South Island, from Nelson and Marlborough to mid Canterbury, below altitudes of about 780 m, and in areas of low to moderate rainfall (Belton 1978, Crozier 1978).

Southern beeches are their main hosts, in particular black beech (*Nothofagus solandri* var. *solandri*) and mountain beech (*N. s.* var. *cliffortioides*), but it has also been found on *Weinmannia silvicola* and *Laurelia novaezelandiae*. Maskell recorded *U. assimile* on *Phyllocladus trichomanoides*, but this has not since been confirmed as a host. In the South Island *U. brittini* is concentrated on the beech trunk, whereas in central and southern areas of the North Island *U. assimile* is usually found in low densities on the twigs and branches.

Another species, *Ultracoelostoma dracophylli* n.sp., occurs on *Dracophyllum* species mostly in the southern South Island, on the Chatham Islands, and on the subantarctic Auckland Islands, but has also been recorded from 3200 ft [960 m] on the Tararua Range in the North Island.

In high-density populations sooty beech scale will infest a tree trunk to such an extent that almost the entire surface will be encrusted with scale tests. Inside the test the pink immature stages feed on beech sap by means of a long stylet permanently lodged in the tree. A minute hole in the test allows excretion of alimentary waste fluid by means of a hollow waxy anal filament projecting about 5 mm from the beech trunk, on the end of which is suspended a drop of honeydew. During summer, when large populations of beech scale are feeding, the trunks are covered in a mat of dense, hair-like, white filaments with glistening droplets of honeydew. The forest is filled with the aroma of honey, and many birds and insects feed on this sweet substance. Gaze *et al.* (1983) have demonstrated the importance of this food source for birds, and Crozier (1978) has given accounts of its importance to beekeepers producing 'bush honey' for export. Native parakeets (*Cyanorhamphus auriceps auriceps*) have been observed cracking open sooty beech scale tests with their beaks and licking out the contents (Taylor 1985). There may be several species of sooty mould growing on the honeydew where it falls; *Capnobe novaezealandiae* is a common example. This mould itself provides a habitat for many arthropods, which in turn are eaten by other forest insects and birds.

Most commercial quantities of honeydew in Europe are produced from coniferous forests by aphids and scale insects, and from this bees make 'forest honey' (Reid 1978). New Zealand honeydew is secreted by *Ultracoelostoma* spp., feeding mostly on *Nothofagus* sp. During the 1960s a major beekeeping industry developed around honeydew honey. This product is exported to West Germany, where it is used to extend traditional honeydew honeys (Crozier 1978). Since 1978 honeydew honey has gained a better export price than premier clover honey, and the value of the honeydew exports until 1985 averaged N.Z.$700,000 (1985 values; J. Smith, pers. comm.). *Ultracoelostoma brittini* is important economically in New Zealand because of its role in the production of honeydew honey. This margarodid was the subject of a study from July 1982 to July 1984 by Morales *et al.* (1988), and the following infomation is from this project.

Description of life history stages. Four female and five male stages were found in *U. brittini* (Fig. 10).

The crawlers are about 1 mm long, bright pink, with well developed legs and antennae. They settle in crevices in the bark, insert their mouthparts, secrete a fluffy, waxy covering, which later becomes harder and resinous, and produce a long, waxy excretory tube from their anal end. Once settled, with its mouthparts inserted into its host, the first instar does not move; if removed it is unable to re-establish and dies, as reported for *Matsucoccus* sp. (Boratynski 1952). The first instar gradually builds up its protective capsule, and moults to form the first of the intermediate or feeding stages of the life cycle.

The second instar is about 1.5 mm in diameter. The legs and antennae are reduced, and the body is more spherical and tightly pressed to the inside of the capsule. The last abdominal segment becomes more sclerotised and the last two abdominal intersegmental areas have areas of sclerotisation which appear as two concentric, black, dotted lines around the anus.

The third-instar female can attain up to 5 mm in diameter, and the last abdominal segment may become extremely heavily sclerotised, to the extent that part of it appears as a raised, thick ring surrounding the anus (Fig. 42). There is also a ring of sclerotised tissue separating the last abdominal segment from its neighbour, and three concentric rings of angular patches of dense intersegmental sclerotisation surround the anus.

The antenna and legs are further reduced in the adult female, and there are no heavy sclerotisations on the body. The adult female's mouthparts are reduced, and she stops feeding and producing an anal excretory tube. After mating she lays up to 245 eggs inside the capsule and dies. All the exuviae from previous moults remain in the test, pushed up against the anal aperture end, which does, however, retain an opening for the remains of the excretory tube.

Adult females are found in small numbers throughout the year, as are eggs, which are laid inside the test. The ovoid, bright pink eggs, about 0.70 mm long, are dusted with a fine, powdery white wax. When examined in the electron microscope the wax appears as circular parings, similar to those found by Gerson (1980) on the eggs of another margarodid, *Icerya* sp. The larvae hatch inside the test and, leaving their eggshells behind, emerge to the outside world through the anal filament aperture. Oliver (1975) observed first instars still with the eggshells attached to the anal hairs wandering on the trunks of their host plant.

The first and second male instars are indistinguishable from those of the female. The male prepupa is formed after the second-instar moult, and although emergence from the test was not observed, it was assumed that shortly after moulting the prepupa squeezes out of the test through the anal filament aperture. The tests containing this male stage seemed to have softer, thinner walls than those of females at an equivalent age. Male prepupae are a bright brick-red colour, with well developed legs, antennae, and ocelli, and are about 3–4 mm long by 2–3 mm wide. In the field they have been observed, mostly in November and December, in great numbers crawling on the trunks of their host plant, from ground level up to about 2–3 m (A.K.Walker, pers. comm.).

The pupae, or fourth-instar males, which are about 5 mm long, are enclosed in white, fluffy coccoons often at the base of the beech tree, festooned on surrounding small branchlets or seedlings or on the trunk itself.

The adult male has wings, legs, antennae, and multifaceted eyes. It is about 3–4 mm long with a wingspan of 8 mm, and is coloured a deep reddish pink; the wings are a clear purplish-pink, with the costal vein complex appearing as a deep pink thickening on the anterior edge and with an indistinct, diagonal, solitary pink vein.

Remarks. The life history of *C. wairoensis* provides an interesting contrast to that of *U. brittini*. The former lives on the tips of young branches of a tall shrub, whereas the latter lives predominantly on the bark of mature trees. One of the main problems in the life history of scales is finding a suitable place to settle and feed. In *U. brittini* the persistence of old tests seems to be a limiting factor in crawler establishment (Morales *et al.* 1988), but in *C. wairoensis* the constantly extending growing tips of the plant provide ample settlement sites. However, the habit in both species of seeking bark crevices could explain their preference for host plants with rather rough or furrowed bark. Competition for oviposition sites seems to be greater in *C. wairoensis*, as 2 or 3 females with eggs are often found crowded together in the same old prepupal test, but this could be due to the first instars settling in these tests soon after hatching. Although population densities have not been calculated, it seems that they are much greater for *C. wairoensis* than for *U. brittini*. *C. wairoensis* appears to have one generation per year, whereas *U. brittini* appears to have overlapping generations, and each generation probably takes more than a year.

Male prepupae of *U. brittini* emerge in early summer and pupate in 1–2 weeks; adult males are found in small numbers in mid to late summer. In contrast, male prepupae of *C. wairoensis* emerge in autumn and take almost 2 months to pupate; adult males are found in large numbers in early winter. All stages of *U. brittini* overwinter, but in *C. wairoensis* the third instars and females are the overwintering stage.

Several species of Margarodidae outside New Zealand form tests on their host plants, but few detailed biological studies have been done on species in the subfamilies represented in the New Zealand fauna.

Icerya purchasi

Margarodids show a wide diversity in their means of reproduction, from bisexual reproduction, in which progeny are produced by the fusion of egg and sperm from sexually dimorphic parents, to various sorts of parthenogenesis and hermaphrodism. This last-named system has been confirmed only for *Icerya* species, in which it is gynomonoecious, i.e., the hermaphrodite is similar to an adult female in external appearance but contains an ovotestis. Fertilisation occurs between the eggs and sperm of the same individual, and is ensured by the earlier development of the testes (Hughes-Schrader 1925). Occasionally sexually functional males are produced from unfertilised eggs.

Icerya purchasi has four 'female' and five male stages (Fig.11). The mature, ovipositing 'female' is recognised by its large, white, fluted egg sac, which contains 600–1000 bright red, oblong eggs. The crawlers have red bodies, black legs and antennae, some white wax, and long, glassy body setae. They squeeze out of the grooves of the egg sac to settle along the midribs and veins of the host plant. The next two instars, which are reddish brown and covered in tufts of glassy setae, black hairs, and yellow and white wax,

Table 1 Host records for six New Zealand species of Margarodidae, host family, and distribution of host genera

Margarodid	Host-plant genus and family	Distribution of host (after Willis 1973)
Coelostomidia		
deboerae	*Dacrycarpus* (Podocarpaceae)	Southern Hemisphere
	Podocarpus (Podocarpaceae)	
	Prumnopitys (Podocarpaceae)	
montana	*Dracophyllum* (Epacridaceae)	Australia, Tasmania, N. Caledonia, N. Zealand
wairoensis	*Kunzea* (Myrtaceae)	Malaya, Australia, N. Caledonia, N. Zealand
	Leptospermum (Myrtaceae)	Malaya, Australia, N. Caledonia, N. Zealand
	Metrosideros (Myrtaceae)	S. Africa, Malaya to Polynesia, Australia, N. Zealand
Platycoelostoma		
compressa	*Libocedrus* (Cupressaceae)	N. Caledonia, N. Zealand
	Podocarpus (Podocarpaceae)	Southern Hemisphere
Ultracoelostoma		
assimile	*Nothofagus* (Fagaceae)	N. Guinea, N. Caledonia, temperate Australia, N. Zealand, temperate S. America
	Laurelia (Monimiaceae)	N. Zealand, Chile
	Weinmannia (Cunoniaceae)	N. Zealand, Andes (Mexico – Chile)
dracophylli	*Dracophyllum* (Epacridaceae)	Australia, Tasmania, N. Caledonia, N. Zealand

migrate to the larger twigs and branches. The 'female' is formed after the fourth moult. Males are uncommon. They have infuscated wings and a pair of fleshy lobes bearing tufts of long setae at the end of the abdomen. In New Zealand there are two generations per year (Scott 1984).

HOST-PLANT ASSOCIATIONS

It is of interest that, with regard to hosts, the New Zealand endemic margarodid fauna is distinct from that of Australia, where the sister-group of the New Zealand margarodids – the subfamily Monophlebinae – predominates. Some of the genera of plants colonised by Coelostomidiinae in New Zealand, such as *Leptospermum*, *Nothofagus*, and *Dracophyllum*, also occur in parts of Australia such as Tasmania, but the New Zealand genera of margarodids have not been recorded from them in spite of thorough searching (J. Cox, pers. comm.). Conversely, in Australia *Araucaricoccus* and *Conifericoccus* (of uncertain position, but at present placed in the Monophlebinae) occur on *Araucaria* sp. and *Agathis* sp. (Brimblecombe 1960). Although another species of *Agathis* occurs in New Zealand there are no records of margarodids on this host.

Very few host-plant records are available for the Neotropical Coelostomidiini apart from those of Lepage (1938). *Mimosicerya* sp. has been found only on tropical legumes; *Cryptokermes* sp. on *Schinus* sp., a South American host, and on *Mimosa* sp., a tropical legume; and *Paracoelostoma* on *Manilkara*, formerly known as *Zapote*, widespread in the tropics. The Marchalinini have been found mostly on Pinaceae in the Mediterranean Basin and in southern Russia.

The New Zealand Margarodidae, except for *Coelostomidia pilosa*, *C. jenniferae*, and *C. zealandica*, are highly host-specific (Table 1). *C. pilosa* occurs mostly on gymnosperm genera such as *Podocarpus*, *Dacrydium*, *Libocedrus*, and *Phyllocladus*, which have a Southern Hemisphere distribution, but is also found on other Southern Hemisphere genera such as *Weinmannia*, *Nothofagus*, *Metrosideros*, *Leptospermum*, *Neopanax*, and *Olearia*, as well as on cosmopolitan plant genera such as *Rubus* and *Senecio*. *C. zealandica*, the most polyphagous species, is found on gymnosperms but also on *Rubus* sp., *Pimelia* sp., *Aristotelia* sp., *Cyathodes* sp., *Muehlenbeckia* sp., *Tupeia* sp., *Myoporum* spp., *Discaria* sp., and *Griselinia* sp., which apart from two cosmopolitan genera are found mostly in South America, Australia, or South-east Asia. *C. jenniferae* has been collected mainly from *Olearia* sp., but also from other hosts such as *Nothofagus* sp., *Phyllocladus* sp., *Libocedrus* sp., and *Pseudowintera* sp.

Habits

The New Zealand hemipteran fauna is characterised by a large proportion of species in certain families with cryptozoic habits. Many are brachypterous, and many are primitive and have close relatives to the hemipteran fauna occurring in South America, New Caledonia, eastern Australia, and Tasmania.

The New Zealand Margarodidae too are partly cryptozoic in their habits. Species of *Platycoelostoma* live under bark, but the female crawls down the tree to oviposit in the soil or in moss. *Ultracoelostoma* species form hard tests on their hosts' branches and bark; the male prepupae crawl down the tree trunk to pupate on the ground or on small shrubs around the tree, and the adult males crawl up the tree again to find females, which are enclosed inside tests. *Coelostomidia zealandica* forms hard tests on its host, and the females oviposit in the soil or under bark; *C. montana* remains on or under bark, and *C. wairoensis* females may remain in their tests, but *C. jenniferae* does not. The male prepupae search for pupation sites near the ground, and adult females seek oviposition sites there.

Wigglesworth (1972) suggested that the insects may have evolved in the litter layer, and Koteja (1985) speculated that scale insects shared this origin. Certainly the New Zealand Margarodidae spend some of their life in litter or under bark, and because they are considered primitive among coccoids they lend credence to these postulations.

The host plants of New Zealand margarodids are predominantly Gondwanan, such as the podocarps *Libocedrus*, *Podocarpus*, *Dacrydium*, etc., or angiosperms such as *Dracophyllum*. These are of ancient origin and have a relict distribution. *Coelostomidia wairoensis* and *C. jenniferae* have colonised more recent floral elements such as *Kunzea*, *Leptospermum*, and *Olearia*. *C. wairoensis* is predominantly northern, extending to mid Canterbury in the South Island, while *C. jenniferae* has a mostly southern distribution and is found also on the Chatham Islands. *Ultracoelostoma dracophylli* is also found in the Chathams, above 900 m in the North Island, and in areas where *Nothofagus* appears to be absent. *U. assimile* and *U. brittini*, on the other hand, are widespread on *Nothofagus*. *Coelostomidia montana* and *C. deboerae* are isolated in alpine areas, and could have speciated there. It is interesting that polphagous species such as *C. zealandica* have not colonised *Agathis* as other margarodid genera have in Australia.

It seems from their host associations, habits, parasite and predator interactions, and distribution that the New Zealand margarodids are an ancient group which originated in the forest litter of Gondwana, colonising podocarps and, later, angiosperms.

Parasites and predators

The absence of parasites in the New Zealand margarodids, except for one hymenopteran in *U. brittini*, fits the pattern for the rest of the Coelostomidiinae. (One of the few hymenopterous parasites of this subfamily, the encyrtid *Cerapterocerus* sp., has been reported from *Neocoelostoma* in South America – Blanchard 1936.) However, many hymenopterous parasites have been recorded from the Monophlebinae, including species of Encyrtidae, Aphelinidae, and Pteromalidae (Thompson 1950). The dipterous predators of Coelostomidiinae are predominantly Cecidomyiidae, which belong to the more primitive Nematocera. In contrast, the monophlebines are parasitised by Cryptochaetidae, which belong to the more advanced acalypterate Diptera. Other predators of margarodids are predominantly Coleoptera or Neuroptera, both of which are thought to have evolved earlier than other insects.

ECONOMIC IMPORTANCE

Most Margarodidae are of no economic importance. A few of them are pests, but some are also useful, and one has provided perhaps the classic example of biological control.

Traditional uses

Margarodids have been used since ancient times by man. In Mexico, *Llaveia* spp. have been used in many traditional medicines, for body paint, and to provide an impervious covering to pottery, and were still being cultivated in the late 1960s (Jenkins 1970). *Porphyrophora* spp., known in parts of Europe as St John's blood (because they were traditionally collected on this saint's day, 24 June) have been used to make a carmine dye (Blanchard 1883) and played a considerable part in European trade, particularly in Poland in the last century. 'Ground pearls', the cyst form of soil-dwelling margarodids, have been used in necklaces and other ornaments (Morrison 1928) in the West Indies and Africa.

Honey production

Honey has been harvested by man since ancient times, and the early honey sources no doubt included honeydew produced by scale insects.

In Greece *Marchalina hellenica* (Gennardius), which lives on *Pinus halepensis* and *P. sylvestris*, is the main source of honeydew that is converted by bees into honey (Crane & Walker 1985). About 65% of honey produced in Greece comes from this honeydew (Santas 1983).

In New Zealand *Ultracoelostoma brittini* produces honeydew from its feeding activity on *Nothofagus solandri* and some other trees, and this honeydew is used by bees to make 'forest honey' (Cook 1971). *Ultracoelostoma dracophylli*, which feeds on *Dracophyllum* sp., was evaluated as a possible honey source in the Chatham Islands of New Zealand (J. Smith, pers. comm.).

The effects on host plants of the feeding activities of the honeydew-producing margarodids have been reported as both damaging (in *M. hellenica* – Gennardius 1883) and probably beneficial (in *U. assimile* – Moller & Tilley 1987). It is speculated that the fall of honeydew from *U. assimile* to the forest floor may nourish soil bacteria, in particular nitrogen fixers, thus enabling the beech tree to absorb this nutrient for its own growth. By enhancing microbial activity in the soil, honeydew may accelerate cycling of other nutrients by speeding up decomposition of fallen leaves (Moller & Tilley 1987).

Pests of cultivated plants

Margarodidae are of economic importance because of the damage caused to cultivated plants by both their feeding activity and by introduction of pathogens. Although there are numerous reports of margarodids feeding on many plant species, few of these contain details as to their economic importance. The damage to the host plant is generally debility as a result of sap loss, introduction of toxins with the insect's saliva, build-up of sooty mould on the honeydew secretions that hinders photosynthesis, and damage to timber caused by the growth changes induced by feeding activity or introduction of pathogens by the mobile stages of bark-inhabiting species.

Pests of fruit crops and ornamentals

The genus *Icerya* probably includes the most ubiquitous and well known margarodid pests of fruit and ornamental plants. This genus is found in most areas of the world and has a wide host range. The best known species, the cottony cushion scale *I. purchasi* Maskell, thought to be of Australian origin, became notorious in the 1880s because of contemporaneous spectacular infestations of citrus orchards in California and South Africa, and of many woody plants in New Zealand. These infestations led to the first attempt to control an insect by means of its natural enemies, i.e., searching for the pest's natural predators and parasites in its country of origin, then transporting, quarantine, screening, propagation, and release of these natural enemies into the countries where infestations of the pest occur.

Alfred Koebele from the California State Department of Agriculture was sent to Australia in 1888 to look for the dipteran parasite *Cryptochaetum iceryae* Williston and for other parasites and predators to ship back to California, to try and save the ailing citrus industry, which was in danger of collapse solely because of *Icerya purchasi* infestations (Bartlett 1978). During this trip Koebele visited New Zealand, and in Napier he collected and dispatched over 6000 *Rodolia cardinalis* Mulsant, a self-introduced Australian species (Wight 1890). Less than 2 years after the introduction of this predator into California, *Icerya purchasi* had almost disappeared (Ebeling 1950), and today is regarded as an occasional and minor pest in many countries where *R. cardinalis* has become established (Bartlett 1978).

The control of cottony cushion scale by *R. cardinalis* remains the classic example of biological control, and was important historically because it promoted public confidence in these methods of pest control. It established biological control as a science, and was instrumental in stopping the use of increasingly toxic chemicals to control orchard pests as well as initiating practices such as quarantine and fumigation of imported produce (Ebeling 1956).

Many species of *Icerya*, too numerous to list here, have been recorded as pests of cultivated plants, mostly in tropical and subtropical regions.

Forest pests

Members of the genus *Matsucoccus* are confined to pines, and are often serious pests in forests, for example *M. resinosae* Bean & Godwin in North America (McClure 1983).

Root pests

Some of the 'ground pearls' (in particular *Margarodes* spp.) are serious pests of plant roots. *M. vitis* (Philippi) is the most important pest of vine roots in Chile, Uruguay, and Argentina (Gonzalez *et al.* 1969). The cysts of *M. vitis* have a disagreeable odour and taint the meat of farmyard animals and birds which have eaten them (Silvestri 1939). In South Africa four species of *Margarodes* are implicated in damage to grape-vines (De Klerk *et al.* 1982).

METHODS AND CONVENTIONS

It is impossible to identify most Margarodidae in the field, and specimens must be prepared for microscopic examination. Margarodids should be collected into 75% ethanol or, if they are in tests on twigs or bark, they can be put into paper envelopes and dried. If the identity of the host plant is in doubt, a sample of the leaves should be included.

Permanent mounts

Margarodids are often covered in a lot of wax. Fresh specimens and those preserved in ethanol can be shaken with 70% ethanol to remove some of this wax. However, dried specimens should be handled with care; the excess wax may be removed after the specimens have been soaked in potassium hydroxide solution (10% KOH).

NOTE. Care should be taken in using these chemicals; KOH is corrosive, chloroform and xylene are inflammable. Because xylene is a suspected carcinogen, inhalation of the fumes or contact with bare skin should be avoided. Likewise, Essig's aphid fluid contains phenol, a suspected carcinogen.

(1) If specimens are fresh or in alcohol, make a small incision on the margin of the body just behind the third leg. If specimens are dried, put them into 10% KOH and as soon as they are soft make an incision as above.

(2) Transfer to 10% KOH. The time needed for specimens to macerate varies, and care should be taken not to over-macerate them. Specimens can be considered macerated when the body contents appear liquid and translucent, are able to be moved easily inside the specimen, and are not adhering to the epidermis. Those which have been attacked by fungus are difficult to macerate because of invasion by hyphae. At least 1–2 hours should be allowed for maceration in cold KOH.

(3) Pump out body contents with a flattened or blunt needle by gently and repeatedly pressing the middle of the specimen. For large specimens, several changes of water may be needed.

(4) Rinse in distilled water and pump the body to expel excess KOH.

(5) Transfer to Essig's aphid fluid* and add 1 or 2 drops of staining solution such as acid fuchsin. Leave for 2–6 hours depending on the size of the specimen and how quickly it has taken up the stain.

(6) Transfer to 75% ethanol; leave for 5 minutes and pump the body again.

(7) Transfer to 90% ethanol; leave for 5 minutes and pump the body again.

NOTE. If there is wax still adhering to the body at this step, the specimen should be soaked in a mixture of 50% absolute alcohol and 50% chloroform for 5 minutes.

(8) Transfer to absolute ethanol; leave for 5 minutes and pump the body again.

NOTE. Do not rush steps 6–8 as specimens will shrink if dehydrated too quickly. Inadequate dehydration results in 'milky' mounts due to water reacting with the mounting medium.

(9) Transfer to xylene for 1–3 minutes and pump the body contents. Do not leave the specimens in xylene as this makes them brittle. It will be obvious at this stage whether the specimen is sufficiently dehydrated. If it is not, a milky solution results, and the specimen should be taken through the ethanol steps again.

(10) Transfer to clove oil and pump the body. The specimen is usually left for about 5 minutes, but it can remain in clove oil for days without damage. It is now ready for mounting on to a slide.

(11) A drop of Canada balsam is placed on the slide, the amount depending on the size of the specimen. The specimen is taken out of the clove oil and briefly touched against filter paper to remove excess oil. It is then placed ventral side up in the balsam. This must be done quickly, as the balsam 'skins' and the specimen has to be under the surface of the balsam blob. A cover slip is applied immediately.

NOTE. Canada balsam can be diluted with xylene, and it is best to keep the balsam reasonably thin.

(12) Label the slide with details of country, locality (i.e., nearest town, or map co-ordinates), height above sea level, host plant and/or habitat, date, and name of collector.

(13) Place in a drying oven at a low heat to cure, i.e., to let the balsam harden. This may take several weeks, but the slide should be dry enough to examine carefully after a day in the oven.

This method of preparing permanent mounts was used for the majority of specimens in this study. The males of *Coelostomidia montana* and *Ultracoelostoma brittini* were prepared according to methods used by Theron (1958) to examine the details of the thorax which are distorted by usual mounting techniques.

Preparation of adult males

Specimens were cleared in 10% KOH, then rinsed in distilled water. They were then dehydrated by passing them through a graded series of alcohols, and from absolute alcohol they were placed in a saturated solution of chlorazol black in absolute methyl alcohol. This stain was used as it has strong affinities for chitin, giving a better differentiation between membranes and sclerotised areas than stains such as fuchsin. It is used by entomologists to study the intricate details of membranes and chitinous structures of insect genitalia. After about 30 minutes the specimens had been stained a bluish colour, and they were left in absolute ethyl alcohol for 2 hours to remove the excess stain. The specimens were then transferred gradually from absolute alcohol to terpineol to prevent shrinkage. This was done as in Theron (1958) by putting some terpineol into a dish, gradually adding some absolute alcohol so that the solutions formed two layers, and placing the specimen in the dish to let it sink slowly into the terpineol at the bottom of the dish. Specimens were examined and stored in terpineol.

NOTE. Terpineol is corrosive; contact with skin and breathing in of its fumes should be avoided.

Repositories of specimens

BMNH	British Museum (Natural History), London
CMNZ	Canterbury Museum, Christchurch, N.Z.
NZAC	N.Z. Arthropod Collection, Mt Albert Research Centre, Auckland
USNM	U.S. National Museum, Washington, D.C.

**Recipe for Essig's aphid fluid (from McKenzie 1967)*

Lactic acid (reagent grade 85%)	20 parts
Phenol (saturated in distilled water)	2 parts
Glacial acetic acid	4 parts
Water (distilled)	1 part

KEY TO SUBFAMILIES OF MARGARODIDAE KNOWN FROM NEW ZEALAND

Adult female

Venter without cicatrices; anal tube sometimes poorly developed, without an inner ring, and anal opening ventral, but if well developed and with a sclerotised ring or band of pores at inner end, then anal opening distinctly apical ... (p. 25) .. **Coelostomidiinae**

—Venter with cicatrices, although these varying in number, size, and arrangement; anal tube always well developed, with an inner ring made up of either a band of pores or an area of sclerotisation; anal opening dorsal, at varying distances from apex of abdomen ... (p. 55) .. **Monophlebinae** (*Icerya*)

Intermediate stages

(2nd instars and 3rd-instar females)

Antennae and legs variously reduced, although sometimes segmentation evident; anal tube with or without an inner ring of sclerotisation, setae, or pores; anal opening apical or ventral ... (p. 25) .. **Coelostomidiinae**

—Antennae and legs fully developed; anal tube always with an inner ring of sclerotisation or pores; anal opening dorsal, some distance from apex of abdomen ... (p. 55) .. **Monophlebinae** (*Icerya*)

First instar

Anal opening variable in position: if apical, then anal tube well developed and always with a ring of sclerotisation or pores or setae and wax pores at inner end; if anal opening ventral, then anal tube without a ring of sclerotisation, pores, setae, or wax pores at inner end ... (p. 25) .. **Coelostomidiinae**

—Anal opening dorsal, sometimes close to abdominal apex; anal tube well developed, always with an inner ring of sclerotised tissue or pores and nearly always with wax pores at inner end ... (p. 55) .. **Monophlebinae** (*Icerya*)

Adult male

Apex and lateral margin of abdomen without fleshy protuberances; antennal segments not binodose, and with setae not arranged in whorls ... (p. 25) .. **Coelostomidiinae**

—Apex and lateral margin of abdomen with at least 1 fleshy protuberance, often several; antennal segments binodose, and with setae in whorls ... (p. 55) .. **Monophlebinae** (*Icerya*)

KEY TO LIFE STAGES OF COELOSTOMIDIINAE KNOWN FROM NEW ZEALAND

01 Mouthparts fully developed ... 02
—Mouthparts absent or vestigial ... 03

02 Legs fully developed ... first instar
—Legs absent or reduced ... intermediate stages

03 Legs absent or reduced ... ***Ultracoelostoma*, adult female**
—Legs fully developed ... 04

04 Antennae 10-segmented; wings and compound eyes present ... ***Coelostomidia*** and ***Ultracoelostoma*, female**
—Antennae 9–12-segmented; wings and compound eyes absent ... 05

05 Antenna 9-segmented; venter with bare patches of cuticle near base of 2nd leg ... prepupa
—Antenna 10–12-segmented; venter without bare patches near base of 2nd leg ... ***Coelostomidia*** and ***Platycoelostoma*,** adult female

KEY TO GENERA OF COELOSTOMIDIINAE KNOWN FROM NEW ZEALAND

Adult female

01 Anal tube short, ventral, without a chitinous ring at inner end; 8 pairs of abdominal spiracles ... (p. 53) .. ***Platycoelostoma***
—Anal tube long, apical, with a chitinous ring at inner end; 7 pairs of abdominal spiracles ... 02

02 Legs and antennae well developed ... (p. 27) .. ***Coelostomidia***
—Legs and antennae reduced ... (p. 45) .. ***Ultracoelostoma***

Intermediate stages

01 Legs reduced to flat, elongate plates, without claws, digitules, or their vestiges; 8 pairs of abdominal spiracles; derm pores large, flat, with simple centres and multilocular rims; antennae 1- or 2-segmented, with more than 10 thickened setae on apical segment; anus ventral ... (p. 53) .. ***Platycoelostoma***
—Legs present at least as cones, each with a claw and digitules (even if vestigial) at apex of tarsus; 7 pairs of abdominal spiracles; derm pores simple or with 3–5

inner loculi; antennae 3–6-segmented, with 2–9 thickened setae on apical segment; anus apical ... 02

02 Modified spines usually present on at least last abdominal segment, or body covered in spines; anal area not sclerotised ... (p. 27) .. ***Coelostomidia***
—Spines and modified spines absent from body; anal area sclerotised ... (p. 45) .. ***Ultracoelostoma***

First instar

01 Antennae 7-segmented, the apical segment and at least 1 preapical segment with thickened setae; 1 large, ventral cicatrix present; beak attached opposite middle coxae; anal tube without pores at inner end; a ring of large, open pores around edge of body; anus ventral ... (p. 53) .. ***Platycoelostoma***
—Antennae 6-segmented, only the apical segment with thickened setae; ventral cicatrices numbering 3; beak attached opposite anterior coxae; anal tube with wax pores at inner end; no ring of large, open-centred pores around body; anus apical ... 02

02 Anal area not sclerotised; either modified spines confined to last abdominal segment, at least on dorsum, or both body surfaces covered in spines ... (p. 27) .. ***Coelostomidia***
—Anal area sclerotised; spines and modified spines absent from body ... (p. 45) .. ***Ultracoelostoma***

Adult male

Third antennal segment approximately 6X as long as wide; penis sheath less than 3X as long as wide; abdomen without ventral cicatrices ... (p. 27) .. ***Coelostomidia***
—Third antennal segment approximately 3X as long as wide; penis sheath 3–5X as long as wide; abdomen with ventral cicatrices ... (p. 45) .. ***Ultracoelostoma***

Pupa

Posterior spiracles more or less the same size as other abdominal spiracles; some body setae with a distinct swelling at tip ... (p. 27) .. ***Coelostomidia***
—Posterior spiracles approximately 1.5X as wide as other abdominal spiracles; body setae without a distinct swelling at tip ... (p. 45) .. ***Ultracoelostoma***

Prepupa

Claw with 1 pair of digitules ... (p. 27) .. ***Coelostomidia***
—Claw with 2 pairs of digitules ... (p. 45) .. ***Ultracoelostoma***

DESCRIPTIONS

Subfamily COELOSTOMIDIINAE

Subfamily characteristics (after Morrison 1928)

Adult female usually retained and ovipositing within a test formed during the growing period; female rarely without a test, and preadult sometimes heavily sclerotised or protected only by a secretion or test, or concealed under host bark.

New Zealand: in one genus the adult female is contained in a test and oviposits there; in two genera the adult female is mobile and oviposits under the bark, or in soil or moss around the base of its host.

Adult female. Body round to elliptical or elongate oval. Derm membranous, without sclerotisation (New Zealand species).

Antennae varying from 1 or 2 segments bearing thickened setae to fully developed with 10 or 11 segments; if fully developed, then with a pore on 2nd segment and thickened setae on at least apical segment.

Legs reduced to 1 or 2 segments or well developed; trochanter with a long seta, and with pores on each face; tarsus 1-segmented; claw with or without a denticle; digitules either knobbed and exceeding claw apex or acute and not exceeding claw apex, absent in one genus (not in New Zealand). Beak usually present, often with more than 1 segment, but if absent then remains of chitinised parts and associated setae present. Thoracic spiracles with a bar; atrium with pores, or pores present outside spiracular opening; thoracic spiracles distinctly larger (in New Zealand species) than abdominal spiracles, which are in 7 pairs (8 in one New Zealand genus), marginal to ventral in position, with pores in atrium or disc pores outside spiracular opening. Derm with or without minute pores, cicatrices, derm hairs, or setae.

Anal opening apical or subapical; anal tube either well developed, with a chitinised ring and wax pores at inner end, complex disc pores, and derm hairs inside, or a simple tube without pores, hairs, or inner chitinised ring.

Intermediate stages. Body round to elongate-oval. Derm membranous, or chitinised mostly at anal end.

Antennae either fully developed or reduced (in some New Zealand forms) to stout cones with varying numbers of segments.

Legs fully developed or reduced (in New Zealand forms) but retaining all segments or reduced to plates of setae and pores; claw with or without a denticle; digitules present (in 1 New Zealand form claw and digitules vestigial), acute, not exceeding claw apex or (in New Zealand forms) knobbed and reaching or exceeding claw apex. Beak 2–3-segmented. Thoracic spiracles with a bar, with disc pores in atrium, or with varying numbers of pores but no setae at opening; abdominal spiracles smaller, in 7 pairs (1 New Zealand species with a poorly developed 8th pair), with pores in atrium, or with pore clusters at opening.

Derm with simple and complex disc pores comprising varying numbers of inner and outer loculi; simple pores of various sizes; derm hairs, setae, modified spines, and spines present in varying shapes, sizes, and numbers, and cicatrices usually present.

Anal opening apical or subapical; anal tube usually with disc pores and a chitinised inner ring, otherwise simple, without pores, setae, or chitinised ring.

First instar. Body elliptical to elongate oval. Derm membranous, or with anal area sclerotised.

Antennae stout, with 6 or (rarely) 7 segments; terminal segment, and occasionally the penultimate and some other segments, bearing thickened setae.

Legs well developed; claw with or without a denticle; digitules either knobbed and surpassing claw apex or blunt and not extending to claw apex. Beak attached opposite anterior legs, usually of 2 or 3 segments, elongate, conical. Thoracic spiracles with a bar, usually without pores in atrium, but often with 1–3 complex disc pores at opening; abdominal spiracles in 7 pairs (1 New Zealand genus with 8), usually with no pores in atrium, but often with 1 or 2 pores outside opening.

Derm with simple or complex disc pores comprising varying numbers of internal and external loculi; simple pores of different sizes; at least 1 ventral cicatrix present; spines rare (present in 2 New Zealand species); derm hairs and setae present, and usually 1–4 pairs of long setae at apex of abdomen.

Anal opening apical or subapical; anal tube usually well developed, with polygonal wax pores, complex disc pores, and a chitinised proximal ring, but sometimes simple and lacking pores or a chitinised ring.

Adult male. The subfamily characteristics listed by Morrison (1928) were based on New Zealand forms only, and may have to be modified as males of other genera in this subfamily are found.

Body elongate. Head acute between antennal bases. Antennae 10-segmented, the terminal segment shortest, with thickened setae on last 2 segments.

Mid-thoracic dorsal area with a conspicuous, clear, unchitinised area (see Morphology, adult male, p. 13). Legs with 20–60 bifurcate setae on tibia and 8–24 on tarsus; trochanter with 4 pores on each face and a long seta; tarsus distinctly 2-segmented; claw with a denticle; digitules knobbed or not, and falling short of or exceeding claw apex. Wings not infuscate; basal diagonal short; costal complex terminating before wing apex; apical diagonal absent; hamulohalteres with 3–6 long, curved, knobbed, apical setae.

Abdomen with no transverse chitinised plates or subapical clusters of tubular pores, but with disc pores, minute pores, setae, derm hairs, and cylindrical tubercles present in varying degrees. Penis sheath stout or narrow at base, tapering to a stout or narrow cone, its tip entire or bilobed; ventral valve shorter than sheath, parallel-sided.

Remarks. Most of the genera in the Coelostomidiinae occur in the Neotropical region and the New Zealand subregion of the Australasian region. A single genus, *Marchalina*, occurs in the Palearctic region, but there is inadequate information about it and its tribal affiliations, so its status in this subfamily is regarded as provisional (Morrison 1927). Morrison erected three tribes: the Marchalinini, to include the Palearctic genus *Marchalina* Vayssière, recorded from *Pinus* species around the Mediterranean and in Russia; the Platycoelostomini, to take the monotypic New Zealand genus *Platycoelostoma* Morrison; and the Coelostomidiini, to include the New Zealand genera *Coelostomidia* Cockerell and *Ultracoelostoma* Cockerell and the South American genera *Paracoelostoma* Morrison, *Cryptokermes* Hempel, and *Mimosicerya* Cockerell. *Neocoelostoma* Hempel has been included in the Coelostomidiini subsequently (Hempel 1932).

Tribe Coelostomidiini

(after Morrison 1928)

Mostly enclosed in a test during the feeding stages, or without a protective covering. Adult female retained inside test and ovipositing inside it, or free-living and ovipositing on host plant or surroundings.

Adult female. Body round to elliptical or elongate. Derm membranous, or with anterior and posterior ends heavily or lightly chitinised (not in New Zealand forms). Antennae well developed or reduced to stout cones; if well developed, then with a pore usually on 2nd segment, and thickened setae at least on apical segment and sometimes on preapical segments.

Legs well developed or variously reduced but retaining all segmentation; claw with or without a denticle and knobbed digitules which usually reach beyond claw apex, or acute digitules not reaching claw apex; digitules rarely absent; trochanter with a long seta on posterior edge and pores on both faces; tarsus 1-segmented. Beak usually not present. Thoracic spiracles with a bar, with no pores in atrium or with complex disc pores in varying numbers on derm near opening, and with or without minute pores; abdominal spiracles slightly smaller or the same size, in 7 pairs, with or without complex disc pores and minute pores in atrium or near opening. Setae, spines, and derm hairs present, often rather thick; complex disc pores and minute pores present; cicatrices, if present, on venter of head.

Anal opening apical; anal tube well developed, not heavily chitinised but with a chitinised ring at inner end and various lobes, derm hairs, and pores.

Intermediate stages. Body usually globular. Derm membranous or with chitinised areas, especially at posterior apex (in New Zealand forms). Antennae rarely fully developed, usually as short cones but retaining segmentation.

Legs usually reduced in varying degrees but retaining all segmentation; trochanter with a long seta on posterior edge and 3 or 4 pairs of pores; claw with or without a denticle, with knobbed or acute digitules which rarely attain claw apex. Beak usually elongate and 3-segmented. Thoracic spiracles with a bar, with complex disc pores, and with or without minute pores on derm at entrance; abdominal spiracles smaller, in 7 pairs, with or without complex disc pores and minute pores in atrium or on derm near opening. Derm with or without modified spines; derm hairs and setae, complex and simple disc pores, simple pores, minute pores, and cicatrices present.

Anal opening apical; anal tube well developed, with an inner chitinised ring. Various setae, hairs, pores, lobes, and patterns of chitinisation present in *Coelostomidia* and *Ultracoelostoma*.

NOTE. The 2nd and 3rd instars can be distinguished in *Coelostomidia* and *Ultracoelostoma* by the numbers of complex disc pores associated with the thoracic and abdominal spiracles, and by the number of rows of pores at the inner end of the anal tube; and in some species of *Coelostomidia* by the number of rows of pores or derm hairs medially in the anal tube.

First instar. Body elongate to elliptical. Derm membranous or with posterior apex chitinised (in 1 New Zealand genus). Antennae well developed, 6-segmented, with various numbers of thickened setae on apical segment.

Legs well developed; claw with a denticle; digitules knobbed and extending beyond claw apex or acute and not reaching claw apex. Beak usually elongate, 3-segmented. Thoracic spiracles with a bar, and with 1 or more complex disc pores at opening; abdominal spiracles with or without complex disc pores in atrium or at opening. Derm with or without complex and simple disc pores, simple pores, minute pores, spines, modified spines, derm hairs, and setae, and with 1–4 pairs of long apical setae and 1–3 ventral cicatrices on last abdominal segment.

Anal opening apical; anal tube well developed, with an inner sclerotised ring and with or without 1 or more bands of wax pores near inner end and/or a ring of complex disc pores or hairs medially or basally.

Adult male. When Morrison (1928) diagnosed the adult male characters for this tribe and for the subfamily Coelostomidiinae only the New Zealand forms were available, and his diagnosis is the same as that for the subfamily.

Prepupa and pupa. Only the New Zealand forms have been studied, and their description is as for the genera *Coelostomidia* and *Ultracoelostoma*.

Genus *Coelostomidia* Cockerell

Coelostoma Maskell, 1880: 294. Type species *Coelostoma zealandica* Maskell, by subsequent designation (Cockerell 1902, p. 258).

Coelostomidia Cockerell, 1900: 367 (replacement name for *Coelostoma*; preoccupied).

Adult female. Body elongate-oval. Derm membranous, without sclerotisation. Antennae 10- or 11-segmented; 4–7 thickened setae on terminal segments, 1–3 on some others.

Legs large, stout; supporting struts of coxa and trochanter often sclerotised; trochanter with a long seta on posterior edge, and on each face 4 or 5 pores; tibia and tarsus with setae on underside varying from long and slender to stout, and from sparse to numerous; claw stout, curved, with or without a denticle or rows of small serrations; digitules almost reaching claw apex, slender, knobbed. Mouthparts sometimes well defined and with sclerotised supports, but more often absent, or vestigial and membranous, with patches of setae. Thoracic spiracles with a bar and a cluster of7–20 complex disc pores and sometimes minute pores at opening; abdominal spiracles with 2–20 complex disc pores and minute pores in atrium, without bars. Derm pores mostly complex disc pores, circular, with 8–14 outer loculi and 2–5 inner loculi; 3 or 4 small, thick-walled, simple pores near eye. Cicatrices, when present, mostly in ventral head region, smaller or larger than disc pores. Minute pores often present. With varying numbers of derm hairs and setae of 2 sizes, those between antennae, around anus and vulva, at margin, and on last segment somewhat larger. Ventral abdominal cicatrices absent.

Anal tube a single, large, long tube opening at posterior apex of body, with a chitinised ring at inner end and with a median ring of 3–25 derm hairs, lobes, minute pores, and surface tesselations.

Intermediate females (2nd and 3rd instars). Body oval or round. Derm membranous. Antennae rarely fully developed, usually as short cones retaining 6–8 segments; 4–9 thick setae on terminal segments, 1 or 2 on others; 2nd segment with a pore. Legs reduced but retaining all segmentation; trochanter with a long seta and, on each face, 3 pores; claw reduced or, if fully developed, with or without a denticle; digitules knobbed, either reduced or extending beyond claw apex. Beak elongate, 3-segmented. Thoracic spiracles with 9–26 complex disc pores and minute pores at opening; abdominal spiracles with 6–14 complex disc pores in atrium, with or without minute pores. Ventrally with bare areas around spiracles, leg bases, and thoracic midline, and with 2 long setae between antennae. Derm with simple disc pores, setae, and derm hairs present; spines, modified spines, complex disc pores, and simple pores lacking in some species. Derm vestiture arranged more or less in bands on abdominal segments but scattered on thorax and head, and more dense on body margins. Modified spines, when present, on last 2–4 abdominal segments.

Last abdominal segments not sclerotised. Anal opening apical; anal tube with a chitinised ring and rows of pores at inner end; medially with pores, derm hairs (one species) or a collar (one species), lobes, and patterns of chitinisation.

First instar. Body elongate to elliptical. Derm membranous. Antennae 6-segmented; terminal segment longest, bearing 5 or 6 thickened setae; 2nd segment with a pore. Legs well developed; trochanter with a long seta and, on each face, 2 pores; claw with a denticle and with 2 knobbed digitules extending beyond claw apex. Beak 3-segmented. Thoracic spiracles with 1 or 2 complex disc pores at opening; abdominal spiracles with or without complex disc pores at opening. Ventrally with bare areas around spiracles, legs, and in thoracic midline, and with 2 long setae between antennae. Derm with simple disc pores, derm hairs, and setae present; spines, modified spines, complex disc pores, and simple pores lacking in some species. Derm vestiture arranged more or less in bands on abdominal segments but scattered on head and thorax. Ventral cicatrices on last abdominal segment numbering 3, the middle one widest. Anal area not sclerotised, with a pair of caudal setae but lacking other long setae. Anal opening apical; anal tube with a sclerotised ring and 2 rows of pores at inner end, medially with a single row of pores.

Adult male. Body elongate. Antennae 10-segmented, with thickened setae on terminal segment; 3rd segment about 6X as long as wide; fine setae present, not arranged in whorls on segments. Head and thorax as for subfamily. Legs well developed, as for subfamily; claw with or without a denticle, and with from 2 to 50+ knobbed digitules, these exceeding claw apex. Hamulohalteres with 3–6 long, curved, knobbed setae at apex. Derm hairs, setae, disc pores, minute pores, and cylindrical tubercles, if present, arranged in rows on abdominal segments.

Penis sheath cone-shaped, less than 3X as long as wide, with a bilobed, rounded tip.

Pupa. Body elongate. Antennae indistinctly 10-segmented. Legs indistinctly segmented, with short, stout setae. Thoracic and abdominal spiracles lacking associated pores; last pair of abdominal spiracles more or less as large as the others. Head and thorax with fine setae, derm hairs, and complex disc pores, all sparse in midline. Minute pores present on head venter. Abdomen with bands of stout, knobbed setae, fine setae, derm hairs, and complex disc pores. Last abdominal segment with stout, knobbed setae of various lengths, and a pair of caudal setae.

Prepupa. Body broadly elongate. Antennae 9-segmented, with thickened setae on terminal segment and on some others; 2nd segment with a pore. Legs fully developed; trochanter with a long seta and, on each face, 3 pores; tibia expanded apically or not; thickened setae present on tibia and tarsus; claw with or without a denticle, and with a pair of knobbed digitules extending beyond claw apex. Thoracic spiracles with 3–6 complex disc pores and some minute pores at opening; abdominal spiracles with 2–4 complex disc pores and minute pores in atrium. Derm with setae, derm hairs, and complex disc pores. Minute pores present in some species. Cicatrices present on venter of head.

Anal tube with an inner chitinised ring, pores, and medially 8–12 fine derm hairs.

KEY TO SPECIES OF *COELOSTOMIDIA*

Adult female

01 Distal end of tibia expanded; numerous (30–60) stout setae on underside; posterior spiracles large, immediately adjacent to anal opening or less than 2 spiracle widths from it ... 02

—Distal end of tibia not expanded; stout setae sparse (less than 30) on underside; posterior spiracles at least 2 spiracle widths from anal opening ... 03

02 Stout setae absent from underside of trochanter and femur; thoracic spiracles with 5–7 complex disc pores at opening; abdominal spiracles with 3 or 4 associated complex disc pores; ventral cicatrices on head about as large as disc pores ... (p. 30) .. ***deboerae***

—Stout setae present on underside of trochanter and femur; thoracic spiracles with 13–20 complex disc pores at opening; abdominal spiracles with 10–16 associated complex disc pores; ventral cicatrices on head about as large as disc pores, or larger ... (p. 41) .. ***zealandica***

03 Ventral cicatrices on head about 1.5X as large as disc pores ... 04

—Ventral cicatrices on head smaller than disc pores, or absent ... 05

04 Claw without a denticle; anal tube with a median collar of thickened tissue, and with about 18 median derm hairs; thoracic spiracles with 18–20 complex disc pores at opening; abdominal spiracles with 8–12 complex disc pores ... (p. 36) .. ***pilosa***

—Claw with a denticle; anal tube lacking a median collar of thickened tissue, with 7 or 8 median derm hairs; thoracic spiracles with 6–8 complex disc pores at opening; abdominal spiracles with 3 or 4 associated complex disc pores ... (p. 32) .. ***jenniferae***

05 Minute pores absent; ventral cicatrices on head with open centres (Fig. 8a); tibia with about 20 stout setae on underside, tarsus with about 10; anal tube with 6–10 median derm hairs ... (p. 34) .. ***montana***

—Minute pores present; ventral cicatrices on head with closed centres (Fig. 8b); tibia with 8–12 stout setae on underside, tarsus with 5 or 6; anal tube with 3 or 4 median hairs ... (p. 39) .. ***wairoensis***

Intermediate stages

01 Modified spines present on body; no spines around anus ... 02

—No spines on body; modified spines present around anus ... 03

02 Anal tube with a medial ring of pores but no clavate derm hairs ... (p. 36) .. ***pilosa***

—Anal tube lacking medial pores but with medial clavate derm hairs (Fig. 8c) ... (p. 32) .. ***jenniferae***

03 Anal tube with a median band of pores several rows wide (Fig. 8d) ... 04

—Anal tube with a single or double row of pores (Fig. 8e) ... 05

04 Modified spines around anus conical, with acute apices (Fig. 8f) ... (p. 30) .. ***deboerae***

—Modified spines around anus dome-like, with rounded apices (Fig. 8g) ... (p. 41) .. ***zealandica***

05 Modified spines around anus conical, with curved, pointed tips (Fig. 8h) ... (p. 34) .. ***montana***

—Modified spines around anus tapered, with uncurved, rounded tips (Fig. 8i) ... (p. 39) .. ***wairoensis***

First instar

01 Spines present on both sides of body and around anus; modified spines absent ... 02

—Spines absent from body; modified spines present around anus only ... 03

02 Spines sparse, absent from dorsum of head and thorax and from ventral midline, those around anus on venter with expanded, truncate tips; 1 complex disc pore at opening of thoracic spiracle ... (p. 32) .. ***jenniferae***

—Spines numerous and evenly spread on dorsum, those around anus not differentiated from those on body; 2 complex disc pores at opening of thoracic spiracle ... (p. 36) .. ***pilosa***

03 Modified spines around anus dome-shaped tubercles (Fig. 8g); derm hairs not clavate ... (p. 41) .. ***zealandica***

—Modified spines around anus stout, conical (Fig. 8h,i); clavate derm hairs present on dorsum and venter ... 04

04 Modified spines surrounding anus narrow, tapering, curved at tip (Fig. 8h); clavate derm hairs with tips scarcely expanded ... (p. 34) .. ***montana***

—Modified spines surrounding anus not narrow and tapering nor curved at tip; clavate derm hairs with tips expanded ... 05

05 Modified spines surrounding anus stoutly triangular, with an acute tip (Fig. 8f); 2 complex disc pores at opening of thoracic spiracle, 1 at opening of abdominal spiracle ... (p. 30) .. ***deboerae***

—Modified spines surrounding anus almost Y-shaped, with a rounded tip (Fig. 8i); 1 complex disc pore at openings of both thoracic and abdominal spiracles ... (p. 39) .. ***wairoensis***

Adult male

01 Claw with 1 pair of digitules ... 02

—Claw with 2–16 pairs of digitules ... 03

02 Cylindrical tubercles (Fig. 8j) present on venter of abdomen; cicatrices on head same width as disc pores; minute pores absent ... (p. 41) .. ***zealandica***

—No cylindrical tubercles on venter of abdomen; cicatrices on head wider than disc pores; minute pores present ... (p. 36) .. ***pilosa***

03 Hamulohalteres with 4 or 5 knobbed apical setae; cylindrical tubercles about 0.7X as tall as wide; minute pores absent ... (p. 34) .. ***montana***

—Hamulohalteres with 3 knobbed apical setae; cylindrical tubercles as tall as wide; minute pores present ... (p. 39) .. ***wairoensis***

Pupa

01 Setae on anal lobes stout; minute pores present on both body surfaces ... (p. 36) .. ***pilosa***

—Setae on anal lobes not stout; minute pores present on venter of head only ... 02

02 Derm hairs on body slender, with pointed tips; spiracles 30 µm or wider ... (p. 41) .. ***zealandica***

—Some derm hairs on body equally thick throughout their length, with blunt or clavate tips; spiracles less than 30 µm wide ... 03

03 Derm hairs slightly clavate; spiracles approximately 25 µm wide and less than 5X their width from anal tube ... (p. 34) .. ***montana***

—Derm hairs equally thick throughout their length, with blunt but not clavate tips; abdominal spiracles approximately 10 µm wide and more than 5X their width from anal tube ... (p. 39) .. ***wairoensis***

Prepupa

01 Posterior spiracles large, 35–37 µm wide, less than 1 spiracle width from anal tube; distal end of tibia expanded, with 16–18 stout setae on underside; anal tube with 20–22 medial derm hairs ... (p. 41) .. ***zealandica***

—Posterior spiracles small, 25–30 µm wide, 5–10X their width from anal tube; distal end of tibia not expanded, with less than 12 stout setae on underside; anal tube with less than 13 derm hairs medially ... 02

02 Cicatrices on head same size as disc pores; claw with a denticle; anal tube with 10–12 derm hairs medially ... (p. 36) .. ***pilosa***

—Cicatrices on head smaller than disc pores; claw without a denticle; anal tube with less than 10 derm hairs medially ... 03

03 Claw less than twice as long as wide; minute pores absent from both body surfaces; 10–12 stout setae on underside of tibia ... (p. 34) .. ***montana***

—Claw more than twice as long as wide; minute pores present on both body surfaces; 6–8 stout setae on underside of tibia ... (p. 39) .. ***wairoensis***

Coelostomidia deboerae new species

Figures 12–14

Adult female (Fig. 12). Appearance of live individuals typical of genus. Body oval-elongate, widest near 4th abdominal segment.

Measurements: body length 6.5–9.1 mm (holotype 9.0 mm), width 4.0–5.2 (5.2) mm; length of hind trochanter plus femur 0.6–1.0 (0.9) mm, of hind tibia plus tarsus 0.9–1.2 (1.1) mm.

Venter. Antenna 11-segmented, as for genus. Legs as for genus; claw with small serrations, and with a pair of knobbed digitules (3 in some specimens); trochanter and femur lacking stout, spine-like setae on posterior edge; tibia with distal tip expanded, with 30–40 stout setae on underside. Thoracic spiracles with 5–7 associated complex disc pores and minute pores at opening; abdominal spiracles with 3 or 4 complex disc pores and minute pores in atrium; last pair of spiracles about 1 spiracle width from anal tube. Complex disc pores present. Cicatrices similar in size to complex pores, on head. Minute pores concentrated around anal area, spiracles, and head. Body hairs and setae of 2 sizes present.

Dorsum. Pores and setae as on venter, but cicatrices absent.

Anal tube with a median ring of about 12 derm hairs, minute pores on inner two-thirds, and an inner chitinised ring.

Third-instar female. Appearance of live individuals unknown. Body round to oval.

Measurements: body length 4.0–4.7 mm (paratype 4.6 mm), width 3.1–4.0 (4.0) mm; length of antenna 0.25–0.28 (0.25) mm; length of hind leg 0.25–0.33 (0.32) mm.

Venter. Antenna as for genus. Legs as for genus; claw reduced, with a pair of knobbed digitules extending beyond claw apex. Thoracic spiracles with 11–14 complex disc pores and minute pores at opening; abdominal spiracles with 1 or 2 inner rings of about 11 complex disc pores and minute pores; posterior spiracles about 1 spiracle width from anal tube to anus. Complex disc pores present, mostly near spiracles and on last abdominal segment. Minute pores present; simple disc pores numerous, larger than simple pores, which have a small and rather raised lumen. Cicatrices present on abdominal segments. Fine setae of 2 sizes and thick derm hairs present. Clavate derm hairs and spines absent. Two rows of complex pores present around anus, and modified spines on last abdominal segment.

Dorsum. Setae and pores more numerous than on venter, comprising mostly simple disc pores, simple pores, and minute pores. Many modified spines around anus and on last 2 abdominal segments. Cicatrices scattered over dorsum.

Anal tube with 3 or 4 medial rows of pores, 5 rows of pores at inner end, and thickened tissue between these pores. Lobes absent.

Second-instar female (Fig. 13). Appearance of live individuals unknown. Body oval.

Measurements: body length 2.4 mm, width 1.5 mm; antenna length 0.16 mm; hind leg length 0.15 mm.

Venter. Antennae as for genus. Legs as for 3rd instar. Thoracic spiracles with 8 or 9 complex disc pores and minute pores at opening; abdominal spiracles with an inner ring of 4–6 complex disc pores and minute pores. Pores, setae, derm hairs, and modified spines as in 3rd instar but less numerous.

Dorsum. Pores, setae, cicatrices, derm hairs, and modified spines as for 3rd instar but less numerous.

Anal tube with a medial band of 1–3 rows of pores, 3 or more rows of wax pores at inner end, and a collar of thickened tissue between these.

First instar (Fig. 14). Appearance of live individuals typical of genus. Body oval.

Measurements: body length 1.2–1.4 mm, width 0.8–1.0 mm; length of hind trochanter plus femur about 0.4 mm, of hind tibia plus tarsus 0.5 mm.

Venter. Antennae and legs as for genus. Thoracic spiracles with 2 complex disc pores at opening; abdominal spiracles with 1 complex disc pore at opening; last pair of abdominal spiracles same size as others, not immediately adjacent to anal tube. Derm hairs, 2 sizes of setae, simple pores with a slightly domed appearance, and simple disc pores of about the same size with 3 (rarely 4) loculi present. Setae of 2 sizes, derm hairs, minute pores, simple disc pores, and complex disc pores present on last abdominal segment. Cicatrices and caudal setae as for genus. Modified spines absent.

Dorsum. Setae, derm hairs, and pores as on venter. A row of modified spines present on last abdominal segment.

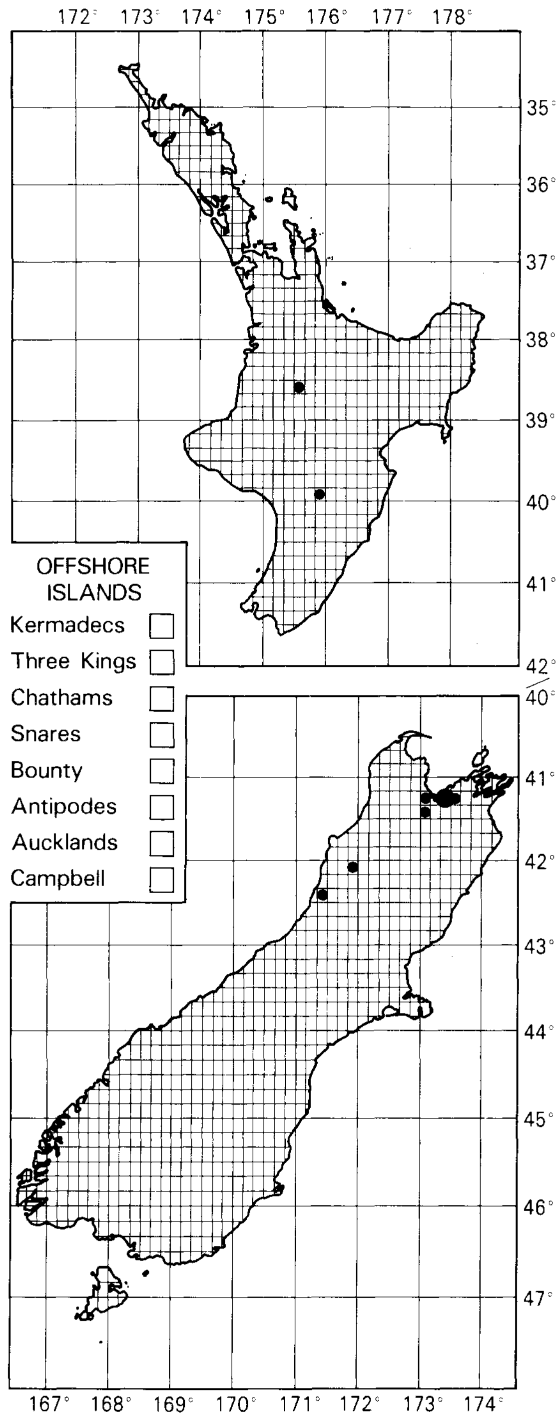
Anal tube as for genus.

Male stages. Not known.

Type data. Holotype (NZAC) an adult female labelled: (1) – "no. 338 *Coelostomidia deboerae* HOLOTYPE adult female"; (2) – "no. 338 *Podocarpus totara*, Maitai Vly, Nelson, 17.1.1968, J.A. deBoer".

Ten **paratypes** have been selected, and so labelled, from specimens in the J.A. de Boer and J.M. Hoy collections.

Material examined. Adult female: holotype and 3 paratypes (NZAC). —/NN. Collected from *Podocarpus totara* and *Prumnopitys taxifolia*. Recorded January.



• **Map 1** Collection localities, *Coelostomidia deboerae* •

Third-instar female: 2 paratypes, plus 3 non-type examples (NZAC, BMNH). TO, WI / NN. Collected from *Prumnopitys taxifolia* and *Podocarpus totara*. Recorded January and April.

Second-instar female: 4 paratypes, plus 2 non-type examples (NZAC). — /NN, BR. Collected from *Podocarpus totara* and *Prumnopitys taxifolia*. Recorded April, August, November, and December.

First instar: 3 paratypes (NZAC, BMNH). — / NN. Collected from *Podocarpus totara* and *Dacrycarpus dacrydioides*. Recorded March, April, and November.

Remarks. *Coelostomidia deboerae* is most similar to *C. zealandica*. The immature female stages are the easiest to distinguish, and can be separated from other species by the different shape of the modified spines around the anus. In adult females the position of the anal tube relative to the posterior spiracle, the smaller size, the small denticle on the claw, the less expanded distal tip of the tibia, the absence of thick setae on the underside of the femur, and the fewer pores associated with thoracic and abdominal spiracles are distinctive for separation from *C. zealandica*.

This species is named after Miss J.A. de Boer, who collected most of the type material and who has contributed significantly to New Zealand coccidology, not least by her many slide mounts, dried specimens, and notes on scale insects.

C. deboerae was inadvertently referred to as *Coelostomidia totarae* (a manuscript name) by Butcher (1986) in a table listing host records of New Zealand Margarodidae. The latter combination is thus a nomen nudum.

This species is the same as that described in Morales (1990) as *Coelostomidia* sp. A.

Coelostomidia jenniferae new species

Figures 15–17

Adult female (Fig. 15). Appearance of live individuals typical of genus. Body elongate oval, widest near hind legs.

Measurements: body length 6.8–7.1 mm (holotype 7.0 mm), width 3.8–4.8 (4.8) mm; length of hind trochanter plus femur 0.72–0.82 (0.82) mm, of hind tibia plus tarsus 0.80–0.98 (0.98) mm.

Venter. Antennae 10-segmented, as for genus. Legs as for genus; trochanter and femur lacking spine-like setae on posterior edge; tibia not expanded apically, but with 20–25 stout setae on posterior edge; tarsus with 12–16 stout setae; claw with a denticle. Thoracic spiracles with 6–8 complex disc pores together with minute pores; abdominal spiracles with 3 or 4 complex disc pores and minute pores in atrium; last pair of abdominal spiracles more than 2 spiracle widths from anal tube. Complex disc pores, minute pores, and derm hairs and setae of 2 sizes scattered over venter. Cicatrices on head as large as or slightly larger than complex disc pores.

Dorsum. Pores, derm hairs, and setae as for venter, but cicatrices absent.

Anal tube with a chitinised inner ring, a medial ring of 7 or 8 derm hairs, and small lobes projecting from surface; minute pores present on inner two-thirds.

Third-instar female. Appearance typical of genus. Body oval.

Measurements: body length 2.4–3.8 mm (paratype 2.5 mm), width 2.0–2.8 (2.1) mm; antenna length 0.1 (0.1) mm; hind leg length 0.15 (0.1) mm.

Venter. Antennae as for genus. Legs as for genus; claw long, with a distinct denticle. Thoracic spiracles with 14 or 15 complex disc pores and minute pores at opening; abdominal spiracles with a double row of 10 or 11 complex disc pores and minute pores medially; last pair of abdominal spiracles separated from anal tube by more than twice their own width. Cicatrices present on abdominal segments. Simple disc pores, minute pores, small setae, clavate derm hairs, and spines present, concentrated on body margins. Complex disc pores absent. Spines on last abdominal segment tending to be longer than elsewhere.

Dorsum. As for venter, but cicatrices sparser and present on head and thorax, and setae, hairs, spines, and pores more evenly distributed. Last abdominal segment as on venter.

Anal tube with 6–10 inner, clavate derm hairs in distal third; a medial band of thickened tissue and lobes and 8 rows of pores at inner end. Medial pores absent.

Second instar (Fig. 16). Appearance typical of genus. Body oval.

Measurements: body length 1.7–2.0 mm, width 1.2–1.5 mm; antenna length 0.1 mm; hind leg length 0.05–0.1 mm.

Venter. Antennae as for genus. Legs as for genus; claw as for 3rd instar. Thoracic spiracles with 6 or 7 associated complex disc pores and a few minute pores at opening; abdominal spiracles with 5 or 6 complex disc pores and minute pores medially. Pores, derm hairs, cicatrices, and spines as for 3rd instar but sparser.

Dorsum. As for 3rd instar, but cicatrices more sparse.

Anal tube with 4 or 5 thick, clavate derm hairs, thickened tissue, and lobes medially, and 4or 5 rows of pores at inner end. Medial pores absent.

First instar (Fig. 17). Appearance of live individuals typical of genus. Body oval.

Measurements: body length 1.4–1.6 mm, width 0.70–0.95

mm; length of hind trochanter plus femur 0.17 mm, of hind tibia plus tarsus 0.19–0.20 mm.

Venter. Antennae and legs as for genus. Thoracic spiracles each with a complex disc pore at opening; abdominal spiracles without associated pores, the last pair at some distance from anal tube. Slightly clavate hairs, setae of 2 sizes, spines, simple disc pores, and simple pores present; complex disc pores absent. Last abdominal segment not differentiated in vestiture from remainder of body except spines longer with sudden, truncate tips. Cicatrices and caudal setae as for genus. Modified spines absent.

Dorsum with setae, derm hairs, spines, and pores as on venter but more numerous and more evenly distributed.

Anal tube as for genus.

Male stages. Not known.

Type data. The **holotype** (NZAC) is an adult female with the following data: label 1 – "*Coelostomidia jenniferae* Morales / adult female / HOLOTYPE"; label 2 – "New Zealand, SL near Curio Bay, Feb 1983, J. Cox, ex *Leptospermum* sp. #83.2631".

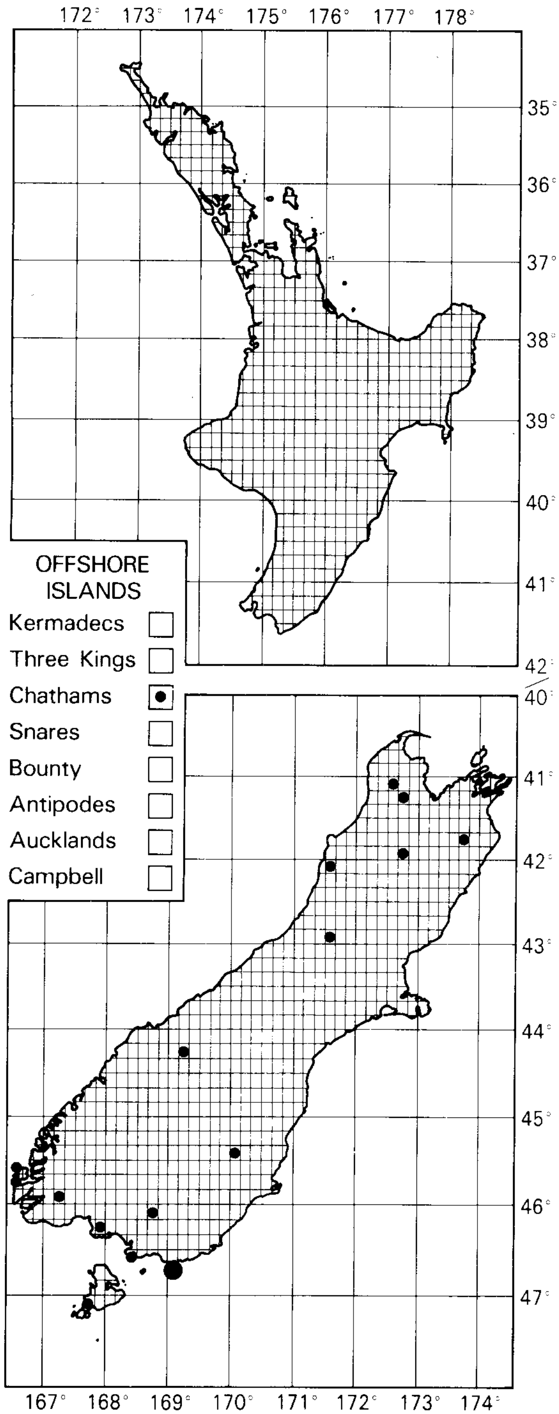
Seventeen **paratypes** have been selected, and so labelled, from among the other specimens examined.

Material examined. Adult female: holotype and 3 paratypes, plus 8 non-type examples (NZAC, BMNH). — / NC–WD, FD, SL / Chatham Is. Collected from *Olearia colensoi*, *O. traversii*, *O. ilicifolia*, *Nothofagus solandri*, *Weinmannia racemosa*, *Aristotelia* sp., *Leptospermum scoparium*, and *Pseudowintera colorata*. Recorded January–March.

Third-instar female: 8 paratypes, plus 11 non-type examples (NZAC, BMNH). — / MB, NN, BR, NC–WD, FD, SL / Chatham Is. Collected from *Aristotelia* sp., *Nothofagus menziesii*, *N. solandri*, *Leptospermum scoparium*, *Olearia* sp., *O. traversii*, *O. colensoi*, *Phyllocladus alpinus*, *Libocedrus bidwilli*, *Pseudowintera colorata*, *Traversia baccharoides*, and *Prumnopitys taxifolia*. Recorded January–May and October–December.

Second-instar female: 8 paratypes, plus 24 non-type examples (NZAC, BMNH). — / MB, NN, BR, NC–WD, CO, OL, FD, SL / SI / Chatham Is. Taken from *Pseudowintera colorata*, *Anisotome imbricata*, *Leptospermum scoparium*, *Olearia avicenniaefolia*, *O. colensoi*, *O. traversii*, *Schefflera digitata*, *Nothofagus solandri*, *N. menziesii*, *N. fusca*, *Phyllocladus alpinus*, *Libocedrus bidwilli*, *Metrosideros* sp., and *Traversia baccharoides*. Recorded January–March, May, and September–December.

First instar: 2 paratypes, plus 4 non-type examples (NZAC). — / NN, FD. Collected from *Leptospermum*



• **Map 2** Collection localities, *Coelostomidia jenniferae* •

scoparium, *Olearia avicenniaefolia*, *Traversia baccharoides*, and *Weinmannia racemosa*. Recorded January–March and November.

Remarks. Second and third instars are easier to identify than the other life stages. Adult females are similar to those of *C. pilosa* except for their smaller size and a denticle on the claw. Second- and third-instar females can be distinguished from intermediate females of *pilosa* by the presence of a ring of strongly clavate derm hairs inside the anal tube instead of the usual ring of pores. The first instars of *jenniferae* have fewer spines than *pilosa*, and the spines at the anal end have expanded, rather truncate ends.

This species is named after Dr Jenny Cox, who found many of the specimens on *Leptospermum* sp. in Southland.

C. jenniferae is the same as *Coelostomidia* sp. B, described in Morales (1990).

Coelostomidia montana Green

Figures 18–23

Coelostomidia montana Green, 1929: 370. Lectotype female, New Zealand (BMNH), here designated [examined].

Adult female (Fig. 18). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) round to oval, widest near 4th abdominal segment. Derm membranous.

Measurements: body length 3.5–6.1 mm (lectotype 3.5 mm), width 2.5–3.2 (2.5) mm; length of trochanter plus femur 0.6–0.7 mm, of tibia plus tarsus 0.7–0.8 mm (legs missing on lectotype).

Venter. Antennae as for genus. Legs as for genus; claw lacking a denticle; trochanter and femur lacking stout setae; distal end of tibia not expanded, but with about 20 stout setae on posterior edge; tarsus with about 10 stout setae on underside. Thoracic spiracles with 7–11 complex disc pores and minute pores at opening; abdominal spiracles with 2 or 3 complex disc pores and minute pores in atrium; last abdominal spiracle more than twice its own diameter distant from anal tube. Derm with complex disc pores present. Cicatrices on head smaller than complex disc pores. Minute pores absent. Setae and derm hairs each of 2 types present but sparsely distributed.

Dorsum. Pores, setae, and derm hairs as for venter, but cicatrices absent.

Anal tube simple, with a thickened ring at inner end, and with lobes, 6–10 derm hairs, and minute pores on inner two-thirds.

Third-instar female. Appearance typical of genus. Enclosed in an oval, rather papery cyst under the thin bark layers of its host. Body shape (slide-mounted specimens) oval.

Measurements: body length 3.1–4.5 mm (paralectotype 3.1 mm), width 2.4–4.0 (2.5) mm; antennal length 0.17–0.2 (0.2) mm; hind leg length 0.17–0.2 (0.2) mm.

Venter. Antennae as for genus. Legs as for genus; claw reduced, the digitules reaching beyond claw apex. Thoracic spiracles with 10–12 complex disc pores and minute pores at mouth; abdominal spiracles with an inner ring of 8–10 complex disc pores and some minute pores; last abdominal spiracle more than twice its own diameter distant from anal tube. Setae of 2 sizes and clavate derm hairs present. Modified spines evenly distributed on last 3 abdominal segments but sparse on 4th. Simple pores mostly thick-walled, and slightly smaller than complex disc pores. Simple disc pores and complex disc pores present. Cicatrices present on all abdominal segments except the last. Last abdominal segment with many modified spines, setae of 2 sizes, clavate derm hairs, simple pores, simple disc pores, complex disc pores, and minute pores, but lacking cicatrices.

Dorsum. Setae, modified spines, derm hairs, and pores as on venter, but cicatrices absent. Anal area as for venter.

Anal tube with a single median row of complex disc pores, 5 rows of pores at inner end, and between these pores a sclerotised band and a narrow collar.

Second-instar female (Fig. 19). Appearance and habits of live individuals as in third instar. Body shape (slide-mounted specimens) oval, slightly pear-shaped.

Measurements: body length 1.4–2.5 mm, width 1.0–1.8 mm; antenna length 0.1–0.12 mm; hind leg length 0.1–0.12 mm.

Venter. Antennae as for genus. Legs as for 3rd instar. Thoracic spiracles with 6 or 7 complex disc pores and minute pores at opening; abdominal spiracles with an inner ring of 4 complex disc pores and minute pores. Setae of 2 sizes and slightly clavate, thin derm hairs present, sparse on thorax and head. Modified spines present on last 4 abdominal segments. Simple pores with thick walls and simple and complex disc pores present. Cicatrices as for 3rd instar. Last abdominal segment with modified spines more or less in 2 rows; setae of 2 sizes, derm hairs, simple pores, simple and complex disc pores, and minute pores present.

Dorsum. Pores, setae, modified spines, and derm hairs as on venter, but cicatrices absent.

Anal tube with a median ring of 10–14 pores, 3 rows of pores at inner end and, between these rows of pores, a sclerotised band and a collar of thickened tissue.

First instar (Fig. 20). Appearance typical of genus. Body shape (slide-mounted specimens) oval.

Measurements: body length 1.1–1.3 mm, width 0.6–0.8 mm; length of hind femur plus trochanter 0.14–0.16 mm, of hind tibia plus tarsus 0.17–0.19 mm.

Venter. Antennae and legs as for genus. Thoracic spiracles each with 2 complex disc pores; abdominal spiracles with 1 complex disc pore at opening. Setae and derm hairs both of 2 sizes; simple disc pores about as large as simple pores, which have thick walls. Complex disc pores present. Last abdominal segment with sparse setae, derm hairs, and simple disc pores present. Ventral cicatrices and caudal setae as for genus. Modified spines absent.

Dorsum. Setae, derm hairs, and pores as on venter, distributed evenly over surface. Last abdominal segment with a single row of modified spines around anus, setae and clavate derm hairs in 1 or 2 rows, and a few simple disc pores present.

Anal tube as for genus.

Adult male (Fig. 21). Appearance of live individuals typical of genus. Body elongate.

Measurements: body length 3.7–4.2 mm; antennal length 2.5–2.6 mm; wing length 3.5–4.5 mm; length of hind trochanter plus femur 0.68–0.84 mm, of hind tibia plus tarsus 1.20–1.3 mm; claw length 0.08–0.10 mm, width 0.05 mm; penis sheath length 0.30–0.35 mm, width at tip 0.05 mm.

Venter. Head and thorax as for subfamily. Head with cicatrices same size as pores. Antennae as for genus. Abdomen with cylindrical tubercles and numerous fine setae; derm hairs few, in 6 wide bands; last 2 abdominal segments with a sparse band of setae only; minute pores absent. Legs as for genus, with about 50 bifurcate setae on tibia and 16–18 on tarsus; claw twice as long as wide, with about 25 knobbed digitules on each side.

Dorsum. Head and thorax as for subfamily. Disc pores and cicatrices the same size. Hamulohalteres with 4 or 5 curved, knobbed, setae at tip. Abdomen: disc pores with obscure loculi; fine setae and blunt derm hairs in 7 bands; last segment without pores. Minute pores absent.

Pupa (Fig. 22). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) elongate oval.

Measurements: body length 3.3–4.3 mm, width 1.5–1.7 mm; width of last abdominal spiracles 25–27 µm, of other abdominal spiracles 27 µm.

Venter. Antennae as for genus. On head, derm hairs of 2 types, one slender, the other stout with slightly expanded tips. Long slender setae, minute pores, and complex disc pores present on head. Complex disc pores, stout setae, and derm hairs in rows on abdomen. Last abdominal spiracles less than 5x their own width from vestige of anal tube.

Dorsum. Derm hairs, pores, and setae as on venter, but minute pores absent. Anal lobe setae mostly slender with expanded tips.

Prepupa (Fig. 23). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) oval-elongate.

Measurements: body length 3.4 mm, width 1.5 mm; length of hind trochanter plus femur 0.50–0.53 mm, of hind tibia plus tarsus 0.56–0.57 mm; claw length 65–75 µm, width 25–32 µm.

Venter. Antennae as for genus. Legs as for genus; tip of tibia not expanded distally; 11 or 12 stout setae present on tibia and 9 or 10 on tarsus; claw less than twice as long as wide, lacking a denticle. Thoracic and abdominal spiracles as for genus. Head with cicatrices smaller than complex disc pores, thick-walled, the wall thickness about half the lumen diameter. Complex disc pores, setae, and derm hairs of 2 sizes present, one slightly thickened with a blunt tip, the other fine and tapering. Minute pores absent.

Dorsum. Setae, derm hairs, and pores as on venter, but cicatrices absent.

Anal tube as for genus, with 5 or 6 medial derm hairs.

Type data. Given by Green (1929, p. 370) as "under loose bark of *Dracophyllum traversii*, Arthur's Pass, 3,300 ft, i.1923". The type slide (BMNH) bears an adult female and a third-instar female, and Green did not specify in his original description which of these specimens is holotype. The adult female is here designated **lectotype**; the third-instar female thus becomes **paralectotype**.

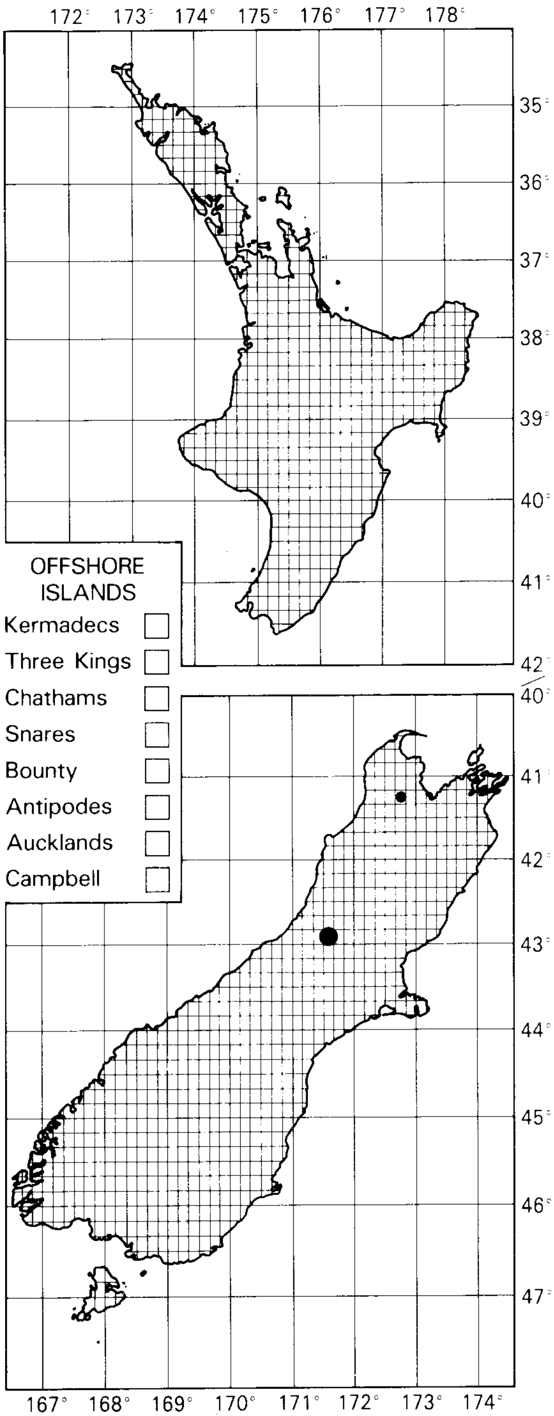
Material examined. Adult female: lectotype, plus 5 non-type examples (NZAC, BMNH). — / NN, NC–WD. Collected from *Dracophyllum* sp. and *D. traversii*. Recorded January, October, and November.

Third-instar female: paralectotype, plus 7 non-type examples (NZAC, BMNH). — / NC–WD. Collected from *Dracophyllum traversii* at altitudes around 900 m. Recorded January and October.

Second-instar female: 7 non-type examples (NZAC, BMNH). — / NC. Collected from *Dracophyllum* sp. and *D. traversii*, at altitudes around 900 m. Recorded January and October.

First instar: 2 non-type examples (NZAC). — / NC–WD. Collected from *Dracophyllum* at around 900 m. Recorded January.

Adult male: 5 non-type examples (NZAC). — / NN, NC –WD. Found under bark of *Dracophyllum traversii* at 3000 ft [900 m] and (1 specimen) on *Leptospermum*



• **Map 3** Collection localities, *Coelostomidia montana* •

ericoides at sea level. Recorded January, October, and November.

Male pupa: 5 non-type examples (NZAC). — / NN, NC. Found under bark of *Dracophyllum traversii* at 3000 ft [900 m]. Recorded January and November.

Male prepupa: 2 non-type examples (NZAC). — / NC. Found under *Dracophyllum* bark. Recorded January and March.

Remarks. The adult female of *C. montana* is almost indistinguishable from that of *C. wairoensis*, except by the small cicatrices on the head venter. The intermediate and first instars can be distinguished from other species in the genus by the shape of the modified spines around the anus. Adult males of *wairoensis* and *montana* are almost indistinguishable except for the dimensions of the cylindrical tubercles on the venter of the abdomen, the number of digitules on the claw, and claw shape. However, both species seem to be host-specific.

Coelostomidia pilosa (Maskell)

shaggy giant scale

Figures 24–28

Coelostoma pilosum Maskell, 1891: 29. Lectotype female, New Zealand (NZAC), here designated [examined].
Coelostomidia pilosa (Maskell). Cockerell, 1902: 258.

Adult female (Fig. 24). Appearance of live individuals typical of genus; often found crawling on forest floor or on host plant. Body shape (slide-mounted specimens) elongate oval, broadest behind last pair of legs.

Measurements: body length 6–12 mm (lectotype 9 mm), width 4–6 (5) mm; length of hind trochanter plus femur 0.6–1.2 (1.1) mm, of hind tibia plus tarsus 0.8–1.4 (1.3) mm.

Venter. Antennae 10- or 11-segmented, as for genus. Legs as for genus; trochanter and femur lacking stout setae on their posterior edge; distal tip of tibia not expanded, with 16–20 stout setae on underside; tarsus with 8–10 setae; claw lacking a denticle. Thoracic spiracles with 18–20 complex disc pores and minute pores at opening; abdominal spiracles with 8–12 complex disc pores and minute pores in atrium; last abdominal spiracle same size as others, more than 2 spiracle widths distant from anal tube. Complex disc pores numerous; minute pores in smaller numbers; cicatrices wider than complex disc pores, on head. Derm hairs of 2 sizes numerous, setae of 2 sizes less so.

Dorsum. Pores and setae as on venter but slightly denser and more evenly distributed. Cicatrices absent.

Anal tube with a chitinised ring and minute pores at inner end, then a group of 5 or 6 lobes, a collar of thickened tissue, and an inner ring of 17 or 18 derm hairs.

Third-instar female. Live examples enclosed in a dull white, thin-walled cyst on host plant, often under bark. Body pink. Body shape (slide-mounted specimens) round to oval.

Measurements: body length 4.0–7.0 mm, width 3.0–6.0 mm; antennal length 0.1–0.2 mm; hind leg length 0.1–0.2 mm.

Venter. Antennae as for genus. Legs as for genus; claw long, with a distinct denticle and digitules not reaching claw apex. Thoracic spiracles with 10 or 11 complex disc pores and minute pores at opening; abdominal spiracles with 1 or 2 inner rings of about 8 complex disc pores and minute pores; last abdominal spiracle more than 2 spiracle widths distant from anal tube. Groups of cicatrices on all but the last 2 abdominal segments, absent from thorax. Minute pores scattered over body and around spiracles. Spines, derm hairs, simple disc pores, and setae concentrated around edge of body. Slightly clavate derm hairs present around mouthparts, longer than on remainder of body. Modified spines, complex disc pores, and simple pores absent. Spines on last abdominal segment not differentiated from those on remainder of body.

Dorsum. Poresand cicatrices as on venter; spines more evenly distributed.

Anal tube with a median double row of 20–22 pores and 6–8 rows of pores at inner end; between these rows of pores a collar of tissue and lobes.

Second-instar female (Fig. 25). Appearance of live examples similar to 3rd instar. Body outline (slide-mounted specimens) round to oval.

Measurements: body length 1.6–4.0 mm (paralectotype 2.3 mm), width 1.1–2.4 (1.7) mm; antennal length 0.07–0.12 (0.07) mm; hind leg length 0.07–0.17 (0.12) mm.

Venter. Antennae and legs as for 3rd instar. Thoracic spiracles with 6 or 7 complex disc pores and minute pores at opening; abdominal spiracles with a median ring of 2 or 3 complex disc pores and minute pores. Spines, setae, derm hairs, and simple disc pores as for 3rd instar. Cicatrices present on all abdominal segments except the last 2. Last abdominal segment as for 3rd instar.

Dorsum. Cicatrices, setae, spines, and pores as for 3rd instar.

Anal tube with 5 or 6 rows of pores at inner end, a single median ring of 10–12 pores, 5 or 6 lobes between the rows of pores, and between these a band of thickened cuticle.

First instar (Fig. 26). Appearance typical of genus. Body shape (slide-mounted specimens) broadly oval, widest at thorax.

Measurements: body length 1.0–1.9 mm, width 0.7–1.1 mm; length of hind femur plus trochanter 0.15–0.20 mm, of hind tarsus plus tibia 0.20–0.22 mm.

Venter. Antennae and legs as for genus. Two complex disc pores associated with thoracic spiracles but not abdominal spiracles. Spines concentrated around body margin and on last segment, the anal spines slightly longer than those on body but not differentiated from them. Setae of 2 sizes, clavate derm hairs, and simple disc pores, rather square in outline, present. Simple pores, complex disc pores, and modified spines absent. Last abdominal segment with cicatrices and caudal setae as for genus; spines present, not differentiated from those on remainder of body.

Dorsum. As for venter, but pores, spines, setae, and clavate derm hairs scattered evenly over surface.Last abdominal segment as for venter, but cicatrices absent.

Anal tube as for genus.

Adult male (Fig. 27). Appearance of live individuals typical of genus.

Measurements: body length 4.7–5.0 mm; wing length 4.5–5.2 mm; length of hind trochanter plus femur 0.80–1.08 mm, of hind tibia plus tarsus 1.64–2.12 mm; claw length 0.10–0.12 mm, width 0.03–0.04 mm; antenna 3.1–3.7 mm; penis sheath length 0.32–0.42 mm, width at tip 0.07–0.10 mm.

Venter. Head with cicatrices almost twice as wide as disc pores, which have 4 or 5 obscure loculi. Minute pores, long pointed setae, and derm hairs present. Antennae as for genus. Legs as for genus; tibia with about 50 bifurcate setae, and tarsus with about 16–18; claw with a denticle and a pair of knobbed digitules. Abdomen with 7 rows of short, spine-like derm hairs, disc pores, and minute pores; last 2 segments with setae only. Cylindrical tubules absent.

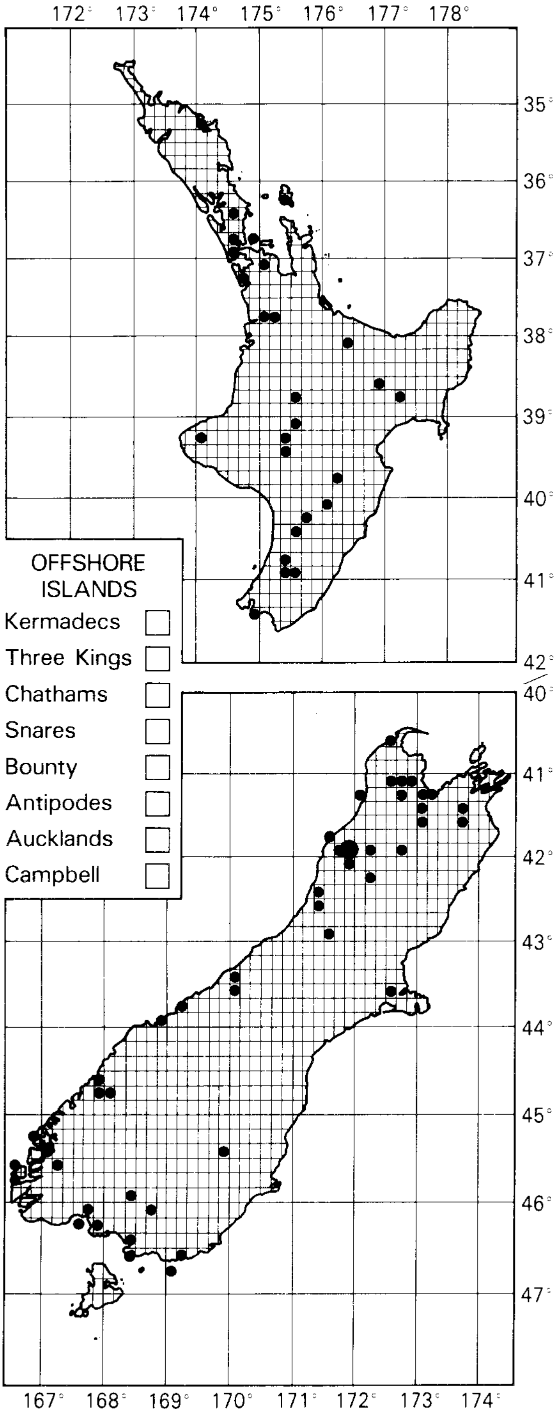
Dorsum. Pores, cicatrices, setae, and hairs on head and thorax as on venter. Abdomen with 7 rows of disc pores, minute pores, long setae with slightly expanded tips, and a few derm hairs with pointed tips. Hamulohalteres with 5 or 6 setae at tip.

Penis sheath as in *C. zealandica*.

Pupa (Fig. 28). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) elongate oval.

Measurements: body length 4.6–5.1 mm, width 1.9–2.4 mm; width of last abdominal spiracles 27–30 µm, of other abdominal spiracles 25–30 µm.

Venter. Antennae and legs as for genus. Head with slender derm hairs and setae, minute pores, and complex



• **Map 4** Collection localities, *Coelostomidia pilosa* •

disc pores present. Thorax and abdomen with similar vestiture, but no slender setae. Conical setae with expanded tips common on abdomen. Anal lobe setae short, stout, conical, with expanded tips.

Dorsum. As for venter, but with some slender setae on abdomen.

Prepupa (see Fig. 23). Appearance of live specimens typical of genus. Body shape (slide-mounted specimens) broadly oval.

Measurements: body length 3.9–4.3 mm, width 1.8–2.2 mm; length of hind trochanter plus femur 0.57–0.75 mm, of hind tibia plus tarsus 0.64–0.88 mm; claw length 40–85 µm, width 25–35 µm.

Venter. Antennae as for genus. Legs as for genus; tibia not expanded distally, with 10–12 setae; tarsus with 5 or 6 setae. Thoracic and abdominal spiracles as for genus; last pair of abdominal spiracles more than 5x their own diameter distant from anal tube. Cicatrices on head as large as complex disc pores or larger. Minute pores, numerous fine-pointed derm hairs of 2 sizes, sparse long setae, and complex disc pores present throughout.

Dorsum. Setae, pores, and derm hairs as on venter, but cicatrices absent.

Anal tube as for genus; about 12 derm hairs medially.

Type data. Given by Maskell (1891, p. 29) as New Zealand, "on various trees in forests, Reefton district, second stage mostly on *Podocarpus totara* or various species of *Fagus*". The syntype series (NZAC) consists of three slides, labelled "larva, 1889, W.M.M.", "female 2nd stage, 1889, W.M.M.", and "adult female, 1889, W.M.M.". This last slide conforms with Maskell's description, and is here designated **lectotype**. The first instar is a misidentification, but the 2nd-stage female becomes **paralectotype**.

Material examined. Adult female: lectotype, plus 10 non-type examples (NZAC, BMNH). ND, CL, BP, WO, GB, TK, RI, WI, WA, WN / NN, MB, BR, WD, MC, CO, FD, SL / SI. Collected from *Podocarpus totara*, *Nothofagus* sp., *Dacrydium cupressinum*, ponga fern, off tree trunks, and on forest floor. Recorded January–March and May.

Third-instar female: 16 non-type examples (NZAC, BMNH). ND, CL, WO, BP, GB, TK, RI, WI / NN, MB, BR, MC, CO, FD, SL / SI. Collected from *Prumnopitys taxifolia*, *Podocarpus totara*, *Dacrydium* sp., *Libocedrus bidwilli*, *Pseudowintera colorata*, *Rubus australis*, and *Ripogonum scandens*. Recorded January, March, April, November, and December.

Second-instar female: paralectotype, plus 38 non-type examples (NZAC, BMNH). ND, AK, CL, WO, BP, GB,

TO, RI, WI, WN / NN, BR, WD, CO, FD, SL / SI. Collected from *Libocedrus bidwilli*, *Dacrydium cupressinum*, *Podocarpus totara*, *Prumnopitys taxifolia*, *P. ferruginea*, *Nothofagus solandri*, *Hebe* sp., *Metrosideros* sp., *Rubus australis*, *Weinmannia racemosa*, *Phyllocladus alpinus*, *Dacrydium biforme*, *Neopanax* sp., *Freycinetia* sp., *Pseudowintera colorata*, and grass roots. Recorded January, March–May, and August–November.

First instar: 7 non-type examples (NZAC). ND, AK, WO, BP, TO, TK / NN, BR, FD / SI. Collected from *Dacrydium* sp. and other Podocarpaceae. Recorded February, April, May, September, and November.

Adult male: 7 non-type examples (NZAC). AK, WO, TK, RI / NN, CO, FD / SI. Collected from various plants. Recorded February–April.

Male pupa: 5 non-type examples (NZAC). — / NN, CO, FD. Collected from various plants and in the ground. Recorded April, May, November, and December.

Male prepupa: 11 non-type examples (NZAC). AK, TK / NN, BR, WD, FD. Recorded January–May, November, and December.

Remarks. Maskell (1891) described the first instar of *C. pilosa* as not possessing the thickened modified setae (= spines) found in the intermediate stages. However, on examination of the original Maskell slide it was found that the specimen has cerarii on the abdomen, and is probably a first-instar pseudococcid. Adult females and males are most similar to *C. zealandica*, but intermediate and first instars are the most distinctive in the genus, possessing very thick, numerous spines. The pupae are also distinctive because of the large, stout, conical setae on the anal lobes.

Coelostomidia wairoensis (Maskell)

manuka giant scale

Figures 29–33

Caelostoma wairoense Maskell, 1884: 141 (misspelling of *Coelostoma*). Lectotype male, New Zealand (CMNZ), here designated [examined].

Coelostoma wairoense Maskell, 1887: 109.

Coelostomidia wairoensis (Maskell). Cockerell, 1902: 258.

Adult female (Fig. 29). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) oval, broadest near 4th abdominal segment.

Measurements: body length 4.0–4.6 mm, width 2.2–3.2 mm; length of hind trochanter plus femur 0.40–0.45 mm, of tibia plus tarsus 0.50–0.55 mm.

Venter. Antennae 10-segmented, as for genus. Legs as for genus; trochanter and femur lacking spine-like setae; tibia with apex not expanded, and with 8–12 stout setae on posterior surface; tarsus with 5 or 6 stout setae on posterior surface; claw with serrations. Thoracic spiracles with 7–9 complex disc pores and minute pores at opening; abdominal spiracles with 3 or 4 complex disc pores and minute pores in atrium; last abdominal spiracle more than 2 spiracle widths distant from anal tube. Complex disc pores and minute pores present. Cicatrices mostly on head, smaller than complex disc pores. Derm hairs and setae scattered over venter. Simple pores and simple disc pores absent.

Dorsum. Pores, derm hairs, setae, and cicatrices as on venter but slightly denser; cicatrices absent.

Anal tube with minute pores and with 3 or 4 derm hairs medially; lobes small; a chitinised ring at inner end.

Third-instar female. Live individuals enclosed in a brittle, thin, oval cyst on host plant. Body bright pink.

Measurements: body length 1.4–2.7 mm, width 1.5–2.1 mm; antennal length 0.10–0.15 mm; hind leg length 0.10–0.17 mm.

Venter. Antennae as for genus. Legs as for genus; claw and digitules reduced. Thoracic spiracles with 8 or 9 complex disc pores and minute pores at opening; abdominal spiracles with a median ring of 4 or 5 complex disc pores and minute pores; last pair of abdominal spiracles more than 2 spiracle widths distant from anal tube. Simple pores with a small lumen and simple disc pores with 2–4 loculi common. Complex disc pores present, mostly around spiracles. Cicatrices present on thorax and on all abdominal segments except the last. Two sizes each of clavate derm hairs and setae present, evenly distributed. Last abdominal segment with 1 or 2 rows of modified spines, 2 or 3 rows of fine setae, and minute pores present. Other pores as on remainder of venter.

Dorsum. Pores, derm hairs, and setae as on venter, but cicatrices rare or absent. Last abdominal segment with modified spines in about 4 rows; simple disc pores, simple pores, and minute pores present; long setae in 2 or 3 rows around anus.

Anal tube with a row of 5 or 6 median pores, a wide outer collar of tissue, and 6–10 rows of pores at inner end.

Second-instar female (Fig. 30). Appearance of live individuals similar to 3rd instar. Body shape (slide-mounted specimens) oval.

Measurements: body length 1.3–2.5 mm, width 0.7–2.0 mm; antennal length 0.10–0.15 mm; hind leg length 0.10–0.17 mm.

Venter. Antennae and legs as for 3rd instar. Thoracic spiracles with 7 or 8 complex disc pores and minute pores at opening; abdominal spiracles with an inner ring of 2 or 3 complex disc pores and minute pores. Setae and slightly clavate derm hairs of 2 sizes evenly distributed. Simple pores with a small lumen and simple disc pores present; simple pores smaller than complex disc pores. Cicatrices as for 3rd instar. Last abdominal segment with setae as on remainder of venter, modified conical spines, and minute pores present; cicatrices absent.

Dorsum. Pores, derm hairs, and setae as on venter, but denser; cicatrices absent. Complex disc pores and modified spines more numerous on last abdominal segment than on venter.

Anal tube as in 3rd instar, but with fewer rows of pores at inner end.

First instar (Fig. 31). Appearance typical of genus. Body shape (slide-mounted specimens) oval.

Measurements: body length 0.71–0.90 mm, width 0.43–0.62 mm; length of hind trochanter plus femur 0.10–0.13 mm, of hind tibia plus tarsus 0.10–0.16 mm.

Venter. Antennae and legs as for genus. Thoracic and abdominal spiracles each with a complex disc pore at opening. Setae of 2 sizes and clavate derm hairs distributed more or less in rows on abdomen, elsewhere scattered. Simple pores and simple and complex disc pores present. Setae, pores, and derm hairs concentrated around edge of body. Last abdominal segment with few setae, clavate derm hairs, complex disc pores, and simple pores, and with no modified spines. Cicatrices and caudal setae as for genus.

Dorsum. Setae, clavate derm hairs, simple pores, and simple disc pores present. Last abdominal segment with slender setae, 3 or 4 modified spines, simple pores, and complex disc pores present.

Anal tube as for genus.

Adult male (Fig. 32). Appearance of live individuals typical of genus.

Measurements: body length 2.4–3.0 mm (lectotype 2.6 mm); wing length 3.0–3.3 (3.0) mm; length of hind trochanter plus femur 0.46–0.60 (0.50) mm, of hind tibia plus tarsus 0.70–0.98 (0.80) mm; claw length 0.08–0.09 (0.09) mm, width 0.036–0.04 (0.04) mm; penis sheath length 0.32 (0.32) mm, width at apex 0.03–0.05 (0.05) mm.

Venter. Head with pores, setae, derm hairs, and a few cicatrices smaller than disc pores. Antennae as for genus. Abdomen with 6 bands of cylindrical tubercles, minute pores, fine derm hairs, and setae; last 2 segments with setae only. Legs as for genus; tibia with 30–40 bifurcate setae, tarsus with 8–10; claw more than twice as long as wide, with up to 18 knobbed digitules on each side, exceeding claw apex.

Dorsum. Head and thorax as for venter. Hamulohalteres each with 3 knobbed setae at apex. Abdomen with 7 bands of disc pores and setae and an 8th band of setae only, the disc pores with 2 or 3 obscure loculi, fine derm hairs, short setae, and minute pores present. Penis sheath flask-shaped, bifid for a short distance at tip, not lobed but narrow.

Pupa (see Fig. 22). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) elongate oval.

Measurements: body length 3.0–3.6 mm, width 1.1–1.3 mm; width of all abdominal spiracles 17–21 µm.

Venter. Antennae and legs as for genus. Pores, derm hairs, and setae similar to those of *C. montana*, but stout derm hairs thick throughout their entire length and lacking an expanded tip. Last abdominal spiracles more than 5x their own width distant from vestige of anal tube.

Dorsum. As for *C. montana*, but anal lobe setae lacking expanded tips.

Prepupa (Fig. 33). Appearance of live individuals typical of genus. Body shape (slide mounts) elongate-oval.

Measurements: body length 2.9–4.0 mm (paralectotype 3.5 mm), width 1.2–2.2 (1.2) mm; length of hind trochanter plus femur 0.38–0.50 (0.50) mm, of hind tibia plus tarsus 0.46–0.52 (0.48) mm; claw length 0.05–0.07 (0.07) mm, width 0.02–0.03 (0.03) mm.

Venter. Antennae as for genus. Legs as for genus; claw more than twice as long as wide, with small serrations; tibia not expanded apically, with 6–8 stout setae; tarsus with 4 or 5 stout setae. Thoracic and abdominal spiracles as for genus; last abdominal spiracles less than 30 µm wide and more than 5x their width distant from anal tube. Complex disc pores, minute pores, sparse long setae, and derm hairs of 2 sizes present. Cicatrices on head thick-walled (wall thickness about equal to lumen diameter), narrower than complex disc pores.

Dorsum. Pores, setae, and derm hairs as on venter, but cicatrices absent.

Anal tube as for genus, with 4 or 5 blunt hairs medially.

Type data. In the syntype series (CMNZ) there are four slides, labelled: "*Coelostoma wairoense*, from *Leptospermum*, April 1883, W.M.M. [prepupa]"; "*Coelostoma wairoense*, from *Leptospermum*, antenna and feet of ... [prepupa], April 1883, W.M.M."; "*Coelostoma wairoense*, from *Leptospermum*, Halter of male, June 1883, W.M.M."; and "*Coelostoma wairoense*, from *Leptospermum*, Male, June 1883, W.M.M.". The last slide fits the original description and drawings by Maskell of the adult male, and is here designated **lectotype**; the other three slides become **paralectotypes**.

Material examined. Adult female: 10 non-type examples (NZAC). Three Kings Is / ND, AK, CL, WO, BP, GB, TK / NN, BR, MB, KA. Collected from *Kunzea ericoides* and *Leptospermum scoparium*. Recorded January–November.

Third-instar female: 18 non-type examples (NZAC). Three Kings Is / ND, AK, BP, TO, GB / NN, MB, KA. Collected from *K. ericoides*, *L. scoparium*, and *Metrosideros* sp. Recorded January, August, and October–December.

Second-instar female: 11 non-type examples (NZAC, BMNH). ND, AK, CL, WO, BP, GB, TK / NN, MB, KA, MC. Collected from *K. ericoides*, *L. scoparium*, and *Metrosideros* sp. Recorded February, April, August, and December.

First instar: 5 non-type examples (NZAC). Three Kings Is / ND, AK, WO, BP, GB, TK / NN, MB, KA, MC. Collected from *K. ericoides* and *L. scoparium*. Recorded April, November, and December.

Adult male: lectotype and 3 paralectotypes (CMNZ), plus 12 non-type examples (NZAC). ND, AK, CL, WO, BP, GB, TK / NN, MB, MC. Collected from *K. ericoides* and *L. scoparium*. Recorded January, April–June, and August.

Pupa: 13 non-type examples (NZAC). ND, AK, WO, GB / NN. Collected from *K. ericoides* and *L. scoparium*. Recorded February-May and December.

Prepupa: 2 paralectotypes, plus 15 non-type examples (NZAC). ND, AK, WO, TK / —. Collected from *K. ericoides* and *L. scoparium*. Recorded February–April.

Remarks. See Remarks under *C. montana*, above. Although specimens have been reported as occurring on both *Kunzea* and *Leptospermum*, and occasionally on *Metrosideros*, subsequent investigations – as in the study of the life history of this margarodid around Auckland described on pp. 16–18 – suggest that *K. ericoides* is by far the most important as a host plant.

Green's (1929) description of the "adult female" was in fact of the prepupa.

Coelostomidia zealandica (Maskell)

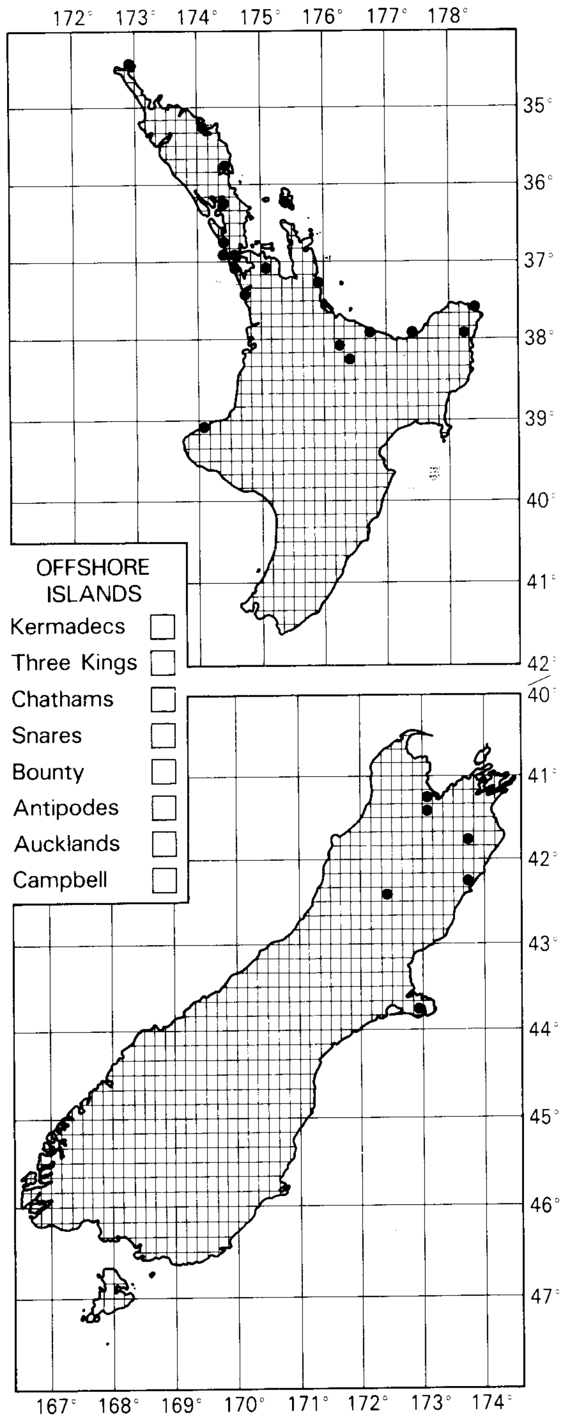
great giant scale

Figures 34–37

Coelostoma zealandicum Maskell, 1880: 294. Lectotype female, New Zealand (NZAC), here designated [examined].

Caelostoma zaelandicum Maskell. Maskell, 1884: 141 (misspelling of *Coelostoma zealandicum*).

Coelostomidia zealandica (Maskell). Cockerell, 1902: 258.



• **Map 5** Collection localities, *Coelostomidia wairoensis* •

Adult female (Fig. 34). Appearance of live females typical of genus. Often found crawling on forest floor or on tree trunks. Large, with well developed legs and antennae; pink, with a fine dusting of white wax. Body shape (slide-mounted specimens) elongate oval, widest behind posterior pair of legs.

Measurements: body length 6–15 mm, width 4–8 mm; length of hind trochanter plus femur 0.80–1.60 mm (lectotype 1.25 mm), of hind tibia plus tarsus 0.80–1.60 (1.30) mm.

Venter. Antennae 11-segmented, as for genus. Legs as for genus; claw slightly serrated; several stout, spine-like setae present on posterior face of trochanter, and 30–40 on femur; tibia with distal tip expanded, and with 40–60 stout setae on posterior edge; tarsus with 15–20 stout setae. Thoracic spiracles each with 13–20 complex disc pores and many minute pores near opening; abdominal spiracles with 10–16 complex disc pores and minute pores in atrium; last pair of spiracles immediately adjacent to anal tube. Derm with complex disc pores and minute pores. Cicatrices rare, occurring mostly in head region, narrower than disc pores. Derm hairs numerous, of 2 sizes. Setae of 2 sizes, sparsely distributed.

Dorsum. Pores, setae, and derm hairs as on venter, but cicatrices absent.

Anal tube with a sclerotised ring at inner end, minute pores on inner two-thirds, small lobes, then a thickening of the surface and a medial ring of about 24–26 slender setae.

Third-instar female. Live females enclosed in a resinous cyst. Body round to oval, bright pink, with a fine dusting of white wax; last abdominal segment not sclerotised.

Measurements: body length 3.0–5.7 mm, width 2.6–5.0 mm; antennal length 0.20–0.30 mm; hind leg length 0.20–0.30 mm.

Venter. Antennae as for genus. Legs as for genus; claw and digitules reduced. Thoracic spiracles each with 20–26 complex disc pores and minute pores at opening; abdominal spiracles with a double inner ring of complex disc pores and some minute pores; last pair of abdominal spiracles adjacent to anal tube. Setae of 2 sizes and non-clavate derm hairs distributed over much of venter. Cicatrices present, mostly on midline of abdominal segments. Simple pores, simple disc pores, complex disc pores, and minute pores scattered on venter, becoming more numerous on last abdominal segment. Clavate derm hairs absent. Dome-like modified spines in 1 or 2 rows and long setae and derm hairs present on last abdominal segment.

Dorsum. Setae, derm hairs, and pores of same type as on venter, evenly distributed. Cicatrices present over entire body surface except for last abdominal segment, which is similar to that of venter, with modified dome-like spines more or less in 4 rows.

Anal tube with 7 or more rows of pores at inner end, a medial band of 5 or more rows of pores, and between these a lightly sclerotised band of derm. Area around anus often becoming sclerotised with age, but never developing a thick band of sclerotisation separating it from remainder of body as in intermediate stages of *Ultracoelostoma* species (q.v.).

Second-instar female (Fig. 35). Appearance in life as in third instar. Body shape (slide-mounted specimens) round to oval.

Measurements: body length 1.6–2.7 mm, width 1.2–2.2 mm; antennal length 0.12–0.20 mm; hind leg length 0.14–2.00 mm.

Venter. Antennae and legs as for 3rd instar. Thoracic spiracles each with 9–12 complex disc pores and minute pores at opening; abdominal spiracles with a single inner ring of about 8 complex disc pores and minute pores present. Derm hairs and setae of 2 sizes, simple pores, simple and complex disc pores, and minute pores present. Cicatrices as for 3rd instar. Clavate derm hairs absent. Last abdominal segment as for 3rd instar, but dome-like modified spines in 2 or 3 rows around anus.

Dorsum. As for venter, but cicatrices present on head and thorax. Last abdominal segment similar to that of venter, with modified dome-like spines in 3 or 4 rows.

Anal tube as for 3rd instar, except for a medial band of 2 or 3 rows of pores, and at inner end 4 or 5 rows of pores.

First instar (Fig. 36). Appearance of live crawlers typical of genus. Often found crawling on host plant or on forest floor. Body shape (slide-mounted specimens) oval.

Measurements: body length 0.97–1.40 mm (paralectotypes 1.07–1.08 mm), width 0.6–1.0 (0.63–0.65) mm; length of hind femur plus trochanter 0.16–0.19 (0.18) mm, of hind tarsus plus tibia 0.20–0.25 (0.24–0.26) mm.

Venter. Antennae and legs as for genus. Thoracic spiracles with 2 associated complex disc pores at opening, abdominal spiracles with 1; last pair of spiracles distinctly larger than the others, immediately adjacent to anal tube. Complex and simple disc pores, simple pores, setae of 2 sizes, and derm hairs present. Clavate derm hairs absent. Last abdominal segment with 8–10 dome-shaped modified spines, spine-like setae, derm hairs, minute pores, and complex disc pores more or less in a single row around anus. Cicatrices and caudal setae as for genus.

Dorsum. Setae and pores as on venter. Last abdominal segment with long setae and derm hairs in rows. Simple disc pores and simple pores more numerous than on venter, and 8–10 modified spines present around anus.

Anal tube as for genus.

Adult male (Fig. 37). Appearance of live individuals typical of genus.

Measurements: body length 3.7–4.5 mm; wing length 3.5–4.3 mm. Length of hind trochanter plus femur 0.78–0.88 mm, of hind tibia plus tarsus 1.20–1.64 mm; claw length 0.09–0.12 mm, width 0.03–0.04 mm; antenna length 2.9–3.4 mm; penis sheath length 0.37–0.45 mm, width at tip 0.07–0.12 mm.

Venter. Antennae, head, and thorax as for genus. Legs as for genus; claw with a denticle and a pair of knobbed digitules; tibia with 50–60 bifurcate setae on posterior edge, tarsus with 20–25. Abdomen with 6 bands of cylindrical tubercles and with long, slender setae, much denser than on dorsum; last 2 segments with setae only. Minute pores absent.

Dorsum. Head with cicatrices larger than disc pores. Derm hairs and setae present. Thorax as for genus. Hamulohalteres membranous, each with 5 or 6 curved setae at tip. Abdomen with 7 bands of disc pores, each with 3 or 4 obscure loculi, slender derm hairs, and setae present. Minute pores absent. Penis sheath with dorsal tip bifid, not lobed.

Pupa (see Fig. 22). Appearance of live individuals typical of genus. Body elongate-oval.

Measurements: body length 4.5 mm, width 1.9 mm; width of last abdominal spiracles 32–35 µm, of other abdominal spiracles 32–37 µm.

Venter. Antennae and legs as for genus. Complex disc pores, minute pores, long setae, and derm hairs present on head; all except minute pores present on thorax also. Abdomen with rows of complex disc pores, derm hairs, and stout setae with faint apical knobs present. Long setae and minute pores absent. Anal lobe setae similar in shape to body setae, but longer. Posterior spiracle close to anal tube vestige, similar in size to other abdominal spiracles.

Dorsum. As for venter, but minute pores absent.

Prepupa (see Fig. 23). Appearance of live individuals typical of genus. Body elongate-oval, widest beyond hind legs.

Measurements: body length 3.5–4.3 mm, width 1.6–2.0 mm; length of hind trochanter plus femur 0.59–0.68 mm, of hind tibia plus tarsus 0.69–0.77 mm; claw length 0.07–0.09 mm, width 0.03–0.04 mm.

Venter. Antennae as for genus. Legs as for genus; claw lacking a denticle, but with a row of small serrations; apex of tibia expanded; tibia with 16–18 spine-like setae on posterior edge, tarsus with 8–10. Posterior spiracles less than their own diameter distant from anal tube vestige, slightly larger than preceding spiracles. Derm hairs of 2 sizes, complex disc pores, and long, slender setae present on body. Minute pores and cicatrices present on head, the latter narrower than complex disc pores.

Dorsum. Pores, setae, and derm hairs as on venter, but minute pores and cicatrices absent.

Anal tube as for genus, with about 8 long derm hairs medially.

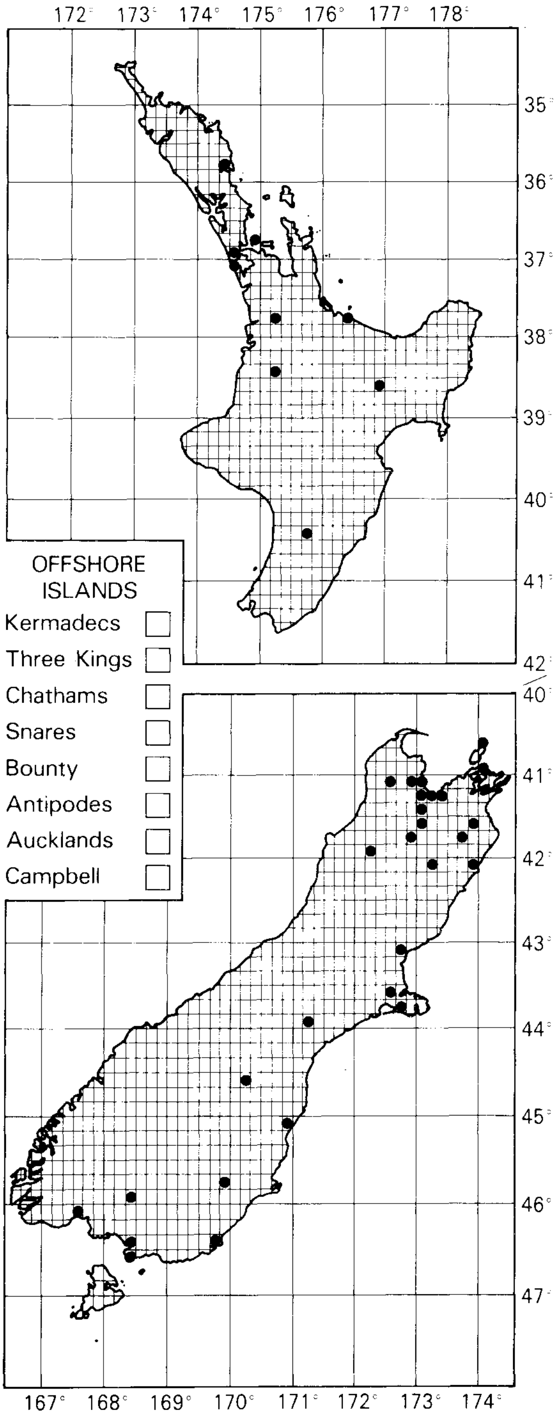
Type data. Given by Maskell (1880, p. 294) as New Zealand, on the bark of various large trees in Otago, and from Canterbury "buried in the ground and in the chinks of rocks, by the Sumner Road, Lyttelton, interspersed with another curious Coccid, feeding on *Muehlenbeckia*, a creeping plant growing thereabouts". The syntype series (NZAC, CMNZ) consists of twelve slides, labelled as follows.

NZAC: "*Coelostoma zealandicum*, underside of female 3rd stage [= adult female] from *Mu[e]hlenbeckia* Feb:' 1880, W.M.M."; "*Coelostoma zealandicum*, young insects from *Mu[e]hlenbeckia* Dec 1879, W.M.M."; "*Coelostoma zealandicum*, Female: 2nd stage from *Mu[e]hlenbeckia* Feb^y 1880 W.M.M."

CMNZ: "*Coelostoma zealandicum*, young insect, from *Mu[e]hlenbeckia* February 1880, W.M.M."; "*Coelostoma zealandicum*, Rostrum, feet and antennae of 2nd stage (Female), Feb^y 1880, W.M.M."; "*Coelostoma zealandicum* oviduct? and ovary?, Feb^y 1880, W.M.M."; "*Coelostoma zealandicum*, 2nd stage of male, from *Mu[e]hlenbeckia*, Jan^y 1880, W.M.M."; "*Coelostoma zealandicum* anal extremity: 2nd stage, Feb^y 1880, W.M.M."; "*Coelostoma zealandicum*, Foot and antenna of female: 3rd stage April 1879, W.M.M."; "*Coelostoma zealandicum*, from *Mu[e]hlenbeckia*, Male (antenna incomplete), Feb^y 1880, W.M.M."; "*Coelostoma zealandicum*, from *Mu[e]hlenbeckia*, head, wing, foot and abdomen of Male, Feb^y 1880, W.M.M."

Maskell's original description indicates that his paper was read before the Philosophical Institute of Canterbury on 5 June 1879. This original description included not only diagrams of the foot and antenna, but also diagrams of the ovipositor (= anal tube) and the ventral and dorsal aspects of the adult female and first instar. The fragments on the slide labelled "... Foot and antenna of female 3rd stage ..." best fit Maskell's original description and diagrams, and are here designated as **lectotype**. The first instars on the other slide thus become **paralectotypes.**

Material examined. Adult female: lectotype (NZAC), 2 paralectotypes (CMNZ), and 21 non-type examples (NZAC, BMNH, USNM). ND, AK, WO, BP, WN / NN, BR, MB, KA, NC, MC, SC, DN, FD. Collected from *Muehlenbeckia australis*, *M. complexa*, *Podocarpus totara*, *Cassinia* sp., *Collospermum* sp., *Nothofagus* spp., on lichen, and in pitfall traps. Recorded January–April and November.



• **Map 6** Collection localities, *Coelostomidia zealandica* •

Third-instar female: 3 paralectotypes (1 NZAC, 2 CMNZ) and 20 non-type examples (NZAC, BMNH, USNM). ND, AK, WO, BP, WN / SD, NN, BR, MB, KA, NC, CO, DN, SL. Taken from *Muehlenbeckia australis*, *M. complexa*, *Aristotelia serrata*, *Rubus australis*, *Pimelea* sp., *Cyathodes colensoi*, *C. fraseri*, *Griselinia* sp., and *Nothofagus menziesii*. Recorded most months.

Second-instar female: 3 original Maskell slides and 24 non-type examples (NZAC, BMNH, USNM). ND, AK, WO, BP, WN / NN, BR, MB, NC, MC, SC, CO, DN, SL. Collected from *Pittosporum tenuifolium*, *Muehlenbeckia australis*, *M. complexa*, *Cyathodes fraseri*, *C. colensoi*, *Tupeia antarctica*, *Plagianthus* sp., *Rubus schmideloides*, *Myoporum laetum*, *Discaria* sp., and *Hebe* sp. Recorded February, March, June, August, and October.

First instar: 2 paralectotypes (1 NZAC, 1 CMNZ) and 20 non-type examples (NZAC). AK / NN, MC. Collected from *Muehlenbeckia*, *Pseudopanax* sp., and many other plants, and from forest litter. Recorded February, March, June, and October.

Adult male: 2 paralectotypes (CMNZ) and 7 non-type examples (NZAC). AK, WO / NN, MC, DN, SL. Collected from many plants. Recorded January–March and December.

Male pupa: 1 non-type example (NZAC) found in NN in December.

Male prepupa: 1 paralectotype (CMNZ) and 7 non-type examples (NZAC) found on tree bark and on the ground, NN, in January, November, and December.

Remarks. The adult female of *C. zealandica* is similar to those of *C. pilosa*, *C. deboerae*, and *C. jenniferae*. It can be distinguished by the position of the posterior spiracles in relation to the anal tube, and by the width of the cicatrices on the venter of the head relative to the complex and simple disc pores. Adult females of *deboerae* are difficult to separate from those of *zealandica* except by the presence of spines on the posterior edge of the trochanter and femur in the latter species. Intermediate and first instars of *zealandica* have characteristic dome-shaped modified spines surrounding the anal opening. Adult males of *zealandica* can be distinguished from *pilosa* males by the cylindrical tubercles on the venter of the abdomen.

* * *

Genus *Ultracoelostoma* Cockerell

Coelostoma Maskell, 1890: 153.
Coelostomidia Cockerell, 1902: 114 (replacement name for *Coelostoma*; preoccupied).
Coelostomidia (Ultracoelostoma) Cockerell, 1902: 114. Type species *Ultracoelostoma assimile* (Maskell), by subsequent designation (Morrison & Morrison 1922, p. 11).
Ultracoelostoma Cockerell. Morrison & Morrison 1922, p. 11 (as genus).

Adult female. Enclosed in a resinous test on bark or branches of host plant. Body broadly oval to spherical, bright pink, without sclerotised areas. Often found with accompanying eggs and 1st instars. Body outline round (as in type species) to elongate-oval.

Venter. Antennae reduced, 4–7-segmented, with 2–6 thickened setae on apical segment and 1 or 2 on segments 3–6. Legs variably reduced, 1–5-segmented; claw well developed or reduced, with or without a denticle, and with 1–3 pairs of digitules extending beyond claw apex. Mouthparts reduced, with no sclerotised supporting struts or stylets; amount of reduction variable. Two pairs of thoracic spiracles and 7 pairs of abdominal spiracles, the former with 6–20 complex disc pores, the latter with 2–10, and all with 1 or 2 minute pores at opening; last pair of spiracles larger than the others, less than 2 spiracle widths distant from anus. Derm with numerous complex disc pores with 8–12 outer loculi and 2–5 inner loculi, in great numbers on last 3 or 4 abdominal segments but sparse elsewhere. Minute pores present in anal area but sparse on remainder of body. Slender derm hairs, some with a slight swelling at tip, short, stout setae with slightly expanded tips, and long, fine setae distributed evenly on body, denser around vulva and margins of last 3 or 4 abdominal segments. Cicatrices, tubercles, simple disc pores, and spines absent.

Dorsum. Setae and hairs as on venter. Pores sparse over head and thorax, concentrated on last 3 or 4 abdominal segments. Setae and hairs denser and longer on last 3 or 4 abdominal segments than on remainder of dorsum. Anal opening apical.

Anal tube simple, with an inner chitinised ring; minute pores present at inner end, and a median ring of derm hairs.

Third-instar female. Enclosed in a thick, resinous test on host plant. Body oval, bright pink, with a raised ring of dark, heavily sclerotised tissue around anus and sclerotised patches on last 3 abdominal intersegmental areas. Body shape (slide-mounted specimens) round-oval. Derm membranous except on final abdominal segment, which is a chitinised plate often separated from remainder of abdomen by a broad, sclerotised band; intersegmental areas between last 4 segments often with sclerotised patches.

Venter. Antennae reduced, 4–7-segmented, with 2–6 thickened setae on terminal segment and 2–4 on preceeding segments. Legs as for tribe, reduced, 1-segmented; claw reduced or fully developed, with 2–4 knobbed digitules extending beyond claw apex. Beak as for tribe. Thoracic spiracles with 7–14 complex disc pores and 1 or 2 minute pores at opening; abdominal spiracles smaller, with 3–9 complex disc pores and 1 or 2 minute pores in atrium; last pair of abdominal spiracles largest, situated on chitinised last segment, with exterior opening less than 2 spiracle widths from anus. Simple disc pores with 2–5 inner loculi and simple pores common, similar in size. Minute pores present, densest around anus. Cicatrices common on midline of anterior abdominal segments, elsewhere absent. Setae long and pointed on venter of head; shorter setae, some with expanded tips, common on remainder of body. Derm hairs thicker than setae, with expanded or pointed tips. Spines and modified spines absent.

Dorsum. Pores, setae, and derm hairs as on venter. Cicatrices (when present) concentrated on body margin.

Anal opening apical. Anal tube long, with 4–9 rows of wax pores at inner end and circles of pores medially.

Second-instar female. Enclosed inside a thick, resinous test on host plant. Body round or oval, bright pink but with last abdominal segment dark brown.

As for 3rd instar, but thoracic spiracles with 3–7 complex disc pores, abdominal spiracles with 1–4 complex disc pores, and both with 1 or 2 minute pores; last abdominal segment less sclerotised, lacking a band of sclerotised tissue separating it from remainder of abdomen; and fewer sclerotised patches on intersegmental areas.

Anal tube as for 3rd instar, but fewer pores at inner end.

First instar. Often found crawling on bark of host plant. Body oval, bright pink, with fully developed legs and antennae. Derm membranous except on last abdominal segment, which is partly sclerotised.

Venter. Antennae 6-segmented; apical segment longest, with 2–6 thickened setae (these absent on other segments). Legs and beak as for tribe. Thoracic spiracles with 1 or 2 complex disc pores at opening; abdominal spiracles in 7 pairs, each with a complex disc pore at mouth; last pair of abdominal spiracles largest, its opening less than 2 spiracle widths distant from anus. Simple disc pores with 2–5 inner loculi concentrated on body margin; simple pores common. Setae long and pointed on venter of head, elsewhere shorter and thicker; derm hairs stout, with clavate or pointed tips. A single pair of caudal setae present, with or without expanded tips. Anal area with thick and fine setae with or without expanded tips, derm hairs, and complex disc pores. Three cicatrices present, situated above area of sclerotisation on last abdominal segment, the middle one widest. Spines and modified spines absent.

Dorsum. As for venter, but without cicatrices, and sclerotised area bearing more setae, derm hairs, and complex disc pores.

Anal tube as for tribe.

Adult male. Appearance of live individuals typical of tribe. Known only from *U. brittini* and *U. dracophylli* (see specific descriptions, below).

Pupa. Appearance of live pupae typical of subfamily.

Known only from *U. brittini* (see specific description, below).

Prepupa. Known only from *U. brittini* (see specific description, below).

Remarks. This endemic genus shows a lot of variation in several characters. There are three species of *Ultracoelostoma* in New Zealand, one highly variable and occurring mainly on *Nothofagus* species, and another mainly on *Dracophyllum* and *Archeria* species.

KEY TO SPECIES OF *ULTRACOELOSTOMA* KNOWN FROM NEW ZEALAND

Adult females

1 Claw with 2 or 3 pairs of digitules; mouthparts lacking chitinised supports or stylets; thoracic spiracles with 18–20 complex disc pores at opening ... (p. 49) .. ***brittini***

—Claw with 1 pair of digitules; mouthparts vestigial; thoracic spiracles with 6 or 7 complex disc pores at opening ... 2

2 Antennae with 2 thickened setae on terminal segment; claw reduced, blunt, lacking a denticle ... (p. 51) .. ***dracophylli***

—Antennae with 5 or 6 thickened setae on terminal segment; claw well developed, pointed, with or without a denticle ... (p. 46) .. ***assimile***

Intermediate stages (2nd- and 3rd-instar females)

1 Simple disc pores with 4 loculi predominant, with 3 or 5 less common, and with 2 absent; dorsal cicatrices common ... (p. 49) .. ***brittini***

—Simple disc pores with 3 loculi predominant, with 2 or 4 less common, with 5 rare; dorsal cicatrices rare ... 2

2 Antennae with 2 thickened setae on terminal segment ... (p. 51) .. ***dracophylli***

—Antennae with 5 or 6 thickened setae on terminal segment ... (p. 46) .. ***assimile***

First instar

1 Setae around anus with pointed tips; simple disc pores with 4 loculi predominant, with 3 or 5 less common, and with 2 absent; last abdominal segment with 26–30 complex disc pores dorsally around anus ... (p. 49) .. ***brittini***

—Setae around anus with expanded or pointed tips; simple disc pores with 3 loculi predominant, with 2 or 4 less common, with 5 rare; last abdominal segment with 12–18 complex disc pores dorsally around anus ... 2

2 Antennae with 2 thickened setae on terminal segment; setae around anus with pointed tips ... (p. 51) .. ***dracophylli***

—Antennae with 4–6 thickened setae on terminal segment; setae around anus with expanded tips ... (p. 46) .. ***assimile***

Adult male

1 Penis sheath approximately 3X as long as wide; hamulohalteres with 5 or 6 apical setae; tibia with 30–36 bifurcate setae, tarsus with 10–16; claw with 2 pairs of knobbed digitules ... (p. 49) .. ***brittini***

—Penis sheath approximately 5X as long as wide; hamulohalteres with 2 or 3 apical setae; tibia with 20–29 bifurcate setae, tarsus with 8–10; claw with 1 pair of knobbed digitules ... (p. 51) .. ***dracophylli***

[The male of *U. assimile* is unknown.]

Ultracoelostoma assimile (Maskell)

sooty beech scale

Figures 38–40

Coelostoma assimile Maskell, 1890: 153. Lectotype female, New Zealand (NZAC), here designated [examined].

Coelostomidia (Ultracoelostoma) assimilis (Maskell). Cockerell, 1902: 114.

Ultracoelostoma assimilis (Maskell). MacGillivray, 1921: 87.

Ultracoelostoma assimile (Maskell). Morrison & Morrison, 1922: 11.

Adult female (Fig. 38). Appearance of live individuals typical of genus. Body shape (slide-mounted specimens) round.

Measurements: body length 2.0–3.8 mm (lectotype 2.2 mm), width 1.8–3.1 (1.7) mm.

Venter. Antennae 5–7-segmented, with 5–8 thickened setae on terminal segment. Legs reduced to 1–4 segments; claw with or without a denticle, and with 1 pair of knobbed digitules. Small vestiges of mouthparts present. Spiracles as for genus; thoracic spiracles with 6 or 7 complex disc pores at opening; abdominal spiracles lacking complex disc pores in atrium but with 1 or 2 around entrance. Complex disc pores commonest on last 4 abdominal segments; minute pores present. Spine-like setae with slightly expanded tips, fine, short derm hairs, long derm hairs, and long setae present as for genus, dense on last 4 abdominal segments, sparse elsewhere. Cicatrices absent.

Dorsum. Setae and derm hairs numerous on last 5 abdominal segments but sparse on remainder of body. Complex disc pores as for venter.

Anal tube as for genus, with 5 or 6 derm hairs medially.

Third-instar female. Appearance typical of genus. Body shape (slide-mounted specimens) round.

Measurements: body length 2.5–4.3 mm, width 2.4–4.8 mm.

Venter. Antennae reduced to 5 or 6 indistinct segments, with 6 or 7 thickened setae on terminal segment and 1 or 2 on segments 2 and 3. Legs reduced to 3 or 4 segments; claw with a denticle and a pair of knobbed digitules. Spiracles as for genus; thoracic spiracles with 8–10 complex disc pores near opening; abdominal spiracles with a ring of 3 or 4 complex disc pores. Derm hairs and spine-like setae of various thicknesses and lengths present, some with expanded tips. Simple pores common; simple disc pores with 3 inner loculi predominant, those with 4, 5, or 2 loculi less so; complex disc pores present. Cicatrices present medially, usually on all except last 3 or 4 abdominal segments. Sclerotisation on last abdominal segment and on last 3 intersegmental joins as for genus. Anal area with very heavy sclerotisation, ill defined setae and pores, a pair of long thick setae, several shorter thick setae, minute pores, and complex disc pores present on sclerotised area.

Dorsum. As for venter, but pores and setae sparser, and concentrated on body margins; cicatrices rare.

Anal tube as for genus, with 6–8 rows of pores at inner end and with a median ring of pores.

Second-instar female (Fig. 39). Appearance and habits typical of genus. Body shape (slide-mounted specimens) round.

Measurements: body length 1.2–2.3 mm (paralectotype 2.3 mm), width 0.9–2.0 (2.0) mm.

Venter. Antennae and legs as for 3rd instar. Thoracic spiracles with 3–5 associated complex disc pores; abdominal spiracles with 1 or 2 associated complex disc pores. Simple pores similar in size to the scarcer simple disc pores which have 3 loculi predominant; those with 2, 4, or 5 loculi less prevalent. Clavate derm hairs, setae of different lengths and thicknesses, and setae with slightly swollen tips present. Last segment of abdomen sclerotised, with complex disc pores, setae, derm hairs, and minute pores. Cicatrices present on all but the last 4 abdominal segments.

Dorsum. As for venter, but cicatrices absent.

Anal tube as for genus, with 3–5 rows of wax pores at inner end.

First instar (Fig. 40). Appearance typical of genus. Body shape (slide-mounted specimens) oval, widest at thorax.

Measurements: body length 0.77–0.92 mm (paralectotype 0.90 mm), width 0.49–0.65 (0.50) mm; length of hind trochanter plus femur 0.12–0.13 (0.13) mm, of tibia plus tarsus 0.13–0.15 (0.14) mm.

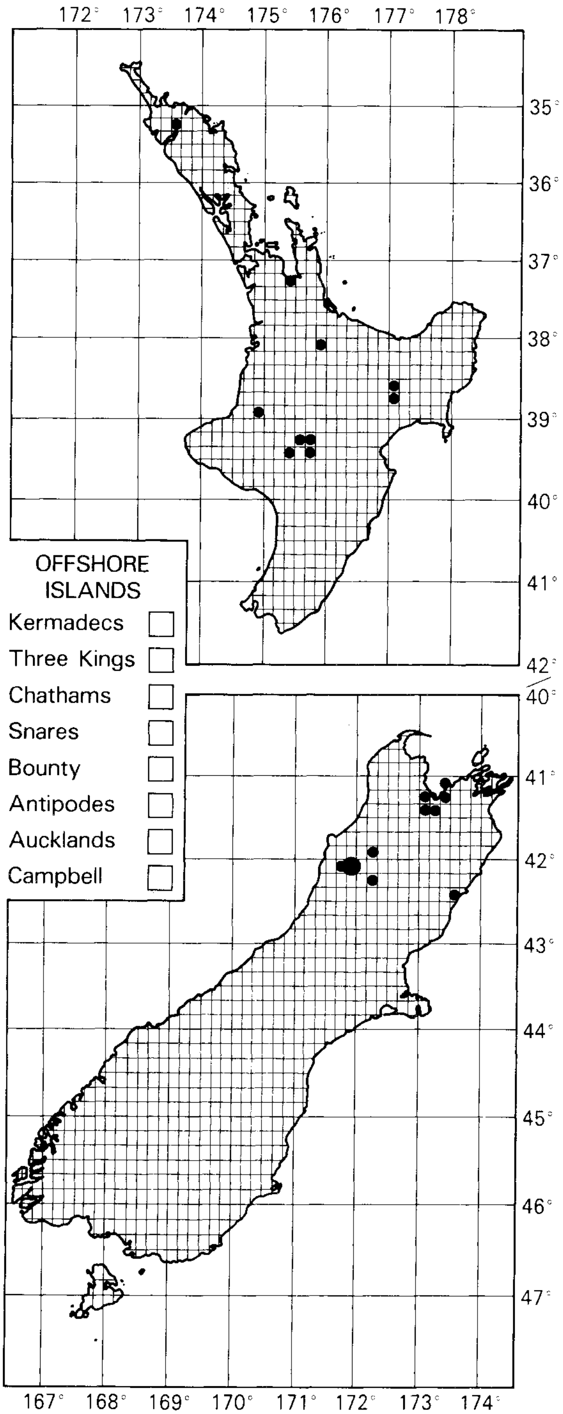
Venter. Antennae as for genus, with 5 or 6 thickened setae on terminal segment. Legs as for genus. Thoracic and abdominal spiracles each with at least 1 associated complex disc pore. Simple pores and simple disc pores with 2–5 inner loculi present, similar in size, those with 3 loculi most common; complex disc pores present. Fine, short, stout and long setae and clavate derm hairs present. Last abdominal segment as for genus except for several long, thick setae with expanded tips.

Dorsum. Derm hairs, simple disc pores, and simple pores as for venter, but thick setae with expanded tips denser on last abdominal segment, which lacks cicatrices.

Anal tube and last abdominal segment as for genus.

Type data. Given by Maskell (1890, p. 153) as New Zealand, on "Fagus" in the Reefton district [BR]. Three original slides have been located (NZAC), labelled "*Coelostoma assimile*, Adult Female, Apr. 1890, W.M.M.", "*Coelostoma assimile*, Larva, Feby. 1890, W.M.M.", and "*Coelostoma assimile*, antenna of second stage female 6 joints, Feby. 1890, W.M.M.". The adult female matches Maskell's original description, and is here designated **lectotype**; the other two slides therefore become **paralectotypes**.

Material examined. Adult female: lectotype, plus 16 non-type examples (BMNH, NZAC). ND, GB, TK, TO / NN, BR. Collected from *Laurelia novaezelandiae*, *Nothofagus fusca*, *N. menziesii*, *N. solandri*, and *Weinmannia sylvicola*. Recorded February, March, September, October, and December.



• **Map 7** Collection localities, *Ultracoelostoma assimile* •

Second- and third-instar females: 1 paralectotype, plus 42 non-type examples (BMNH, FRNZ, NZAC). ND, WO, GB, TK, TO / NN, BR, KA. Collected from all species of *Nothofagus*, *Weinmannia sylvicola*, and *Laurelia novaezelandiae*. Recorded January–April, June, and August–December.

First instar: 1 paralectotype, plus 11 non-type examples (NZAC). WO, GB, TK, TO / NN, BR, KA. Collected from *Nothofagus solandri*, *N. fusca*, *N. menziesii*, *Laurelia novaezelandiae*, *Weinmannia sylvicola*, and *Senecio* sp., as settled first instars and as crawlers on tree trunks and stems. Recorded February–April, June, and December.

Remarks. The adult female of *U. assimile* is very similar to those of *U. brittini* and *U. dracophylli*. It differs from the former in size, number of claw digitules, greater reduction of legs and antennae, and numbers of spiracles and pores, and from the latter in the greater number of thickened setae on the terminal antennal segment, and the greater number of derm hairs and setae on the last abdominal segments. Intermediate and first instars of *assimile* have simple disc pores with predominantly three loculi, but in *brittini* the quadrilocular form is more prevalent. Intermediate instars of *assimile* are similar to those of *dracophylli*, but can be separated by their greater number of thickened setae on the last antennal segment. First instars of *assimile* differ from the other two species in having knobbed setae on the last abdominal segment, and those of *brittini* can be distinguished by their greater size and the double row of closer packed complex disc pores around the anus. Adult males of *assimile* and *dracophylli* differ in the shape of the penis sheath, the number of setae on the hamulohalteres, the number of bifurcate setae on the tibia and tarsus, and the number of claw digitules.

Previously *U. assimile* was regarded as one variable species (Morales *et al.* 1988), but on closer examination it was found that these variations represented two species, *U. assimile* and *U. brittini*. It is of particular interest that, where collectors have recorded the part of the host plant from which specimens of *Ultracoelostoma* have been taken, *assimile* has occurred mostly on branches (including the type specimen: Maskell 1890) and *brittini* exclusively on trunks of *Nothofagus* spp. All specimens from the two sites used in the life history study of sooty beech scale (Morales *et al.* 1988) are now recognised as *U. brittini*. The males from this latter study show no variation, and are thus taken to be *U. brittini*. No male specimens of *Ultracoelostoma* in NZAC have been collected in association with populations of *U. assimile* on stems. Descriptions from a morphological study of *U. assimile* collected on *Nothofagus solandri* bark in mid Canterbury (Oliver 1975) conform to *U. brittini* – for instance, predominance of simple disc pores with four loculi, and the dimensions of the life history stages.

Second instars of *U. brittini* with well developed legs have been collected from various hosts. There is no great difference in size between them, and the legged form may be a precursor of the prepupa. No legged forms have been found in *U. dracophylli*, however.

Ultracoelostoma brittini new species

Figures 41–47

Adult female (Fig. 41). Body shape (slide-mounted specimens) round.

Measurements: body length 4.4–6.0 mm (holotype 4.9 mm), width 3.6–5.2 (4.0) mm.

Venter. Antennae as for genus, 6-segmented, with 4 or 5 thickened setae on terminal segment. Legs reduced, 3- or 4-segmented; claw long, with or without a prominent denticle and 2 or 3 pairs of digitules with distinct knobs. A distinct sclerotised beak present, but no stylets or sclerotised supports. Spiracles as for genus; thoracic spiracles with 18–20 complex disc pores at opening; abdominal spiracles slightly smaller. Complex disc pores and minute pores distributed as for genus. Long slender setae present. Short stout setae, and derm hairs of 2 sizes present, mostly with slightly expanded tips. Last 4 abdominal segments with dense rows of complex disc pores, these sparse on remainder of body.

Dorsum. As for venter, but rows of pores on last 3 abdominal segments densest, and last 3 segments very pilose.

Anal tube as for genus, with 8–10 derm hairs medially.

Third-instar female (Fig. 42). Appearance typical of genus. Body shape (slide-mounted specimens) round.

Measurements: body length 5.3–5.6 mm, width 4.0–5.3 mm.

Venter. Antennae as for genus, reduced to 6 or 7 segments, with 5 or 6 thickened setae on terminal segment and 1 or 2 on each of segments 3 and 4. Legs reduced to 2–4 segments; claw distinct, with or without a denticle, and with 2 or 3 pairs of knobbed digitules. Spiracles as for genus; thoracic spiracles with 14–16 complex disc pores at opening; abdominal spiracles with a ring of 8–12 complex disc pores. Simple disc pores with 4 loculi most common, those with 3 or 5 loculi less so. Simple pores, minute pores, derm hairs, and setae distributed as for genus. Cicatrices numerous, present on thorax and all but the last 4 abdominal segments. Anal area heavily sclerotised, as for genus; setae with pointed tips.

Dorsum as for venter, but cicatrices more numerous and also present on head and thorax.

Anal tube as for genus, with 8–10 rows of wax pores at inner end.

Second-instar female (Fig. 43). Appearance typical of genus. Body shape (slide-mounted specimens) round.

Measurements: body length 1.9–2.1 mm, width 1.2–1.3 mm.

Venter. Antennae as for 3rd instar, reduced to 5 or 6 segments, with 5 or 6 thickened setae on terminal segment and 1 or 2 on segments 4 and 5. Legs as for 3rd instar; claw and digitules sometimes ill defined because of reduction of legs. Spiracles as for genus; thoracic spiracles with 5 or 6 complex disc pores at mouth; abdominal spiracles with a ring of 2 or 3 complex disc pores. Pores, cicatrices, setae, and derm hairs as for 3rd instar but sparser, and absent from thorax. Anal area as for genus, but setae without expanded tips.

Dorsum. As for venter, but cicatrices fewer.

Anal tube as for genus, with 3–5 rows of wax pores at inner end.

First instar (Fig. 44). Body shape (slide-mounted specimens) oval, widest at thorax.

Measurements: body length 1.08–1.33 mm, width 0.60–0.75 mm; length of hind trochanter plus femur 0.14–0.17 mm, of hind tibia plus tarsus 0.18–0.19 mm.

Venter. Antennae as for genus, with 5 or 6 thickened setae on terminal segment. Legs and spiracles as for genus. Complex disc pores present. Simple pores and simple disc pores present, similar in size. Simple disc pores with 4 loculi commonest, those with 3 or 5 less so; no bilocular pores present. Long fine setae, short setae, and derm hairs distributed as for genus; derm hairs lacking expanded tips. Last abdominal segment as for genus, but long thick setae with pointed tips.

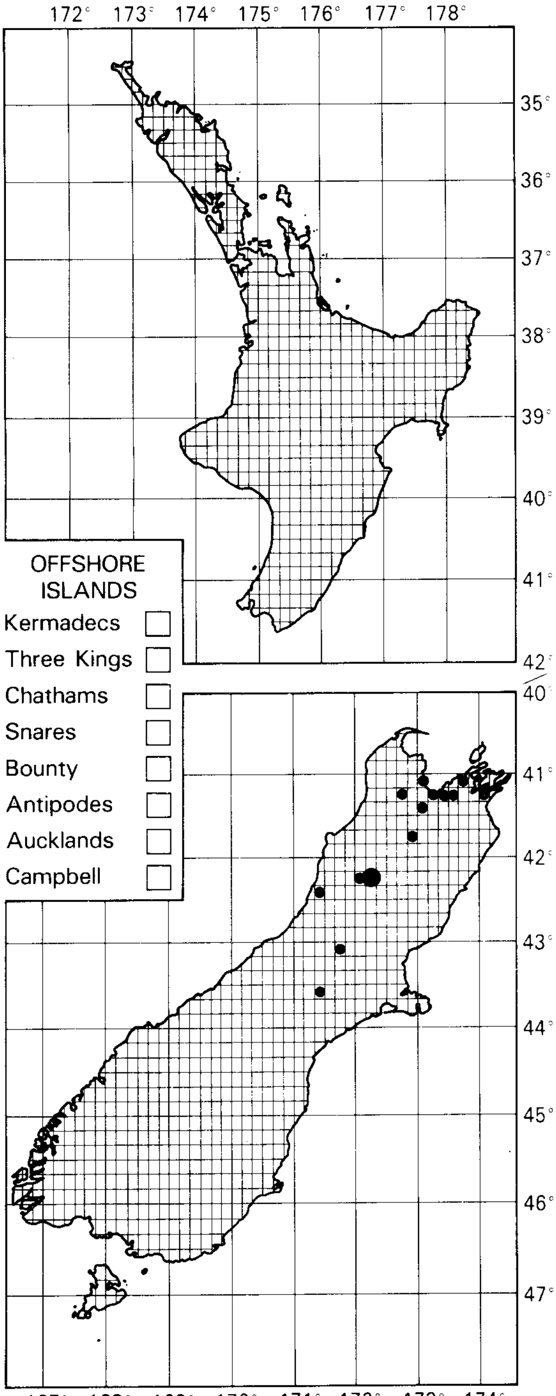
Dorsum. As for venter, but last abdominal segment with denser thick setae, lacking cicatrices, but with a double row of 26–30 complex disc pores around anus.

Anal tube as for genus.

Adult male (Fig. 45). Appearance of live individuals typical of tribe. Body shape elongate, narrow.

Measurements: body length 3.0–3.4 mm; wing length 2.7–3.3 mm; length of hind trochanter plus femur 0.60–0.64 mm, of hind tibia plus tarsus 0.90–1.00 mm; claw length 0.06–0.07 mm, width about 0.02 mm; antenna length 1.7–2.1 mm; penis sheath length 0.32–0.47 mm, width 0.07–0.10 mm.

Venter. Antennae, head, and thorax as for subfamily. Legs as for subfamily; claw with a denticle, and with 2 or 3 pairs of knobbed digitules extending beyond claw apex; tibia with 32–36 bifurcate spines on underside, tarsus with



• **Map 8** Collection localities, *Ultracoelostoma brittini* •

10–12. Thoracic and abdominal spiracles as for tribe. Abdomen with 7 bands of cicatrices; minute pores numerous; derm hairs with pointed tips, setae with expanded tips. Disc pores absent.

Dorsum. Head and thorax as for subfamily. Hamulohalteres with 5 or 6 thick, knobbed setae at apex. Abdomen: slender pointed setae and derm hairs of 2 sizes, with expanded tips, sparser on last 3 abdominal segments; disc pores present in 5 bands on abdominal segments. Minute pores present on all segments. Cylindrical tubercles and cicatrices absent. Penis sheath as for tribe, but bilobed at tip, more than 3x as long as wide, and with a narrow base.

Pupa (Fig. 46). Appearance of live individuals as for family. Body shape (slide-mounted specimens) elongate.

Measurements: body length 2.7–2.9 mm, width 1.0 mm; diameter of posterior spiracles 37–47 µm, of other spiracles 25 µm.

Venter. Antennae and legs as for family. Some long setae on head. Minute pores present only on head. Numerous knobbed setae in 2 sizes, smaller numbers of fine, small derm hairs, and complex disc pores present. Pores, setae, and derm hairs in rows on abdomen, elsewhere sparsely scattered. Anal lobes bearing a pair of stout, knobbed setae, 10x as long as wide, associated with 3 or 4 other setae longer than those on body. Posterior spiracles much wider than other abdominal spiracles.

Dorsum. Pores, hairs, and setae as on venter, but denser, and minute pores absent. Buds of wings and hamulohalteres as for subfamily.

Prepupa (Fig. 47). Appearance of live individuals as for family. Body shape (slide-mounted specimens) broadly oval.

Measurements: body length 2.3–2.9 mm, width 1.0–1.5 mm; length of hind trochanter plus femur 0.38–0.46 mm, of hind tibia plus tarsus 0.41–0.47 mm; claw length 0.04–0.05 mm, width about 0.02 mm.

Venter. Antennae as for family. Legs as for family; claw with a denticle and 2 pairs of knobbed digitules; tibia with 12 stout setae, tarsus with 5. Thoracic spiracles with 4 or 5 complex disc pores and some minute pores at opening; abdominal spiracles lacking associated pores. Cicatrices on head about the same size as disc pores. Long setae, derm hairs of 2 sizes, some thickened and with pointed tips, and complex disc pores present; minute pores absent.

Dorsum. Pores, setae, and derm hairs as on venter, but denser on abdominal segments.

Anal tube as for tribe, with an inner sclerotised ring and 10–12 derm hairs medially.

Type data. Holotype: adult female labelled "on *Notho-*

fagus menziesii, Maruia 18.12.35, G. Brittin", "Coccidae Margarodinae, *Coelostomidia assimile* variety 1 Adult", "*Ultracoelostoma brittini* Morales Holotype", "Entomology Div., DSIR, N.Z., G. Brittin Collection" (NZAC).

Paratypes: 23 examples on 14 slides (NZAC).

Material examined. Adult female: holotype and 4 paratypes, plus 13 non-type examples (NZAC, BMNH). — / SD, NN, MC. Collected from "Fagus", *Nothofagus fusca*, *N. solandri*, and *N. menziesii*. Recorded March, April, and August–October.

Third-instar female: 4 paratypes, plus 40 non-type examples (NZAC, BMNH). — / NN, MC. Collected from "Fagus", *Nothofagus fusca*, *N. solandri*, and *N. menziesii*. Recorded January–April and August–December.

Second-instar female: 5 paratypes, plus 20 non-type examples (NZAC). — / NN, MC. Collected from *Nothofagus fusca*, *N. menziesii*, and *N. solandri*. Recorded February–April, June, and August.

First instar: 6 paratypes, plus 22 non-type examples (NZAC). — / NN, BR, MC. Collected from "Fagus", *Nothofagus fusca*, and *N. menziesii*. Recorded January–April, September, November, and December.

Adult male: 5 non-type examples (NZAC). — / NN, BR. Found mostly on *Nothofagus* bark. Recorded January–March and December.

Male pupa: 2 non-type examples (NZAC). — / NN, MC. Found on *Nothofagus* bark or at base of *Nothofagus* trees. Recorded December and January.

Male prepupa: 9 non-type examples (NZAC). — / NN. Found mostly on *Nothofagus* bark or on surrounding vegetation. Recorded January, November, and December.

Remarks. See *U. assimile*, above. This species is named after Mr G. Brittin, a New Zealand amateur entomologist who worked on Coccoidea in the early part of this century, and who collected the holotype.

This species is the same as that described as *Ultracoelostoma* sp. A in Morales (1990).

Ultracoelostoma dracophylli new species

Figures 48–51

Adult female (Fig. 48). Appearance typical of genus, but resinous test on host plant rather oval. Body shape (slide-mounted specimens) broadly oval-elongate.

Measurements: body length 1.6–3.4 mm (holotype 2.2 mm), width 1.1–2.2 (1.9) mm.

Venter. Antennae as for genus, with 2 thickened setae on terminal segment. Legs reduced to 2–4 segments; claw reduced, without a denticle but with a pair of knobbed digitules. Vestiges of mentum present. Spiracles as for genus; thoracic spiracles with 6 or 7 complex disc pores; abdominal spiracles with 3 or 4 complex disc pores around opening. Complex disc pores numerous, and minute pores present. Pores as for genus, denser on last 4 abdominal segments. Setae and derm hairs as for genus, fine or stout, in 2 sizes, with tips expanded very slightly or not, denser on last abdominal segment.

Dorsum. As for venter, but setae and derm hairs densest on last 4 abdominal segments.

Anal tube as for genus, with a median ring of 6–8 derm hairs.

Third-instar female. Appearance and habits of live individuals typical of genus, but sclerotisation at anal end not extensive, and rings of sclerotised patches on last 2 abdominal segments absent. Body shape (slide-mounted specimens) elongate, sometimes tending to be pear-shaped.

Measurements: body length 1.8–3.2 mm, width 1.25–2.2 mm.

Venter. Antennae 5-segmented, with 2 thickened setae on terminal segment and some thickened setae also on segments 2–4. Legs reduced to 1–3 obscure segments; claw indistinct, lacking a denticle but with a pair of reduced, knobbed digitules just reaching claw tip. Spiracles as for genus; thoracic spiracles with 6–9 associated complex disc pores; abdominal spiracles with a ring of 5 complex disc pores. Last abdominal segment sclerotised, but without a ring of heavy sclerotisation. Simple pores most numerous; smaller numbers of simple disc pores with 3 or 4 inner loculi present. Clavate derm hairs, stout long setae, and short setae of 2 sizes, mostly with pointed tips, present. Cicatrices present on all but the last 3 abdominal segments.

Dorsum. As for venter, but without cicatrices.

Anal tube as for genus, with 5 rows of pores at inner end.

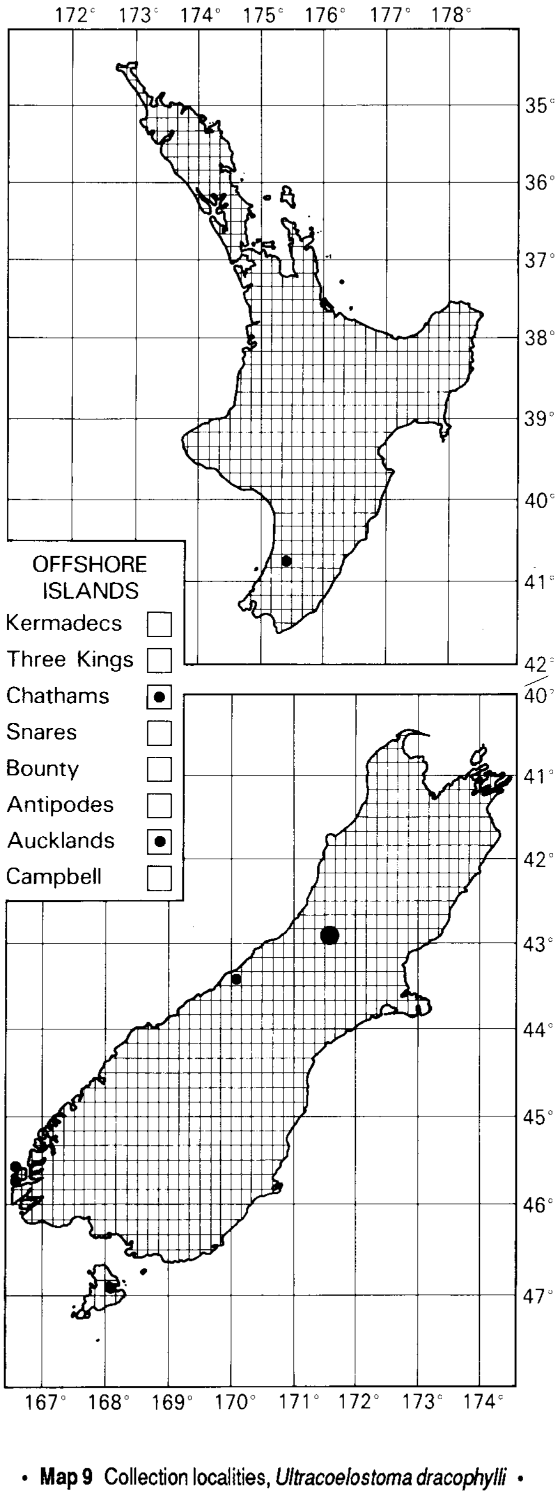
Second-instar female (Fig. 49). Appearance and habits of live individuals as for 3rd instar. Body shape (slide-mounted specimens) oval.

Measurements: body length 1.2–1.5 mm, width 0.9–1.2 mm.

Venter. Antennae as for 3rd instar, indistinctly 5-segmented, with 2 thickened setae on terminal segment. Legs 3- or 4-segmented. Spiracles as for genus; thoracic spiracles with 6 or 7 complex disc pores, abdominal spiracles with 1 or 2. Pores, cicatrices, setae, and derm hairs as for 3rd instar. Last abdominal segment lightly sclerotised, not distinctly separated from previous segment; setae short, without swollen tips.

Dorsum. As for venter, but cicatrices absent.

Anal tube as for genus, with 4 or 5 rows of pores at inner end.



• **Map 9** Collection localities, *Ultracoelostoma dracophylli* •

First instar (Fig. 50). Appearance typical of genus. Body shape (slide-mounted specimens) elongate-oval.

Measurements: body length 0.65–0.93 mm, width 0.39–0.68 mm; length of hind trochanter plus femur 0.10–0.12 mm, of hind tibia plus tarsus 0.10–0.13 mm.

Venter. Antennae as for genus; terminal segment with 2 thickened setae. Legs and spiracles as for genus. Simple pores most numerous; simple disc pores mostly with 3 loculi present, these pores similar in size; a few complex disc pores present; long setae as for genus; short pointed setae of 2 sizes and faintly clavate derm hairs present. Last abdominal segment as for genus; setae of 2 sizes with pointed tips and complex disc pores present. Cicatrices and caudal setae as for genus.

Dorsum. As for venter, but thick setae with pointed tips denser on last abdominal segment, 10–12 complex disc pores present around anus, and cicatrices absent.

Anal tube as for genus.

Adult male (Fig. 51). Appearance typical of tribe.

Measurements: body length 3.2 mm; wing length 2.7 mm; length of hind trochanter plus femur 0.50–0.57 mm, of hind tibia plus tarsus 0.83–0.85 mm; claw length 0.05 mm, width about 0.01 mm; length of antenna 1.8 mm; penis sheath 0.87 x 0.05 mm.

Body as in *U. brittini*, except as follows: 2 thickened setae on apical antennal segment; 2 knobbed, curved setae on hamulohalteres; claw with 2 digitules; penis sheath longer, about 5x as long as wide; and 20–30 bifurcate setae on tibia and 10–12 on tarsus.

Male pupa and prepupa. Unknown.

Type data. Holotype: adult female labelled "NC, Arthurs Pass, 23.1.1983, C.F. Butcher, ex *Dracophyllum longifolium*" (slide no. 83.284a; NZAC).

Paratypes: 40 examples on 25 slides (NZAC).

Material examined. Adult female: holotype and 5 paratypes, plus 9 non-type examples (NZAC, BMNH). WN / NC, WD, FD / SI / Auckland Is / Chatham Is. Collected from *Archeria* sp., *Dracophyllum* sp., *D. longifolium*, *D. paludosum*, and *D. filiforme*. Recorded January–April.

Third-instar female: 7 paratypes, plus 17 non-type examples (NZAC, BMNH). WN/ NC, WD, FD / SI / Chatham Is / Auckland Is. Collected from *Dracophyllum longifolium*, *D. lyalli*, *D. filiforme*, *D. paludosum*, and *Archeria* sp. Recorded January–March, September, and November.

Second-instar female: 10 paratypes, plus 34 non-type examples (NZAC). WN / NC, FD / SI / Auckland Is / Chatham Is. Collected from *Dracophyllum* sp., *D. filiforme*, *D. longifolium*, and *Archeria* sp. Recorded January–March, September, and November.

First instar: 16 paratypes, plus 20 non-type examples (NZAC, BMNH). — / NC, WD, FD / SI / Chatham Is / Auckland Is. Collected from *Dracophyllum longifolium*, *D. lyalli*, and *Archeria* sp. Recorded February–April, September, and November.

Adult male: 1 paratype (NZAC). WN / —. Collected from *Dracophyllum longifolium*. Recorded February.

Remarks. *Ultracoelostoma dracophylli* is similar to *U. brittini*. Dumbleton (1967) had suggested that specimens from *Dracophyllum* sp. at 3000 ft [900 m] at Arthur's Pass might be a species distinct from *assimile* [= *U. brittini*], as they were not found on surrounding trees of *Nothofagus solandri* even though this plant carried populations of *assimile* [and *U. brittini*] at lower altitudes. Dumbleton noted that this *Ultracoelostoma* on *Dracophyllum* was present in areas where *Nothofagus* was absent or at the limit of its range, such as on the Chatham Islands, Auckland Islands, and Stewart Island, and also where *brittini* is rare, as at Arthur's Pass. Since Dumbleton's study *dracophylli* has been found in Westland, Fiordland, and at 900 m in the Tararua Range of the North Island, all areas outside the optimum for *Nothofagus* sp. and *U. brittini*.

This species is named after its main host plant, *Dracophyllum*, and is the same as that described as *Ultracoelostoma* sp. B in Morales (1990).

Tribe Platycoelostomini

Genus *Platycoelostoma* Morrison & Morrison

Coelostoma Maskell, 1892: 45.

Coelostomidia Cockerell, 1902: 258 (replacement name for *Coelostoma*; preoccupied). Type species *Coelostoma compressum* Maskell, 1892, by original designation and monotypy.

Platycoelostoma Morrison & Morrison, 1923: 34.

Tribe and genus defined by the characters described below for the species.

Remarks. The tribe Platycoelostominiini was erected by Morrison & Morrison (1923) for the single New Zealand genus *Platycoelostoma* Morrison. Because of a lack of complete adult females and males at that time, Morrison (1928) regarded the true affinities of *Platycoelostoma* as obscure and its assignment at that time as tentative. Since then complete adult females have been found, but no males of any stage, despite intensive searching.

Platycoelostoma compressa (Maskell)

Figures 52–55

Coelostoma compressum Maskell, 1892: 45. Lectotype female, New Zealand (NZAC), here designated [examined].

Coelostomidia compressa (Maskell). Cockerell, 1902: 258.

Coelostomidia compresses (Maskell). MacGillivray, 1921: 86 (misspelling of *compressa*).

Platycoelostoma compressa (Maskell). Morrison & Morrison, 1923: 35.

Adult female (Fig. 52). Found under the bark of the host plant or crawling on tree trunks or the forest floor, and resembling a very large mealybug. Body elongate, pale pink, with a thick covering of long, fluffy white wax often forming fluted horizontal rows on parts of the body at oviposition; derm membranous.

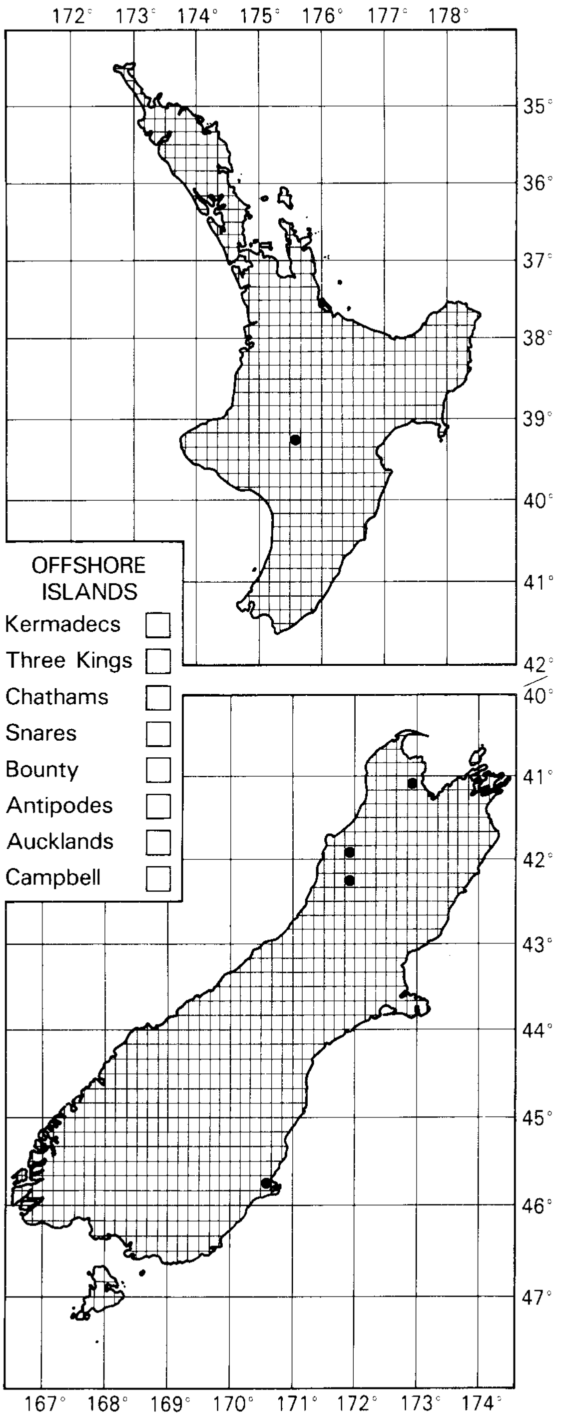
Measurements: body length 10.0–12.0 mm, width 3.3–4.0 mm; length of trochanter plus femur 0.95–1.0 mm (lectotype 0.8 mm), of tibia plus tarsus 1.3–1.5 (1.2) mm.

Venter. Antennae long, 10-segmented, the segments obconical; antennal bases rather close together; apical segment longest, with 12–18 stout setae; segments 5–9 also with thick setae; a pore present on 2nd segment. Legs well developed, thick, with many short, stout setae, 50–60 on tibia and 36–40 in 2 rows on tarsus; claw curved, tapering, broad at base, lacking a denticle but with a pair of unknobbed, slender digitules not reaching apex of claw; trochanter with a long seta and, on each face, 6 pores. Mouthparts represented by chitinous vestiges and hairs. Thoracic spiracles with a bar, an expanded atrium with a band of about 20 complex disc pores, smaller than those on body, and with 3 (rarely 2) inner loculi and several smaller loculi varying in size and shape. Abdominal spiracles comprising 8 pairs; anterior 7 with a double row of complex pores near inner end, but posterior pair lacking pores. Spiracles lacking associated minute pores. Complex disc pores with 2–5 internal loculi and 12–14 outer loculi. Minute pores and long setae of 2 sizes present. Derm hairs distributed mostly in rows. Cicatrices, spines, modified spines, simple pores, and simple disc pores absent. No concentration of setae or pores around anus. Anal opening subapical, ventral.

Dorsum. Pores and setae as on venter, but minute pores absent.

Anal tube simple, short, wide, without setae, pores, or chitinised ring but slightly differing in texture from remainder of body.

Third-instar female (Fig. 53). Found in flat, oval, cell-like, papery cysts between thin bark layers of *Libocedrus bidwilli* (and *Podocarpus totara*, according to Maskell



• **Map 10** Collection localities, *Platycoelostoma compressa* •

(1890), but this host record has not been confirmed). Body very flat, deep reddish pink. Body shape (slide-mounted specimens) elongate oval.

Measurements: body length 3.8–9.6 mm (paralectotype 4.0 mm), width 1.8–3.5 (3.0) mm.

Venter. Antennae reduced to 2 indistinct segments with numerous thick setae. Legs reduced to flat plates of cuticle, each bearing 2 long setae and 30–40 short, stout setae; claw vestige present. Thoracic spiracles with a bar and a large atrium with 2 or 3 bands of complex disc pores. Abdominal spiracles comprising 8 pairs; anterior 7 with a double row of complex pores at inner end, but the smaller, indistinct posterior pair lacking pores; spiracles without associated minute pores. Open-centred pores large, with a rim of about 30 loculi and an inner projection containing 1 pore. Long, pointed setae of different thicknesses and lengths present. Midline of body with 2 or 3 rows of pores and setae; some setae longer around body margin, on head, and around anus. Cicatrices larger than pores, concentrated around edge of body but rare on midline of abdominal segments; inner lumen lacking distinct loculi. Spines, modified spines, derm hairs, minute pores, simple pores, and simple disc pores absent.

Dorsum. Pores and setae as on venter, but cicatrices absent. Anal opening subapical, ventral.

Anal tube as in adult female.

Second-instar female (Fig. 54). Appearance and habits as for 3rd instar. Body shape (slide-mounted specimens) elongate oval.

Measurements: body length 2.8 mm (paralectotype 3.1 mm), width 1.3 (1.8) mm.

Venter. Antennae reduced to 2 indistinct segments with about 15 thickened setae on apical segment. Legs as in 3rd instar, but with fewer setae. Spiracles as in 3rd instar, but with 1 or 2 bands of complex disc pores. Open-centred pores absent from midline but numerous along body margins and around anus. Cicatrices larger than pores, usually in a submarginal row, i.e., absent from midline. Setae of 2 sizes and thicknesses, sparse on body margins, around anus, and on head.

Dorsum. Setae and pores as on venter; cicatrices absent. Anal opening as in 3rd instar.

Anal tube as in adult female.

First instar (Fig. 55). Found under or on *Libocedrus bidwilli* bark. Body red, flattened. Body shape (slide-mounted specimens) elongate elliptical.

Measurements: body length 1.1 mm, width 0.36 mm; length of hind trochanter plus femur 0.14 mm, of hind tibia plus tarsus 0.15 mm.

Venter. Antennae placed close together but not touching, stout, 7-segmented; terminal segment with scattered thick setae and a terminal tuft of 4 or 5 setae, 6th segment also with a group of 4 or 5 setae; segments 5 and 3 lacking setae; segment 2 with a pore. Legs stout, with few setae; claw slender, with a denticle and with 2 knobbed digitules exceeding apex of claw; trochanter with a long seta and a pair of pores on each face. Beak placed opposite middle legs, 2-segmented, elongate. Thoracic spiracles large, with a bar and with 4 or 5 complex pores in atrium. Abdominal spiracles without pores in atrium; 8th pair very small. Large open-centred pores scattered around rim of body. Setae in 2 longitudinal rows on abdomen and scattered on head, thorax, and body margin. Derm hairs scarce on head, thorax, last abdominal segment, and body margin. A single pair of large setae on last abdominal segment. One large, round cicatrix present. Anal opening subapical, ventral. Spines, modified spines, minute pores, simple pores, and simple and complex disc pores absent.

Dorsum. Complex disc pores with 2–5 central loculi and 8–12 outer loculi in 2 medial rows and a submarginal row. Thorax with a single extra pore in midline. Setae in 2 longitudinal rows on thorax and abdomen, and scattered on head and body margin. Derm hairs rare, scattered on body margin, head, and thorax.

Anal tube simple, rather chitinised, with no pores.

Type data. Given by Maskell (1892, p. 45) as New Zealand, the second stage of the female occurring between the layers of bark on *Podocarpus totara*. The adult female that Maskell described was presumably reared from these immature stages.

The type series (NZAC) comprises four original Maskell slides labelled "*Coelostoma compressum*, antenna and feet of adult female, 1890, W.M.M. ", "*Coelostoma compressum*, 2nd stage female, 1890, W.M.M. [2 slides]", and "*Coelostoma compressum* larva 1891 W.M.M.". The only slide with fragments of adult female is here designated **lectotype**; the others become **paralectotypes**.

Material examined. Adult female: lectotype, plus 8 non-type examples (NZAC). TO / NN, DN. Collected from moss at base of trees. Recorded January.

Third-instar female: 1 paralectotype, plus 10 non-type examples (NZAC, BMNH). TO / NN, BR, DN. Collected from *Libocedrus bidwilli*. Recorded in January and March.

Second-instar female: 1 paralectotype, plus 13 non-type examples (NZAC, BMNH). TO / NN, BR, DN. Collected from *Libocedrus bidwilli*. Recorded January.

First instar: 1 paralectotype, plus 10 non-type examples (NZAC). TO / —. Collected from *Libocedrus bidwilli*. Recorded February.

Remarks. *Platycoelostoma compressa* has been found on *Libocedrus bidwilli* in alpine North Island and alpine and subalpine South Island areas of New Zealand, but not on *L. plumosa*, a lowland and northern species.

Subfamily MONOPHLEBINAE

Subfamily characteristics (after Morrison 1928)
Adult female and pre-adult stages living unprotected by a test but covered with waxy secretions, on branches and leaves of host plant. Eggs laid into a posterior ovisac or deposited under body of female.

This diagnosis serves to characterise species recorded from New Zealand. For a more detailed treatment of the subfamily, see Morrison (1928). See also the key on p. 24 for characters separating the subfamilies Coelostomidiinae and Monophlebinae.

Adult female. Body round or elongate-oval, broader at posterior end; derm membranous, lacking chitinised areas. Antennae 9–11-segmented; setae fine, rarely stout. Legs stout, well developed; claw lacking a denticle but with unknobbed digitules not reaching claw apex; trochanter with a long seta and with pores; setae on underside of segments stout but not spine-like. Beak short, stout, 3-segmented; apical setae short, stout, truncate, knobbed or bifid at tip. Thoracic spiracles as in family, with a bar, but lacking pores in atrium or at opening; abdominal spiracles comprising 2 or 3 posterior pairs, with a bar but much reduced in size and lacking associated pores. Open-centred pores of various sizes present, with an outer rim of loculi; centres sometimes indistinctly divided. Complex disc pores with varying numbers of inner and outer loculi present around anus and vulva. Small pores present, mostly on venter. Ovisac pores forming an ovisac-secreting band on venter of abdomen. Spines absent; derm hairs and setae varying in abundance, size, and shape. Ventral cicatrices numbering 3–7, posterior to the vulva. Anal tube short, with a chitinised ring at inner end.

Intermediate female stages (2nd and 3rd instars). In general similar to adult female, but smaller, lacking an ovisac band of pores, and usually with fewer antennal segments, pores, derm hairs, and setae.

First instar. Body broadly oval; derm membranous. Antennae 6-segmented; terminal segment expanded, with several very long setae and some thickened setae; segment 3 next longest; segment 2 with a pore. Legs well developed; claw with a denticle and with a pair of knobbed digitules extending beyond claw apex; trochanter with a long seta on posterior edge and with pores. Beak short, stout, 3-segmented, apically with a group of stout setae, these truncate, knobbed, or bifid. Thoracic and abdominal spiracles with a bar, without associated pores; only posterior 2 or 3 pairs of abdominal spiracles developed. Derm hairs, setae, and open-centred pores of 2 sizes present, arranged in longitudinal rows. Apex of abdomen with 2 or 3 pairs of long setae; body margins bearing long setae. Anal tube well developed, with a double band of wax pores at proximal end and a median ring of complex disc pores.

Adult male. Body elongate; apex of head triangular. Antennae 10-segmented; segments 4–10 binodose, each with 2 whorls of long, fine setae. Wings infuscate; diagonal vein short; costal complex terminating before wing apex; hamulohalteres membranous, with 5 or 6 elongate, curved, knobbed setae at apex. Legs slender; claw lacking a denticle, with a pair of unknobbed digitules not reaching claw apex; trochanter with a long seta and 2 pores on each face; anterior femora and other segments with bifurcate setae; tarsus 2-segmented. Thoracic spiracles and 2 or 3 pairs of abdominal spiracles without associated pores. Setae, derm hairs, and pores scattered over head and thorax. Abdomen membranous, with some sclerotised areas; disc pores with 3 or 4 inner loculi; setae and derm hairs arranged in segmental rows; apically a pair of fleshy tassels bearing many long setae at tip. Penis sheath short, stout, tapering apically.

Male pre-adult stages. Not known.

Remarks. Two species of the genus *Icerya* have been recorded from New Zealand (Wise 1977): *Icerya purchasi* Maskell, the cottony cushion scale, a common cosmopolitan pest species; and *Icerya seychellarum* Westwood, the Seychelles scale, which has not established in New Zealand but is often intercepted in quarantine. *I. purchasi* is thought to have originated in Australia, and is widespread in tropical and sutropical regions. *I. seychellarum* is also widely distributed, mostly in tropical areas.

Both species attack a wide range of woody hosts, and can cause premature leaf drop; in severe infestations the plant is killed. These scale insects are found mostly on the underside of leaves, concentrated along the midrib, or on twigs and branchlets, but seldom on fruit or flowers. They exude honeydew, which attracts ants as well as covering the leaves and fruit, promoting the growth of sooty mould. Damage to plants is more severe in times of drought.

* * *

Tribe Iceryini

Of the five tribes in the Monophlebinae (Morrison 1928) only Iceryini, genus *Icerya*, is represented in New Zealand.

Genus *Icerya* Signoret

Icerya Signoret, 1875: cclviii. Type species *Icerya sacchari* Signoret (=*Dorthesia seychellarum* Westwood), by monotypy.

KEY TO ADULT FEMALES OF *ICERYA* KNOWN FROM NEW ZEALAND

(after Morrison 1928)

With 2 pairs of abdominal spiracles; derm setae conspicuously black, mostly grouped in numerous clusters on body; dorsum with small open-centred pores, but with few large open-centred pores; ovipositing female with a distinctly fluted posterior ovisac; dorsum dark brown, covered with a thin, white waxy secretion ... (p. 56) .. ***purchasi***

—With 3 pairs of abdominal spiracles; derm hairs and setae pale, in loose clusters on body; dorsum with many large, open-centred pores arranged in small clusters or transverse rows, in addition to small open-centred pores; ovipositing female with a fluffy, indistinct ovisac; dorsum brown, covered in a thick layer of white wax, long, glassy wax filaments and plates, and tufts of yellow and white wax plates ... (p. 58) .. ***seychellarum***

Icerya purchasi Maskell

cottony cushion scale

Figures 56, 57

Icerya purchasi Maskell, 1879: 221. Lectotype female, Australia (NZAC), here designated [examined].

Adult female (Fig. 56). Found on leaves and branches of host. Body pale or dark brown, covered in white or pale yellowish wax, with black hairs and long setae; ovipositing females produce a long, white, fluted ovisac. Legs and antennae black. Body shape (slide-mounted specimens) broadly oval, widest near posterior end.

Measurements (females with ovisac bands): body length 3.0–6.5 mm (lectotype 3.0 mm), width 2.0–5.5 (2.0) mm; length of hind trochanter plus femur 0.5–0.6 (0.5) mm, of hind tibia plus tarsus 0.8–0.9 (0.8) mm.

Venter. Antennae 11-segmented, with many hair-like setae; thickened setae present on some segments, including terminal one. Legs as for subfamily; trochanter with a long seta on posterior edge and, on each face, 4 pores; femur, tibia, and tarsus lacking thick, spine-like setae. Thoracic and abdominal spiracles with a bar, lacking disc pores at opening and in atrium; only the distalmost 2 pairs of abdominal spiracles present. Beak as for subfamily, apically bearing 8 thickened setae with slightly expanded truncate tips. Small pores with rims of 4 or 5 loculi and open centres present on head, thorax, and abdomen, sometimes mixed with the ovisac band; perivulvular pores of complex disc pores with 10–12 outer loculi and 1–3 indistinct inner loculi. Band of ovisac pores with rims of 6–9 loculi and 1 inner loculus extending across 1st abdominal segment and continuing around body margin. Small open-centred pores with rims of 6–9 loculi and 2 indistinct inner loculi present. Large open-centred pores present on body margin. Fine, black setae of 2 sizes, long setae in tufts on margin and on mid-venter of 1st abdominal segment, these tufts also with large open-centred pores with rims of 8–10 loculi and a wide central lumen, short setae, and derm hairs present on surface of venter. Ventral cicatrices posterior to vulva, numbering 3, the median one largest. Cicatrices with a granular or reticulate surface texture.

Dorsum. Long, fine, black setae and derm hairs numerous, grouped on mid-dorsal areas of head and thorax; fine and stout short derm hairs present. Small open-centred pores with 7 or 8 outer loculi and 2 indistinct inner loculi present. Large open-centred pores present with tufts of setae on head and thorax and body margins. Complex disc pores around anus. Anal tube as for subfamily.

First instar (Fig. 57). Appearance of live crawlers typical of genus, red dusted with white wax, with black legs and antennae, and with 3 pairs of long setae at tip of abdomen. Body shape (slide-mounted specimens) broadly oval.

Measurements: body length 0.8–1.1 mm (paralectotypes 0.8–0.9 mm), width 0.5–0.8 (0.5–0.6) mm; length of hind trochanter plus femur 0.2 (0.2) mm, of hind tibia plus tarsus 0.3 (0.3) mm.

Venter. Antennae as for subfamily, with 7 or 8 thickened setae and 3 long setae; other segments with long setae. Legs as for subfamily; trochanter with a long seta and, on each face, 3 pores. Beak and spiracles as for adult. Derm hairs and setae in rows on abdominal segments. Small open-centred pores in a single longitudinal row on abdomen, and larger open-centred pores in a submarginal row. A single median cicatrix present on last abdominal segment. Marginal setae in loose groups of 3 or 4, or in a single row.

Dorsum. Derm hairs and setae as on venter; open-centred pores in 3 longitudinal rows on abdomen, scattered on head and thorax. Anal opening surrounded with a ring of setae. Apex of abdomen with 3 pairs of long setae exceeding body length. Anal tube as for subfamily.

Type data. Given by Maskell (1879, p. 221) as New Zealand, "on a hedge of Kangaroo acacia in Auckland".

The syntype series (NZAC, CMNZ) consists of seven slides labelled as follows. "*Icerya purchasi* from acacia, females: 3rd stage final, April 1878. W.M.M." (unmounted specimens, CMNZ); "*Icerya purchasi* from acacia, females: 3rd stage medium, April 1878. W.M.M." (unmounted specimens, CMNZ); "Coccidae, *Icerya purchasi*, females: 3rd stage beginning to form sac, March 1878 W.M.M." (uncleared specimens, NZAC); "Coccidae, *Icerya purchasi*, female: early in 3rd stage, March 1878, W.M.M." (NZAC); "Coccidae, *Icerya purchasi*, from acacia, female: 2nd stage, March 1878 W.M.M." (CMNZ); "Coccidae, *Icerya purchasi* from acacia, young insect, March 1878, W.M.M." (NZAC); and "Coccidae, *Icerya purchasi*, young insect, from Acacia, March 1878. W.M.M." (CMNZ).

The slide labelled "... female: early in 3rd stage ..." best fits Maskell's original description and diagrams, and is here designated **lectotype**; the other six slides become **paralectotypes**.

Material examined. Adult female: lectotype (NZAC), 3 paralectotypes (2 CMNZ, 1 NZAC), and 20 non-type examples (NZAC). ND, AK, WO, WN / SD, NN, MC. Collected from *Ulex* sp., *Citrus* sp., *Acacia* sp., *Fatsia japonica*, *Pittosporum* sp., *Malus* sp., *Hedyscepe canterburyana*, *Melicope ternata*, and *Acer* sp. Recorded in most months.

Intermediate females: 1 paralectotype (CMNZ) and 15 non-type examples (NZAC). ND, AK, WO, WN / SD, NN, MC. Collected from same host plants as adult female. Recorded throughout the year.

First instar: 2 paralectotypes (1 CMNZ, 1 NZAC) and 12 non-type examples. ND, AK, WO, WN / SD, NN, MC. Collected from same host plants as adult female. Recorded in most months.

Remarks. *Icerya purchasi* was first described from specimens found on kangaroo acacia (*Acacia ornata*) in Auckland in March 1877 by Mr T.F. Cheesman and Rev. Dr Purchas, after whom it was named. It quickly became a pest in gardens and citrus orchards. Its subsequent control by the introduced coccinellid *Rodolia cardinalis* (Mulsant) remains the classic example of biological control of an insect pest by a natural predator.

It is not well known that a large proportion of the founding population of *R. cardinalis* used to save the California citrus industry from *I. purchasi* originated in New Zealand (Morales & Hill 1990).

Today *I. purchasi* is a relatively uncommon pest in New Zealand, because of control by *R. cardinalis* and *Cryptochaetum iceryae* (Williston), a small fly of Australian origin, also introduced into many countries about 100 years ago (Morales 1989).

Icerya seychellarum (Westwood)

Figure 58

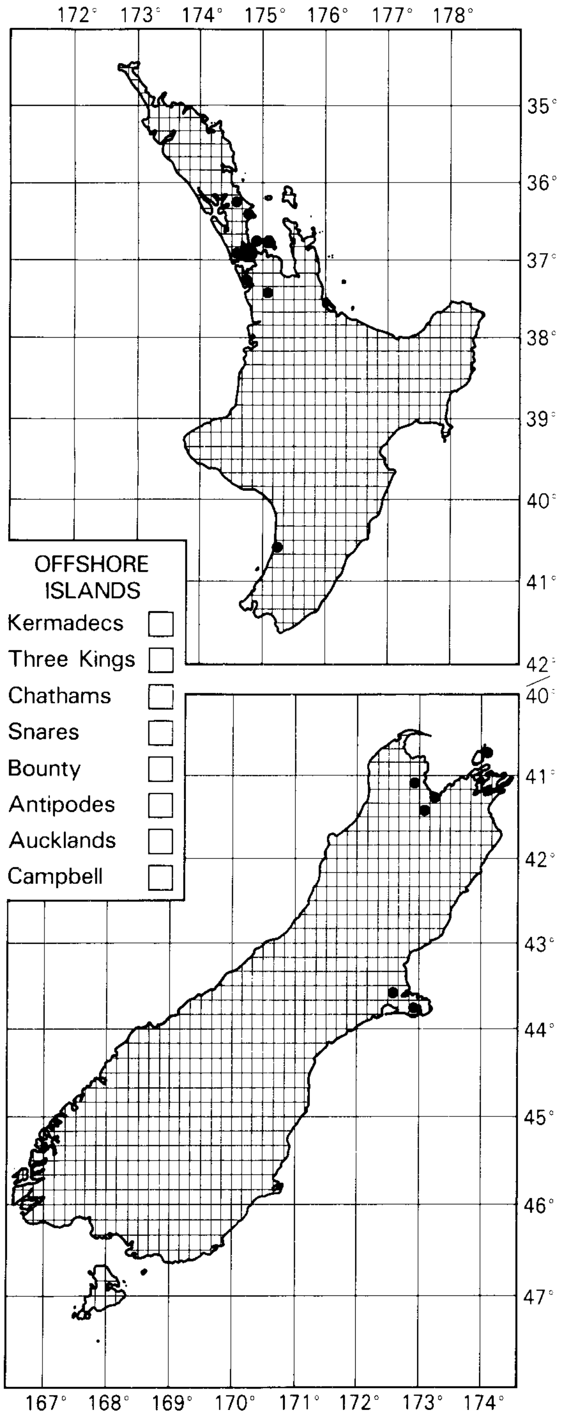
Dorthesia seychellarum Westwood, 1855: 836.
Icerya seychellarum (Westwood). Maskell, 1897: 329.

Although this species was recorded by Fernald (1903) as occurring in New Zealand, it is not known to have established, but has been intercepted many times in quarantine on produce from other countries.

In life, adult females can be distinguished from those of *I. purchasi* by their median and marginal rows of bright yellow and white wax and long, fine, silky hairs, and by the lack of a large, fluted ovisac (see Fig. 58). Slide-mounted specimens can be distinguished in all stages by the numbers of spiracles, two in *I. purchasi* and three in *I. seychellarum* (see Fig. 56 cf. 58).

More detailed descriptions of *I. seychellarum* can be found in Morrison (1928) and Williams & Watson (1990). The latter authors also redescribe *Icerya purchasi* and *I. aegyptiaca* and document their occurrence in the tropical South Pacific region.

* * *



• **Map 11** Collection localities, *Icerya purchasi* •

REFERENCES

Balachowsky, A. 1942: Essai sur la classification des cochinelles (Homoptera: Coccoidea). *Annales de la Grignon École Nationale d'Agriculture (ser.3) 3:* 34–48.

Bartlett, B.R. 1978: Margarodidae. Pp. 132–136 *in:* Clausen, C., Introduced parasites and predators of arthropod pests and weeds, a world review. *U.S.D.A. agriculture handbook 480.*

Beardsley, J.W. 1964: Insects of Campbell Island. Homoptera: Coccoidea. *Pacific insects monograph 7:* 238–252.

——— 1968: External morphology of the adult male of *Matsucoccus bisetosus. Annals of the Entomological Society of America 61:* 1449–1549.

Belton, M.C. 1978: The place of beech scale insect (*Ultracoelostoma assimile*) in the ecology of mountain beech. MAF Honeydew Seminar, 10 August 1978. Christchurch, New Zealand, MAF Advisory Service.

Ben-Dov, Y. 1981: Redescription of *Matsucoccus josephi* Bodenheimer & Harpaz (Homoptera: Coccoidea: Margarodidae). *Israel journal of entomology XV:* 35–51.

Blanchard, R. 1883: Les coccides utiles. *Bulletin de la Société Zoologique de France 8:* 217–328.

Blanchard, E.E. 1936: Apuntes sobre calcidoideos Argentinos, nuevos e conocidos. *Revista de la Societa Entomologica de Argentina 6:* 8–32.

Bodenheimer, F.S. 1952: Citrus entomology in the Middle East. Gravenhage, Netherlands, W. Junk. 663 p.

Boratynski, K.L. 1952: *Matsucoccus pini* (Green, 1925) (Homoptera, Coccoidea, Margarodidae). Bionomics and external anatomy, with reference to the variability of some taxonomic characters. *Transactions of the Royal Entomological Society of London 103:* 285–326.

Boratynski, K.L.; Davies, R.G. 1971: The taxonomic value of male Coccoidea (Homoptera), with an evaluation of some numerical techniques. *Biological journal of the Linnean Society 3:* 57–102.

Borchsenius, N.S. 1950: Mealybugs and scales of the U.S.S.R. (Coccoidea). *Tableau Analytique de la Faune de l'U.R.S.S. 32.* Akademii Nauk Zoologicheskii Institut. 258 p.

——— 1958: On the evolution and phylogenetic interrelations of the Coccoidea (Insecta, Homoptera). *Zoologicheskii Zhurnal 37:* 765–780.

Brimblecombe, A.R. 1960: Studies of the Coccoidea, 11: New genera and species of Monophlebidae. *Department of Agriculture and Stock, Queensland, Division of Plant Industry bulletin no. 167:* 1–11.

Brittin, G. 1935: Notes on the genus *Coelostomidia* with descriptions of one species and a table for identification. *Transactions and proceedings of the Royal Society of New Zealand 65:* 63–74.

——— 1936: Further notes on the genus *Coelostomidia* Cockerell. *Transactions and proceedings of the Royal Society of New Zealand 66:* 225–229.

Büchner, P. 1985: Endosymbiosis of animals with plant microorganisms. New York, Interscience Publications, John Wiley & Sons Inc. 909 p.

Butcher, C.F. 1986: Life history of *Ultracoelostoma assimile* (Maskell) (Margarodidae). Proccedings of the 5th International Symposium on Scale Insects (ISSIS-V), Portici (Naples), Italy, 24–28 June 1986. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri', Portici, XLIII:* 143–147.

Cockerell, T.D.A. 1900: The Coccidae of New Zealand. *Nature 61:* 367–368.

——— 1902: A contribution to the classification of the Coccidae. *Entomologist 35:* 257–266.

Cook, V.A. 1971: Beech honeydew's export potential. *New Zealand journal of agriculture 122:* 51.

Cooper, R.A.; Oetting, R.D. 1986: Adaptations of scale insects to host variability. *Journal of agricultural entomology 3(2):* 163–169.

Cox, J.M. 1983: An experimental study of morphological variation in mealybugs (Homoptera: Coccoidea: Pseudococcidae). *Systematic entomology 8(4):* 47–53.

——— 1987: Pseudococcidae (Insecta: Hemiptera). *Fauna of New Zealand 11.* 230 p.

Crane, E.; Walker, P. 1985: Important honeydew sources and their honeys. *Beeworld 66:* 105–112.

Crosby, T.K.; Dugdale, J.S.; Watt, J.C. 1976: Recording specimen localities in New Zealand: an arbitrary system of areas and codes defined. *New Zealand journal of zoology 3:* 69 + map.

Crozier, L.A. 1978: Honeydew resource of the Oxford State Forest. MAF Honeydew Seminar, 10 August 1978. Christchurch, New Zealand, MAF Advisory Service.

Danzig, E.M. 1984: Most important aspects in the phylogeny of scale insects (Homoptera : Coccinea). Pp. 318–320 *in:* Proceedings of the 10th International Symposium of Central European Entomofaunistics (SIEEC), Budapest, Hungary, August 1983.

——— 1986: Coccids of the far east of the U.S.S.R. (Homoptera, Coccinea) with an analysis of the phylogeny of coccids of the world fauna. New Delhi, Oxonian Press. 450 p.

de Boer, J.A.; Valentine, E.W. 1977: The identity of *Leucaspis gigas* (Homoptera: Diaspididae), with descriptions of four similar species in New Zealand. *New Zealand journal of zoology 4(2):* 153–164.

Deitz, L.L. 1979: Selected references for identifying New Zealand Hemiptera (Homoptera and Heteroptera), with notes on nomenclature. *New Zealand entomologist 7:* 20–29.

Deitz, L.L.; Tocker, M.F. 1980: W.M. Maskell's Homoptera: species-group names and type material. *New Zealand Department of Scientific and Industrial Research information series no. 146.* 76 p.

De Klerk, C.A.; Ben-Dov, Y.; Giliomee, J.H. 1982: Redescriptions of four vine-infesting species of *Margarodes* Guilding (Homoptera: Coccoidea: Margarodidae) from South Africa. *Phytophylactica 14:* 61–76.

Dumbleton, L.J. 1967: A note on the genus *Ultracoelostoma* Cockerell (Homoptera: Margarodidae). *New Zealand entomologist 3(5):* 39–40.

Ebeling, W. 1950: Subtropical entomology. San Francisco, folio edition. 747 p.

——— 1956: Subtropical fruit pests. Los Angeles, University of California. 436 p.

Emms, L.M. 1985: The scale insect genus *Leucaspis* in the Christchurch / Banks Peninsula area. New Zealand Diploma of Science dissertation, Christchurch Polytechnic, New Zealand.

Fernald, M.E. 1903: A catalogue of the Coccidae of the world. Amherst, Massachusetts, Carpenter & Moorehouse. 360 p.

Ferris, G.F. 1917: A new genus and species of Coccidae. *Canadian entomologist 49:* 375–378.

——— 1957: A brief history of the study of the Coccoidea. *Microentomology 22(2):* 39-57.

Gaze, P.D.; Clout, M.N. 1983: Honeydew and its importance to birds in beech forests of the South Island, New Zealand. *N.Z. journal of ecology 6:* 33–37.

Gennardius, P. 1883: Déscriptions de trois nouvelles éspèces de cochinelles. *Annales de la Société Entomologique de France (sér. 6) 3:* 31–32.

Gerson, U. 1980: Wax filaments on coccid eggs. *Israel journal of entomology 14:* 81–85.

Ghauri, M.S.K. 1962: The morphology and taxonomy of male scale insects (Homoptera: Coccoidea). London, British Museum (Natural History). 221 p.

Giliomee, J.H. 1967: Morphology and taxonomy of adult males of the family Coccidae (Homoptera: Coccoidea). *Bulletin of the British Museum (Natural History), entomology supplement 7.* 168 p.

——— 1968: Morphology and relationships of the male of an *Asterolecanium* species (Homoptera: Coccoidea: Asterolecaniidae). *Journal of the Entomological Society of South Africa 31:* 297–308.

Gonzalez, R.H.; Kido, H.; Marin, A.; Hughes, P. 1969: Biologia y ensayos preliminares de control del margarodes de la vid, *Margarodes vitis* (Philippi). *Agricultura technica (Chile) 29:* 93–122.

Green, E.E. 1929: Some Coccidae collected by Dr J.G. Myers in New Zealand. *Bulletin of entomological research 19(4):* 372.

Guilding, L. 1829: An account of *Margarodes*, a new species of insects found in the neighbourhood of ant's nests. *Transactions of the Linnean Society of London 16:* 115–119.

Hempel, A. 1932: Descripcão de vinte e duas especies novas de coccideos (Hemiptera: Homoptera). *Revista de entomologia 2:* 301–339.

Hennig, W. 1966: Phylogenetic systematics. Urbana, University of Illinois Press. 263 p.

——— 1981: Insect phylogeny. Toronto, Chichester. 514 p.

Hill, M.G. 1980: Wind dispersal of the coccid *Icerya seychellarum* (Margarodidae: Homoptera) on Aldabra atoll. *Journal of animal ecology 49:* 939–957.

Howell, J.O. 1984: Review of recent studies on the utilisation of the immatures in the classification and phylogeny of scale insects. Pp. 328–330 *in:* Proceedings of the 10th International Symposium of Central European Entomofaunistics (SIEEC), Budapest, Hungary, August 1983.

Hoy, J. M. 1962: Eriococcidae of New Zealand. *New Zealand Department of Scientific and Industrial Research bulletin 146.* 219 p.

Hughes-Schrader, S. 1925: Cytology of hermaphrodism in *Icerya purchasi* (Coccidae). *Zeitschrift für Zellforschung und Mikroskopische Anatomie 2:* 264–292.

——— 1948: Cytology of coccids (Coccoidea: Homoptera). *Advances in genetics 2:* 127–203.

Jenkins, K.D. 1970: The fat-yielding coccid *Llaveia*, a monophlebine of the Margarodidae. *Pan-Pacific entomologist 46(1):* 79–81.

Kosztarab, M.; Kozar, F. 1988: Scale insects of Central Europe. Akademiai Kiado, Budapest, Hungary. 427 p.

Kosztarab, M.; O'Brien, L.B.; Stoetzel, M.B.; Deitz, L.L.; Freytag, P.H. 1990: Problems and needs in the study of Homoptera in North America. Pp. 119–149 in M. Kosztarab & C.W. Schaeffer (eds), Systematics of the North American Insects and arachnids – status and needs. Virginia Agricultural Experiment Station information series 90-1. Blacksburg, Virginia Polytechnic Institute and State University.

Koteja, J. 1974: On the phylogeny and classification of the scale insects (Homoptera, Coccinea). [Discussion based on the morphology of the mouthparts.] *Acta biologica Cracoviensia, ser. zool. 22:* 73–88.

——— 1985: Essay on the prehistory of scale insects (Homoptera, Coccinea). *Annales zoologici, Warsaw, 38:* 461–503.

——— 1988: *Baisococcus victoriae* gen. et sp. n., a Lower Cretaceous coccid. *Acta zoologica Cracoviensia 32:* 93–106.

Lambin, P.L.; Kasztarab, M. 1976: The genus *Solenophora* and its type species (Homoptera: Coccoidea: Cerococcidae). *Virginia Polytechnic Institute and State University Research Division bulletin 111:* 33–41.

Lepage, H.S. 1938: Catalogo dos Coccideos do Brasil. *Revista do Museu Paulista 23:* 327–491.

McClure, M.S. 1983: Population dynamics of a pernicious parasite; density-dependent vitality of red pine scale. *Ecology 64:* 710–718.

MacGillivray, A.D. 1921: The Coccidae. Urbana, Illinois, Scarab. 502 p.

McKenzie, H.L. 1967: Mealybugs of California with taxonomy, biology, and control of the North American species (Homoptera: Coccoidea: Pseudococcidae). Berkeley, University of California Press. 526 p.

Maskell, W.M. 1879: On some Coccidae in New Zealand. *Transactions and proceedings of the New Zealand Institute 11:* 187–228.

——— 1880: Further notes on New Zealand Coccidae. *Transactions and proceedings of the New Zealand Institute 12:* 291–301.

——— 1884: Further notes on Coccidae in New Zealand with descriptions of new species. *Transactions and proceedings of the New Zealand Institute 16:* 120–144.

——— 1887: Further notes on New Zealand Coccidae. *Transactions and proceedings of the New Zealand Institute 19:* 45–49.

——— 1890: Further notes on New Zealand Coccidae, with descriptions of new species from Australia, Fiji and New Zealand. *Transactions and proceedings of the New Zealand Institute 22:* 133–156.

———1891: Further coccid notes, with descriptions of new species from New Zealand, Australia and Fiji. *Transactions and proceedings of the New Zealand Institute 23:* 1–36.

——— 1892: Further coccid notes, with descriptions of new species and remarks on Coccidae from New Zealand, Australia and elsewhere. *Transactions and proceedings of the New Zealand Institute 24:* 1–64.

——— 1897: Further coccid notes, with descriptions of new species and discussion of points of interest. *Transactions and proceedings of the New Zealand Institute 29:* 293–331.

Miller, D.R. 1984: Phylogeny and classification of the Margarodidae and related groups (Homoptera: Coccoidea). Pp. 321–324 *in:* Proceedings of the 10th International Symposium of Central European Entomofaunistics (SIEEC), Budapest, Hungary, August 1983.

Miller, D.R.; Kosztarab, M. 1979: Recent advances in the study of scale insects. *Annual review of entomology 24:* 1-27.

Moller, H.; Tilley, J. 1987: Honeydew, a South Island beech forest resource. *Alpha 58*. Wellington, DSIR Publishing.

Morales, C.F. 1989: *Icerya purchasi* Maskell (Homoptera: Coccoidea: Margarodidae). Cottony cushion scale. *In:* Cameron, P.J. *et al.* (eds), A review of biological control of invertebrate pests and weeds in New Zealand, 1874 to 1987. Wallingford, U.K., CAB International. 415 p.

——— 1990: The taxonomic revision of the New Zealand Margarodidae with studies of the life history and biology of two species. Unpubl. PhD thesis, Imperial College of Science and Technology, University of London.

——— (in press): Towards a cladistic analysis of the Margarodidae. Poster paper *in:* Proceedings, 6th International Symposium of Scale Insect Studies, Cracow, Poland, 6–12 August 1990, vol. 2.

Morales, C.F.; Hill, R.L. 1990: *Vedalia:* the New Zealand connection. Poster paper. Pp. 129–130 *in:* Proceedings, 6th International Symposium of Scale Insect Studies, Cracow, Poland, 6–12 August 1990, vol. 1.

Morales, C.F.; Hill, M.G.; Walker, A.K.W. 1988: Life history of the sooty beech scale (*Ultracoelostoma assimile*) (Maskell) (Hemiptera, Margarodidae) in New Zealand *Nothofagus* forests. *New Zealand entomologist 11:* 24–37.

Morrison, H. 1927: Descriptions of new genera and species belonging to the coccid family Margarodidae. *Proceedings of the Biological Society of Washington 40:* 99–110.

———1928: A classification of the higher groups and genera of the coccid family Margarodidae. *USDA technical bulletin 52*. 239 p.

Morrison, H.; Morrison, E. 1922: A redescription of the type species of the genera of Coccidae based on species originally described by Maskell. *Proceedings of the U.S. National Museum 60(12)*. 120 p.

——— 1923: The scale insects of the subfamilies Monophlebinae and Margarodinae treated by Maskell. *Proceedings of the U.S. National Museum 62 (17)*. 47 p.

——— 1927: The Maskell species of scale insects of the subfamily Asterolecaniidae. *U.S. National Museum proceedings 71, article 17 (no. 2689)*. 67 p.

Myers, J. G. 1922: A synoptic list of New Zealand Coccidae. *N.Z. journal of science and technology 5:* 196–201.

Nur, U. 1980: Evolution of unusual chromosome systems in scale insects (Coccoidea: Homoptera). *In:* Blackman, R.L. *et al.* (eds), Insect cytogenetics. Oxford, U.K., Blackwell Scientific Publications.

Obenburger, S. 1957: Entomologie III. Systematicka xix. Rad. Homoptera. *Nakladatelstvi Ceskoslovenska Akademii ved Praha:* 344–439.

Oliver, O.M. 1975: A study of the structure and function of the external morphology of *Ultracoelostoma assimile* (Maskell) (Homoptera; Coccoidea), associated with *Nothofagus solandri*. Unpubl. B.Sc. (Hons) project, Victoria University of Wellington, New Zealand.

Pesson, P. 1939: Une glande exsertile ventrale chez les coccides. *Bulletin de la Société Zoologique de France 64:* 144–152.

Quayoom, M.A.; Khan, M.R. 1974: Studies on tribal affinities within the Archaeococcoidea. *Pakistan journal of agricultural science 11:* 148–161.

Reid, G.M. 1978: Some aspects of honeydew production in other countries. MAF Honeydew Seminar, 10 August 1978. Christchurch, New Zealand, MAF Advisory Service.

Robison, W.G. 1977: Ultrastructure of Coccoidea sperm. Proceedings of symposium 'Recent advances in the study of scale insects'. XVth International Congress of Entomology, Washington, D.C., U.S.A., 11–27 August 1976. No. 9 *in:* Morphology and systematics of scale insects. *Research Division bulletin 177*, Virginia Polytechnic and State University, Blacksburg, Va.

Russell, L.M. 1941: A classification of the scale insect genus *Asterolecanium*. *USDA miscellaneous publications 424*. 319 p.

Saakyan-Baranova, A.A.; Dergunova, Z.R. 1978: A comparative morphological study of *Lepidosaphes mesasiatica* and *L. ulmi* (Homoptera: Coccoidea) and their parasites. *Entomological review 57 (1):* 1–16.

Santas, L.A. 1983: Insects producing honeydew exploited by bees in Greece. *Apidologie 14(2):* 93–103.

Scott, R.R. (ed.)1984: New Zealand pests and beneficial insects. Lincoln University College of Agriculture, New Zealand.

Schlee, D. 1969: Die Verwandtschaftbeziehungen innerhalb der Sternorrhyncha aufgrund synapomorpher Merkmale. Phylogenetische Studien an Hemiptera. II. Aphidiformes als monophyletische Gruppe. *Stuttgarter Beiträge zur Naturkunde aus dem Staatlichen Museum für Naturkunde in Stuttgart 199:* 1–19.

Signoret, V. 1875: Lectures. *Bulletin de la Société Entomologique de France, 1874 (5ᵉ série) 4:* cclvii–cclviii.

Silvestri, F. 1939: Fam. Coccidae. Pp. 618–860 *in:* Compendio di Entomologia Applicata, parte speciale 1(2).

Stoetzel, M.; Davidson J. A. 1974: Biology and morphology of immature stages of nine species in the Aspidiotini (Homoptera: Diaspididae). *Annals of the Entomological Society of America 67(3):* 475–509.

Takagi, S. 1969: Diaspididae of Taiwan based on material collected in connection with the Japan–U.S. co-operative science program, 1965. *Insecta Matsumurana 32:*1–110.

Taylor, R.H. 1985: Status, habits and conservation of *Cyanorhamphus* parakeets in the New Zealand region. *International Council for Bird Preservation, technical publication no. 3:* 195–211.

Theron, J.G. 1958: Comparative studies on the morphology of male scale insects (Hemiptera: Coccoidea). *Annals of the University of Stellenbosch 34 (A1):* 1–71.

Thompson, W.R. 1950: Section I, Parasite/host catalogue; Part 3, Parasites of the Hemiptera, *in* A catalogue of the parasites and predators of invertebrate pests, 2nd edn. Ottawa, CIBC. 149 p.

Westwood, J.O. 1855: The Seychelles Dorthesia. *Gardeners' Chronicle, 1855:* 836.

Wigglesworth, V.B. 1972: The life of insects. London, Weidenfeld & Nicholson. 360 p.

Wight, R.A. 1890: *Icerya* and *Vedalia* in New Zealand. *Insect life: USDA bulletin 3(1):* 395.

Williams, D.J.; de Boer, J.A. 1973: The taxonomy of some New Zealand Pseudococcidae (Homoptera: Coccoidea). *Transactions of the Royal Entomological Society of London 125(2):* 227–252.

Williams, D.S.; Watson, G.W. 1990: The scale insects of the tropical South Pacific, part 3. Wallingford, Oxon., U.K., CAB International.

Willis, J.C. 1955: A dictionary of the flowering plants and ferns. Cambridge University Press. 1245 p.

Wise, K.A.J. 1977: A synoptic checklist of the Hexapoda of the New Zealand sub-region. The smaller orders. *Auckland Institute and Museum bulletin 11*. 176 p.

ILLUSTRATIONS

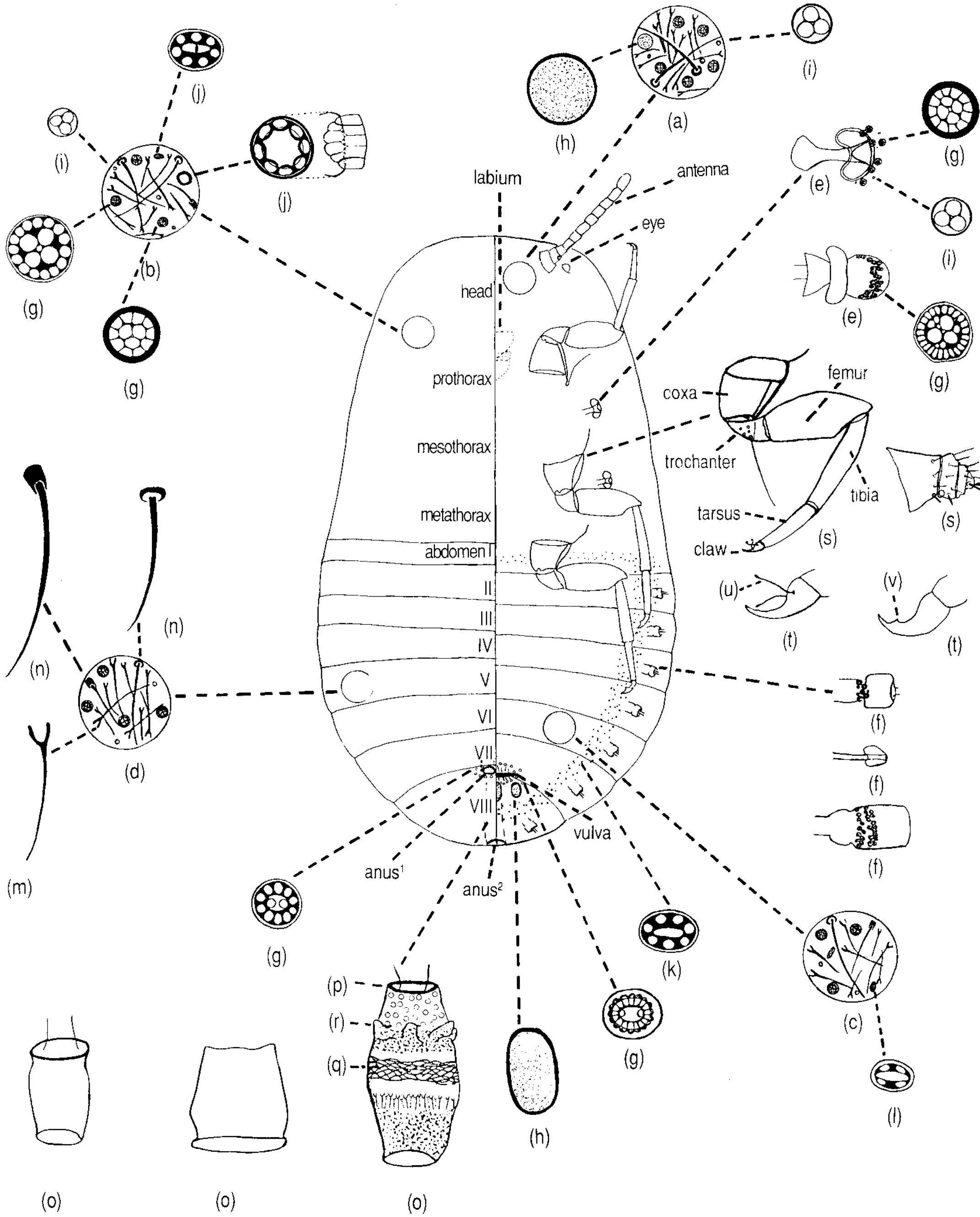


Fig. 1 Adult female margarodid: (a,b) head derm, venter and dorsum; (c,d) abdominal derm, venter and dorsum; (e,f) spiracles, thoracic and abdominal; (g) complex disc pore; (h) cicatrix; (i) minute pore; (j) open-centred pore; (k) ovisac pore; (l) small pore; (m) derm hair; (n) seta; (o) anal tube; (p) chitinised ring; (q) thickening; (r) lobes; (s) leg; (t) claw; (u) digitules; (v) denticle. Anus[1,2]: alternate positions.

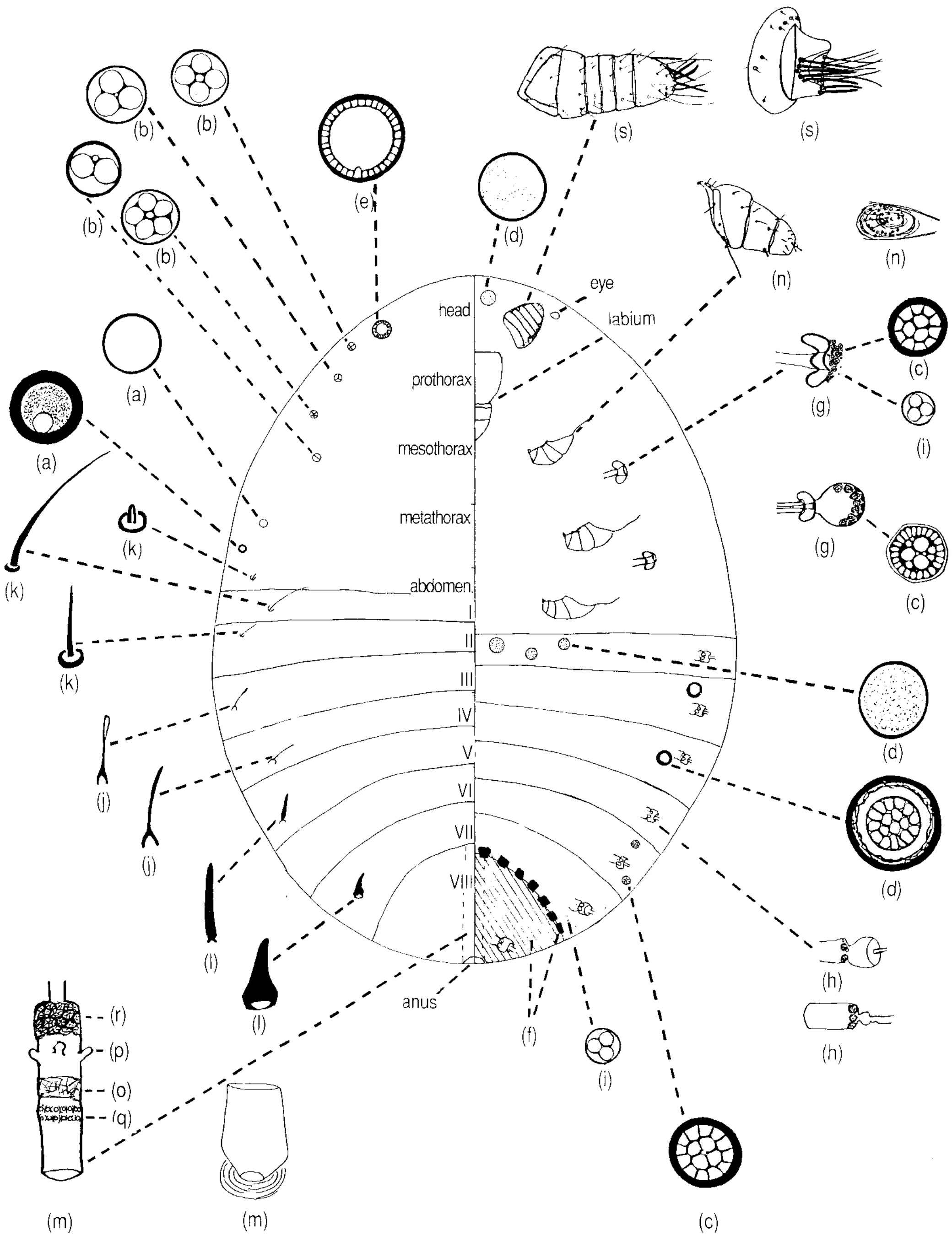


Fig. 2 Intermediate female margarodid: (a) simple pore; (b,c) disc pores, simple and complex; (d) cicatrix; (e) open-centred pore; (f) sclerotisation; (g,h) spiracles, thoracic and abdominal; (i) minute pore; (j) derm hair; (k) seta; (l) modified spine; (m) anal tube; (n) leg; (o) thickening; (p) lobe; (q) medial pores; (r) pores at inner end; (s) antenna.

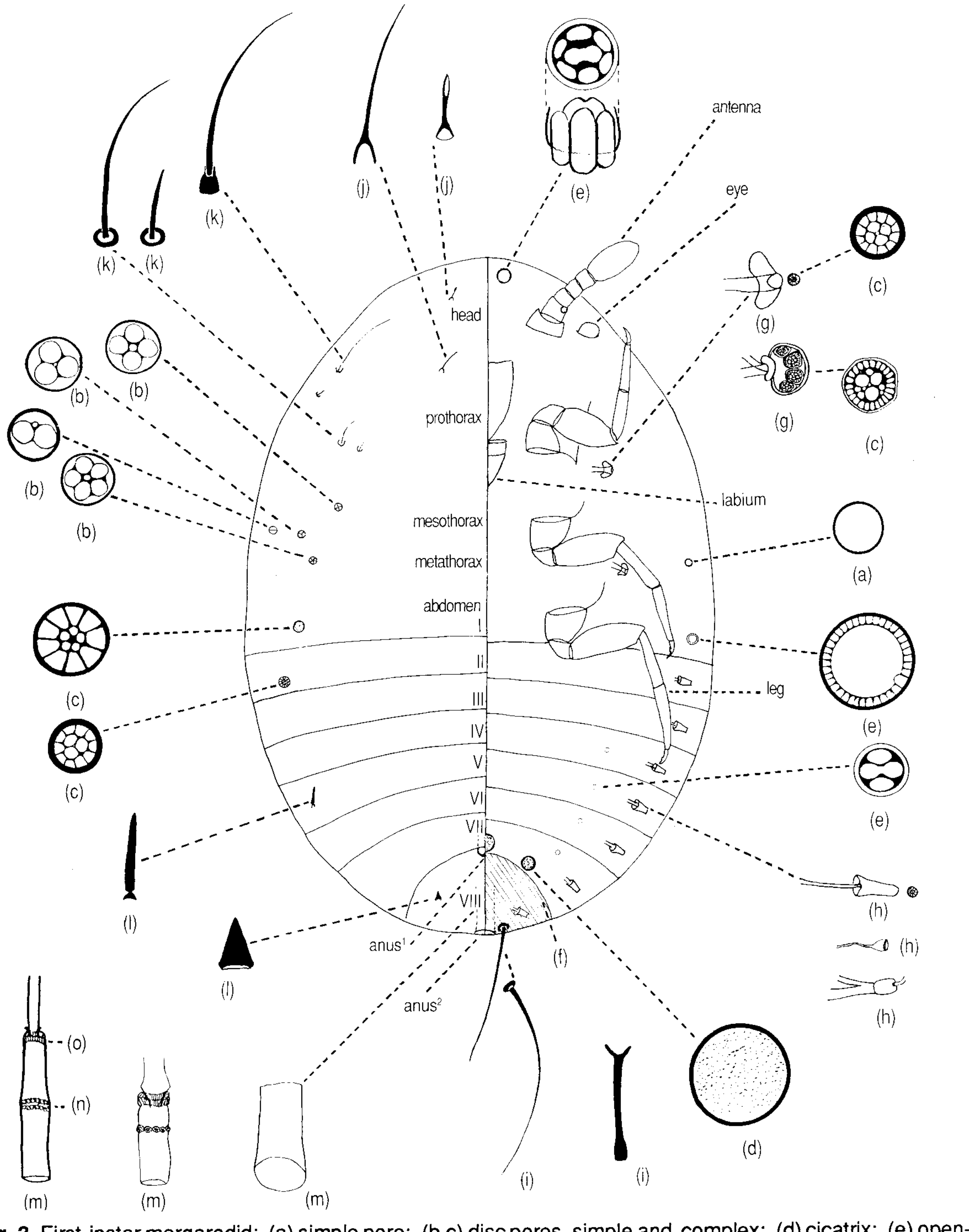


Fig. 3 First-instar margarodid: (a) simple pore; (b,c) disc pores, simple and complex; (d) cicatrix; (e) open-centred pore; (f) sclerotisation; (g,h) spiracles, thoracic and abdominal; (i) caudal seta; (j) derm hair; (k) seta; (l) modified spine; (m) anal tube; (n) medial row of pores; (o) pores at inner end of anal tube. Anus[1,2]: alternate positions.

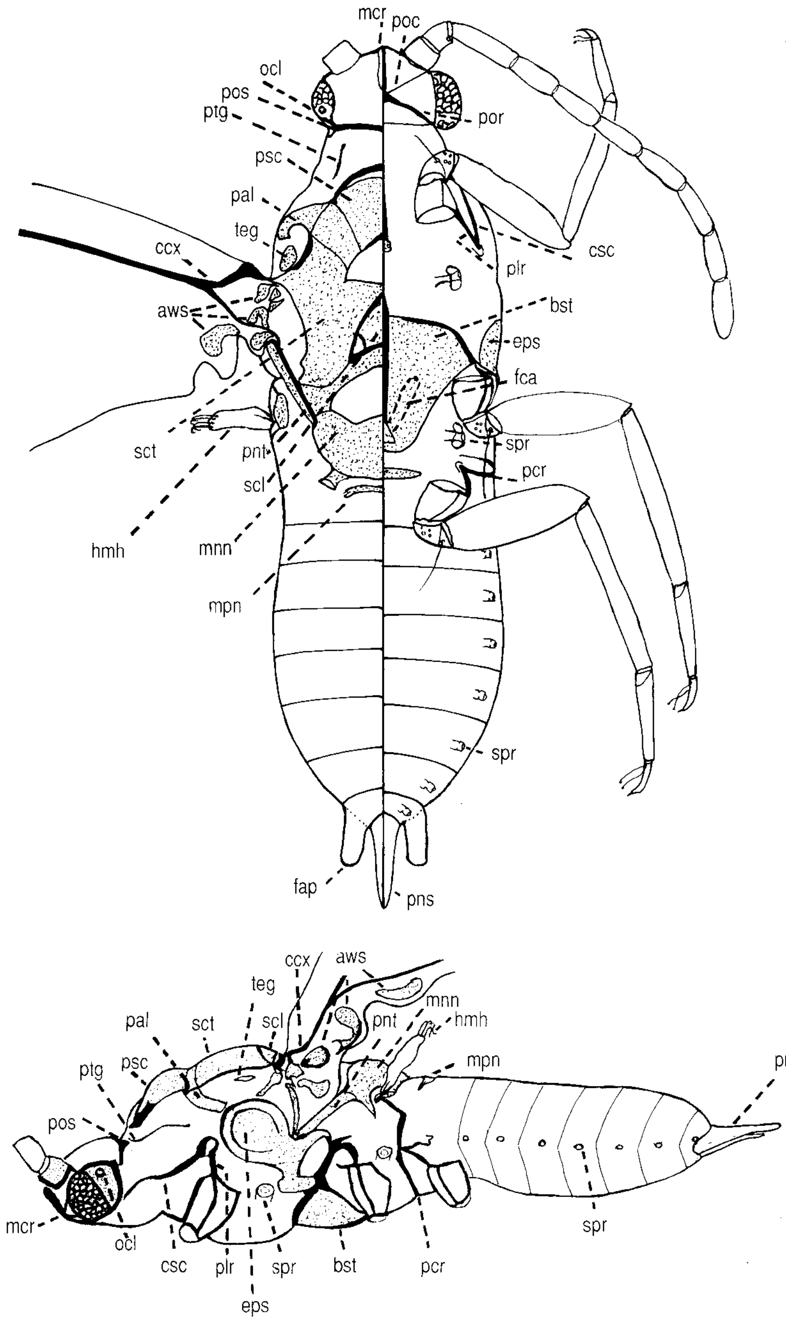


Fig. 4 Adult male margarodid: aws, axillary wing sclerotisation; bst, basisternum; ccx, costal complex; csc, cervical sclerite; eps, episternum; fap, fleshy abdominal protuberance; fca, furca; hmh, hamulohaltere; mcr, mid-cranial ridge; mnn, mesopostnotum; mpn, metapostnotum; ocl, ocellus; pal, prealare; pcr, precoxal ridge; plr, pleural ridge; pns, penis sheath; pnt, postnotum, lateral extension; poc, pre-ocular ridge; por, pre-oral ridge; pos, post-occipital suture; psc, prescutum; ptg, post-tergite; scl, scutellum; sct, scutum; spr, spiracle; teg, tegula.

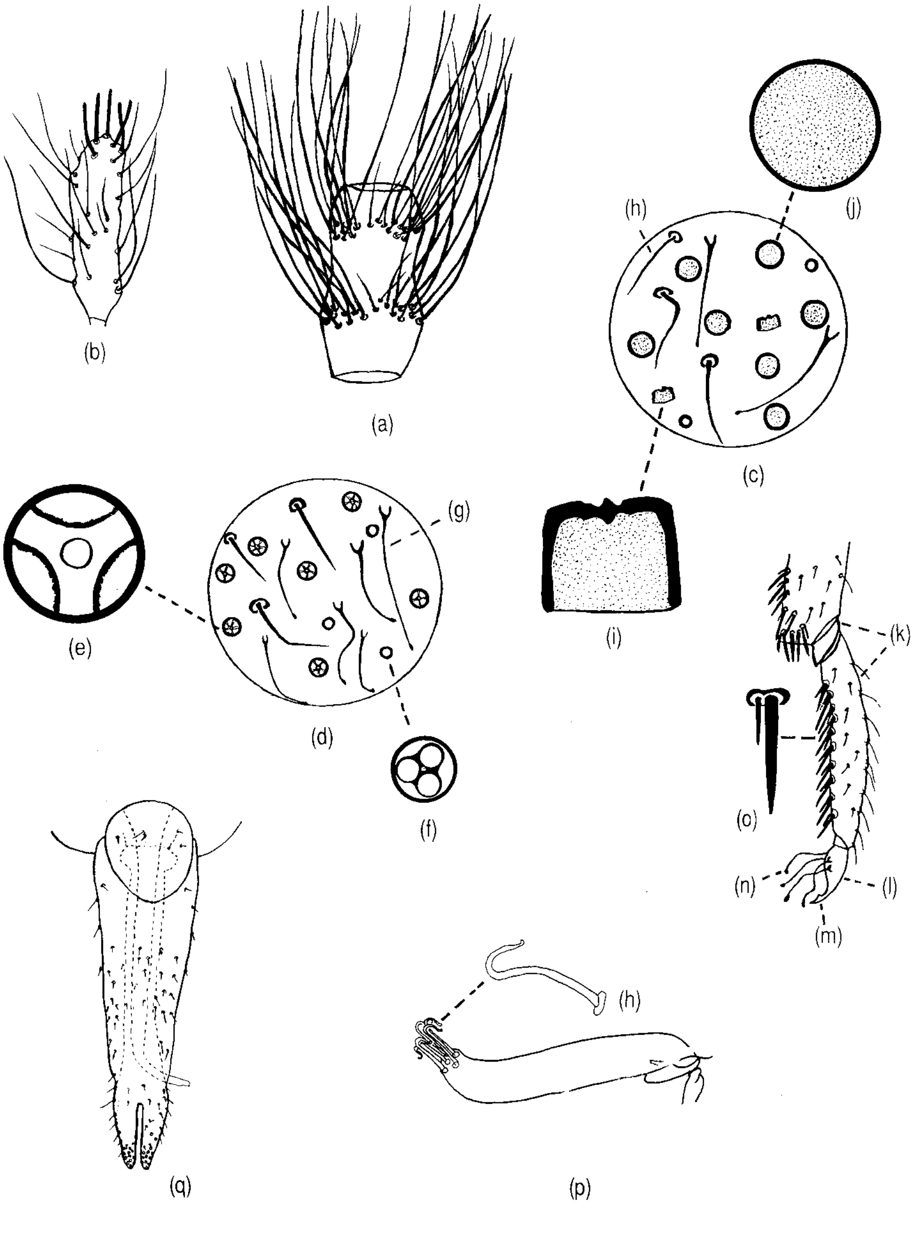


Fig. 5 Adult male margarodid, details: (a,b) antennal segments, binodose with setae in whorls, and apical with thickened setae; (c,d) abdominal derm, venter and dorsum; (e) disc pore; (f) minute pore; (g) derm hair; (h) seta; (i) cylindrical tubercle; (j) cicatrix; (k) tarsal segments; (l) claw; (m) denticle; (n) digitule; (o) bifurcate seta; (p) hamulohaltere; (q) penis sheath.

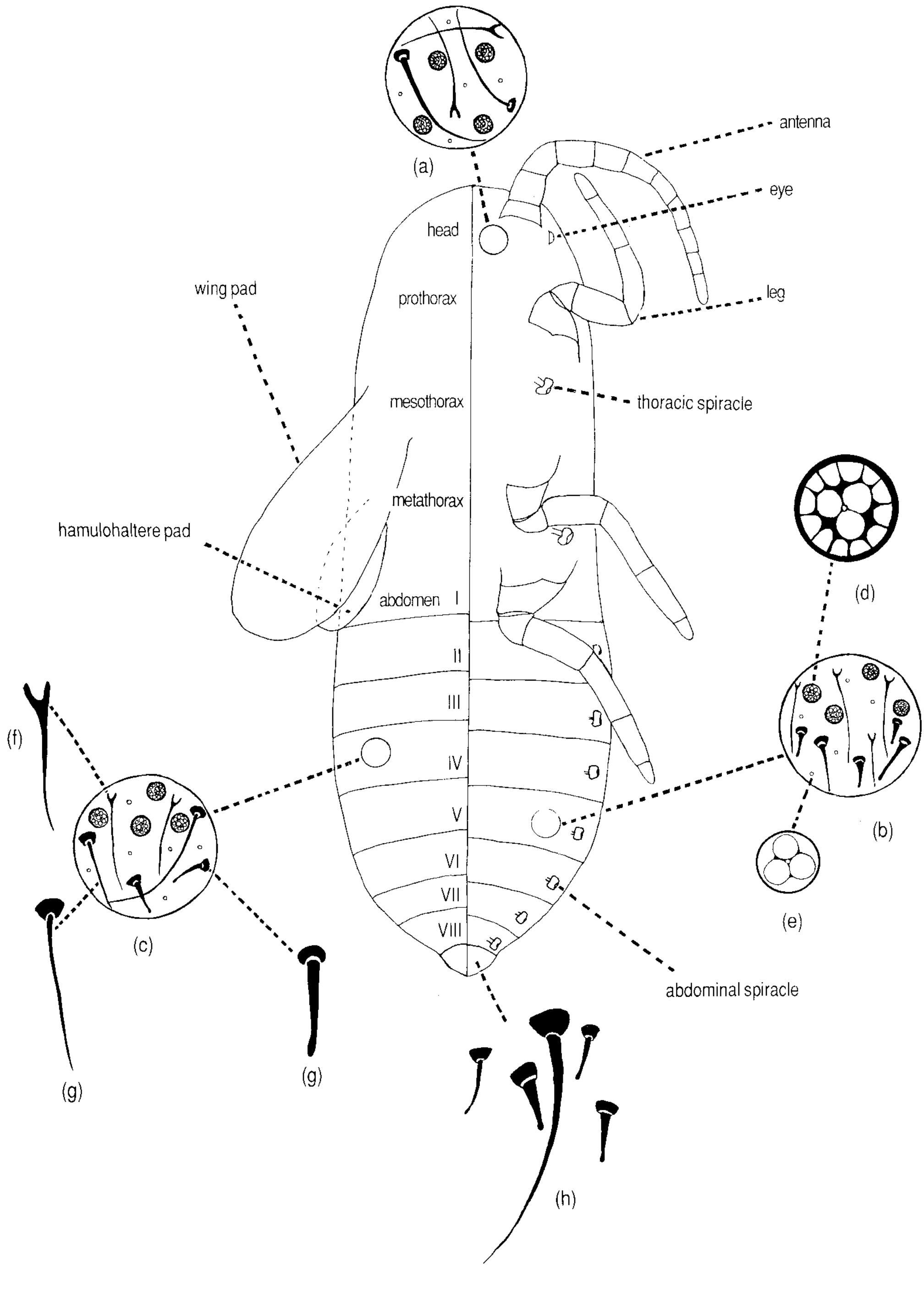


Fig. 6 Margarodid pupa: (a) head derm, venter; (b,c) abdominal derm, venter and dorsum; (d) complex disc pore; (e) minute pore; (f) derm hair; (g) seta; (h) anal lobe setae.

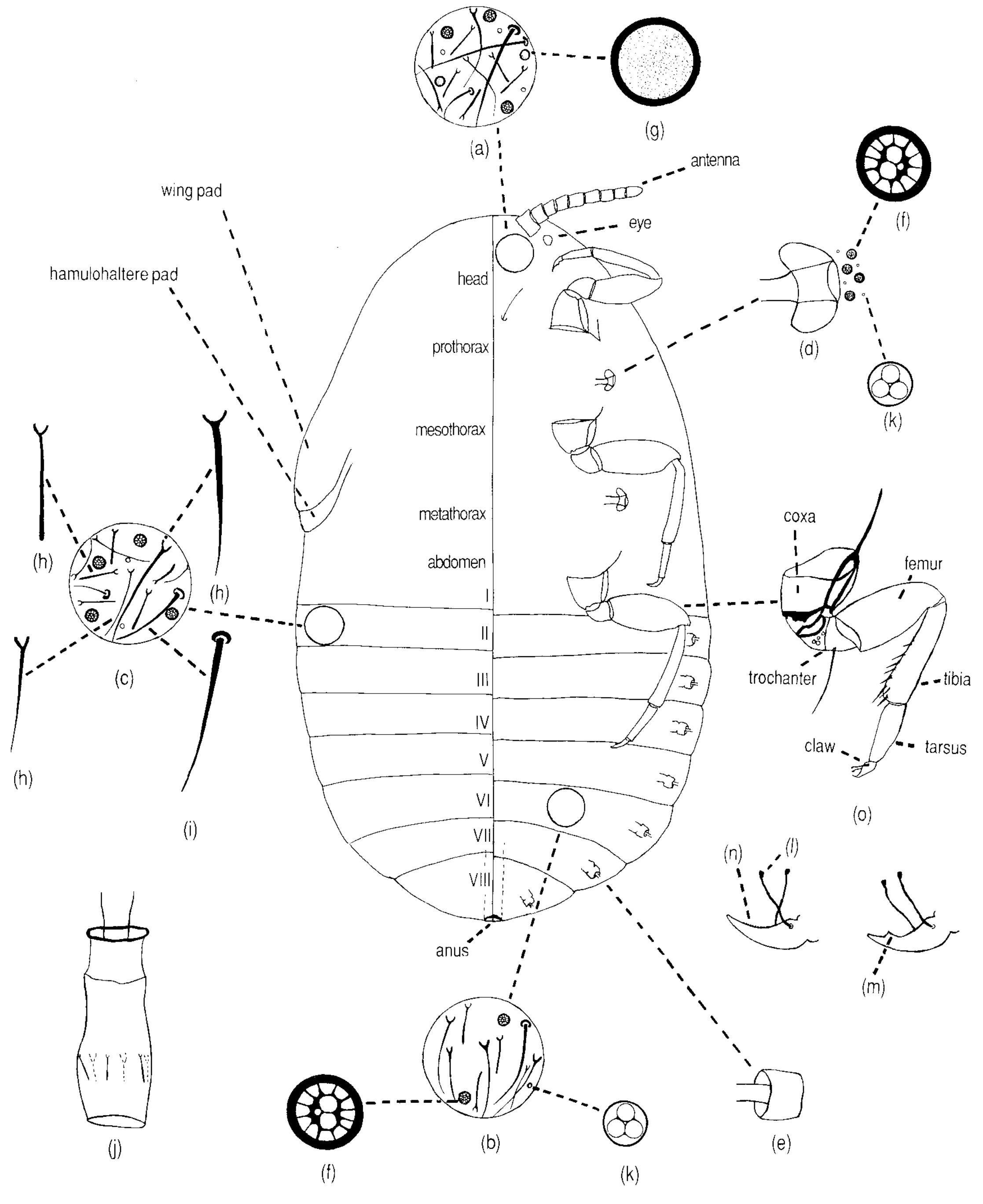


Fig. 7 Margarodid prepupa: (a) head derm, venter; (b,c) abdominal derm, venter and dorsum; (d,e) spiracles, thoracic and abdominal; (f) complex disc pore; (g) cicatrix; (h) derm hair; (i) seta; (j) anal tube; (k) minute pore; (l) claw digitule; (m) claw denticle; (n) claw serrations; (o) leg.

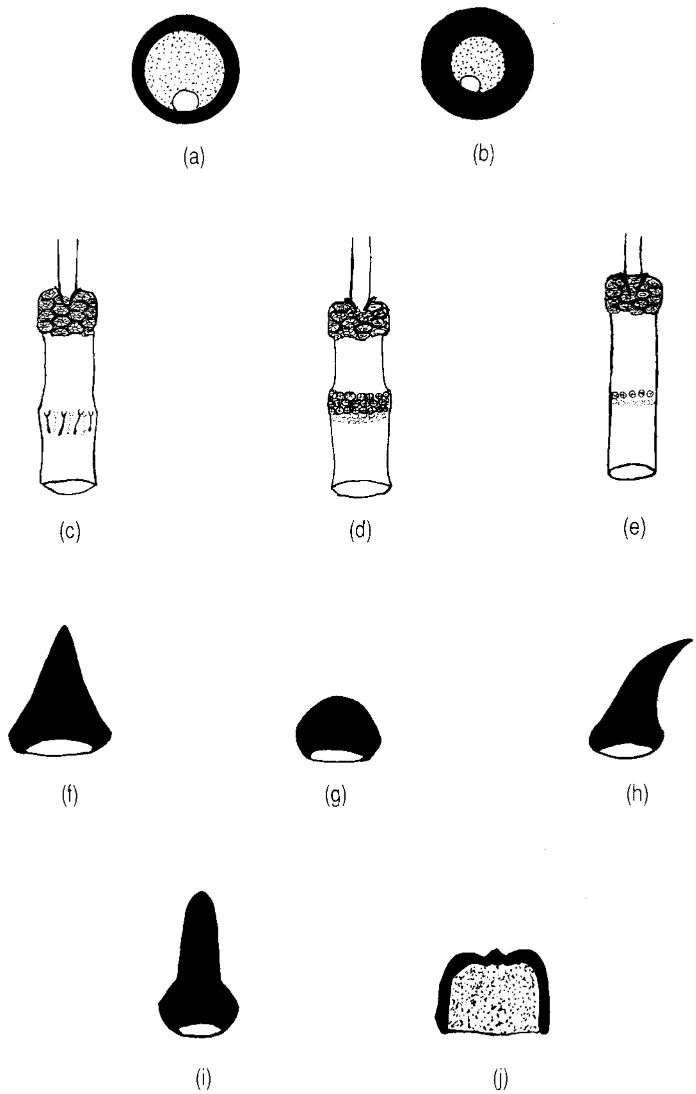


Fig. 8 Margarodid dermal structures and anal tubes: (a,b) cicatrices with open and closed centre; (c–e) anal tube with clavate derm hairs, with band of pores, and with row of pores; (f–i) modified spines – conical, dome-like, with curved tip, and with rounded tip; (j) cylindrical tubercle.

Fig. 1–8 Generalised morphology of life stages of Margarodidae, dorsum / venter and detail of structures.

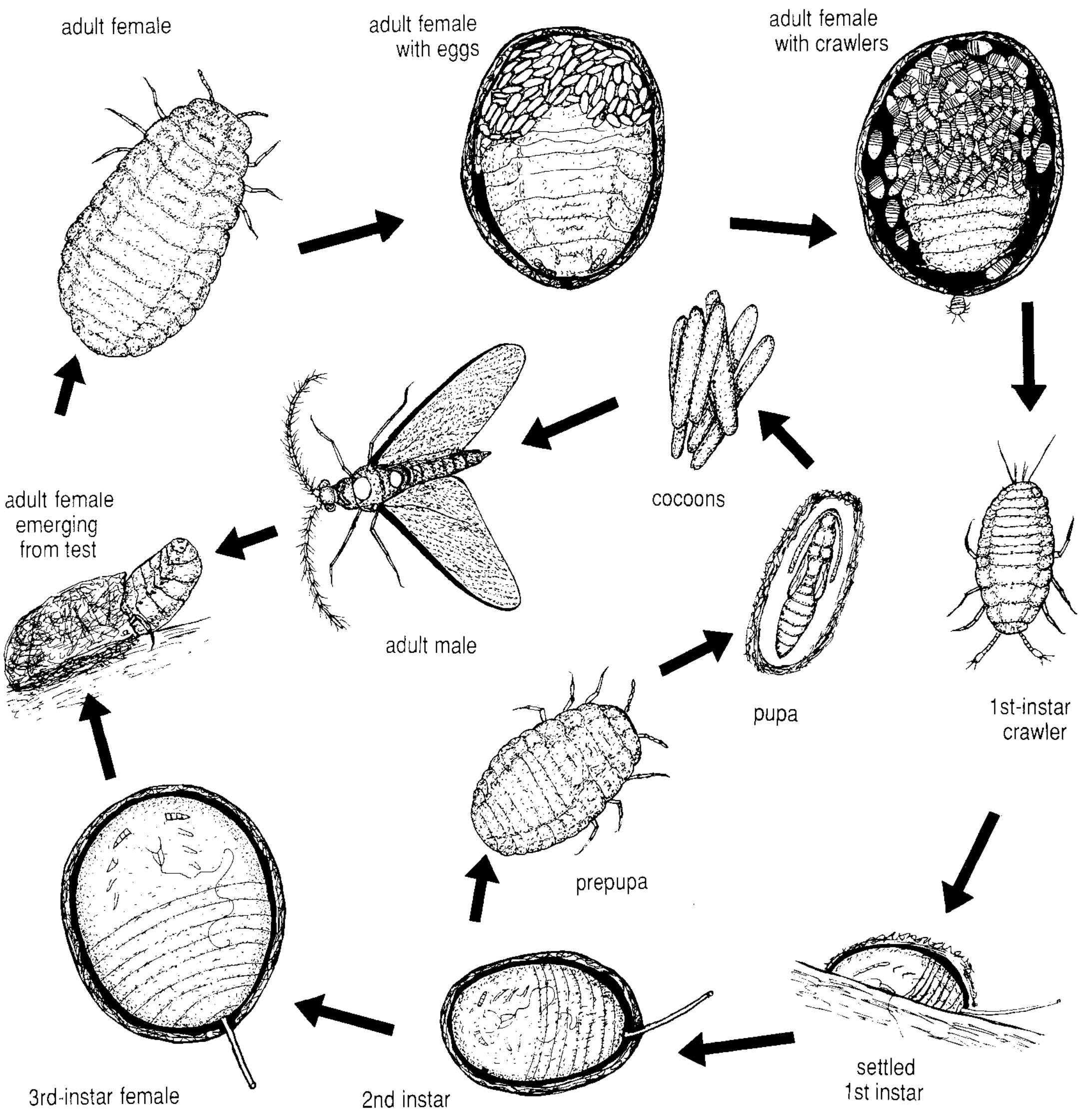


Fig. 9 Life history of *Coelostomidia wairoensis*.

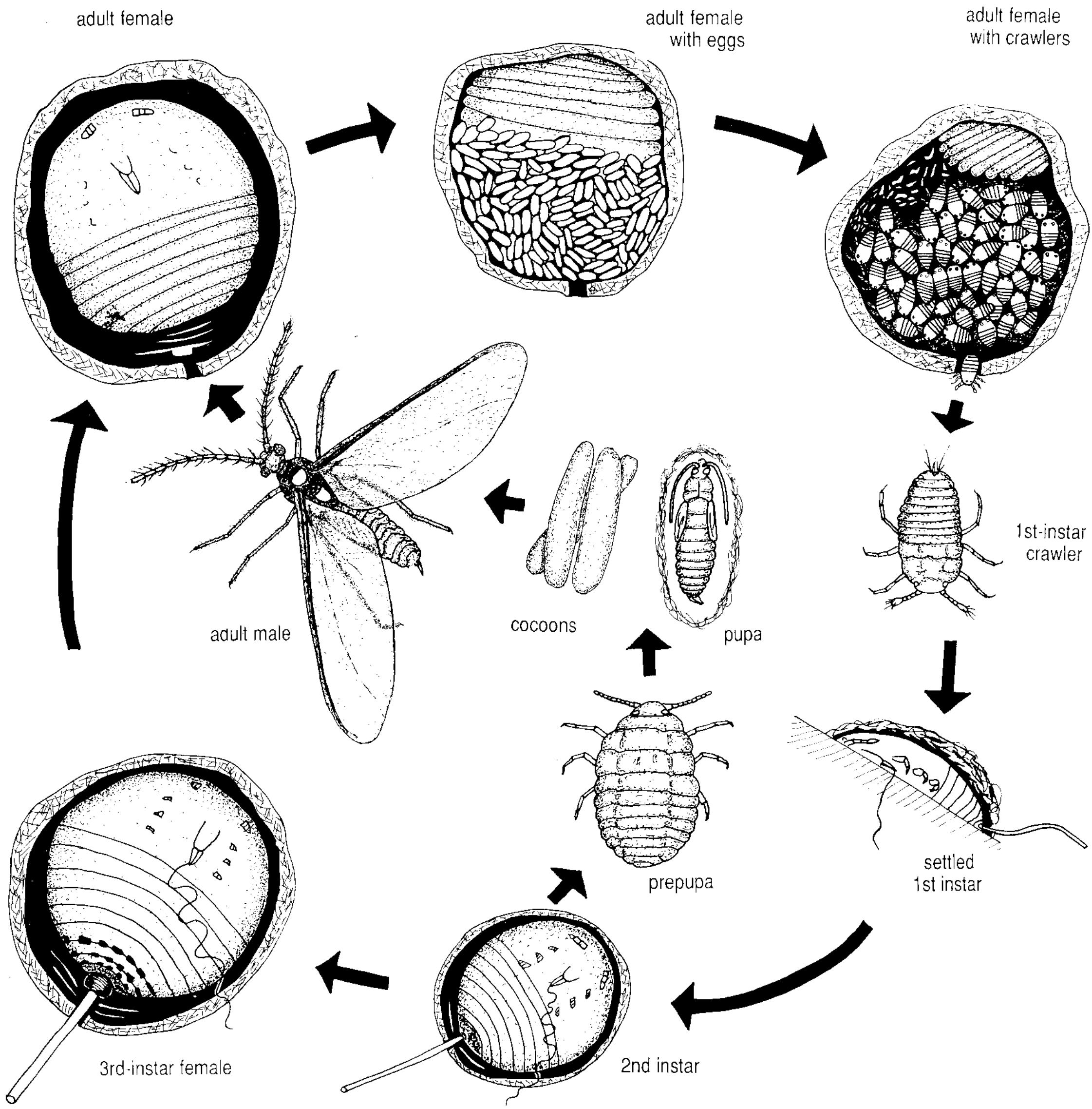


Fig. 10 Life history of *Ultracoelostoma assimile*.

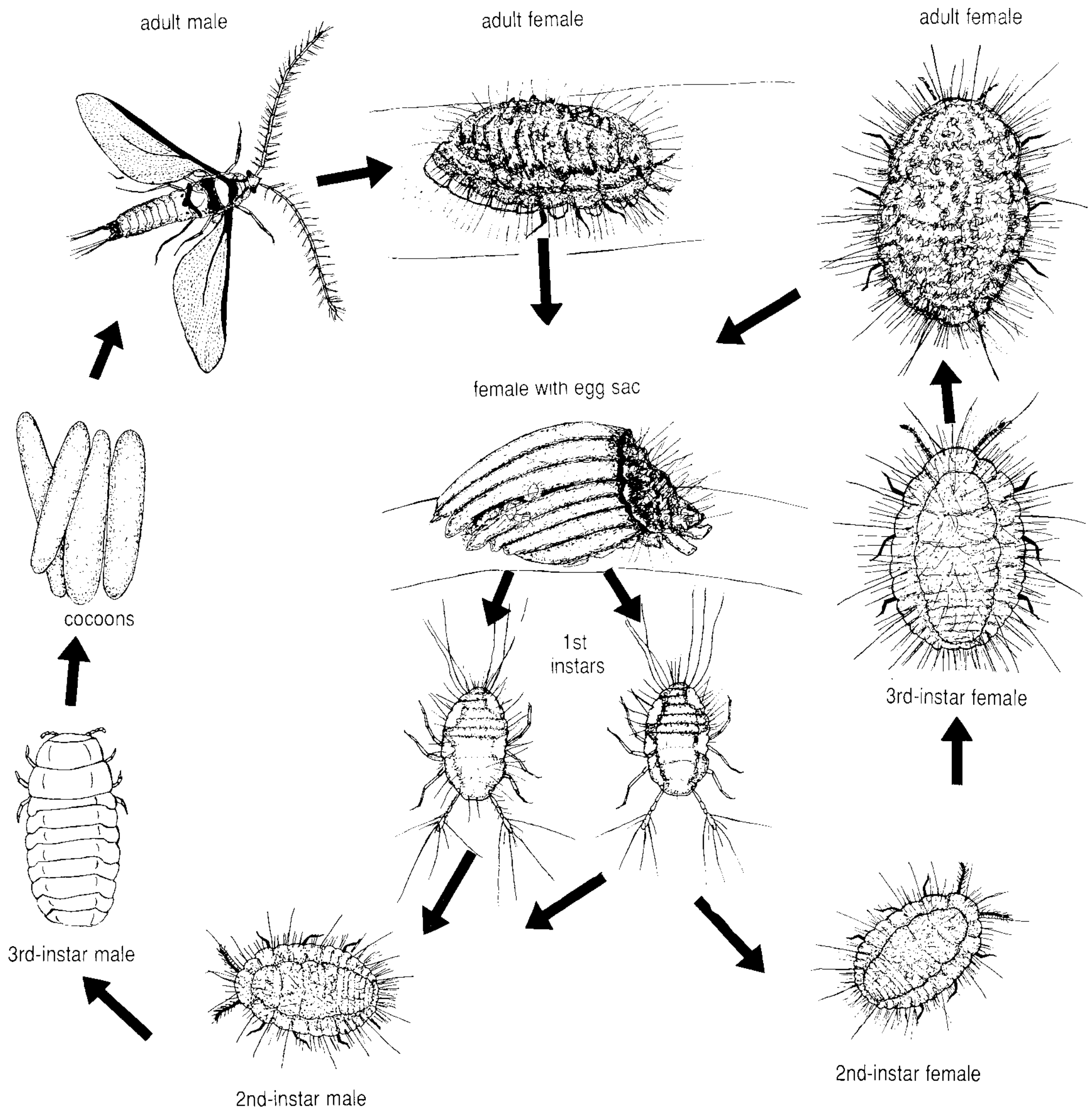


Fig. 11 Life history of *Icerya purchasi.*

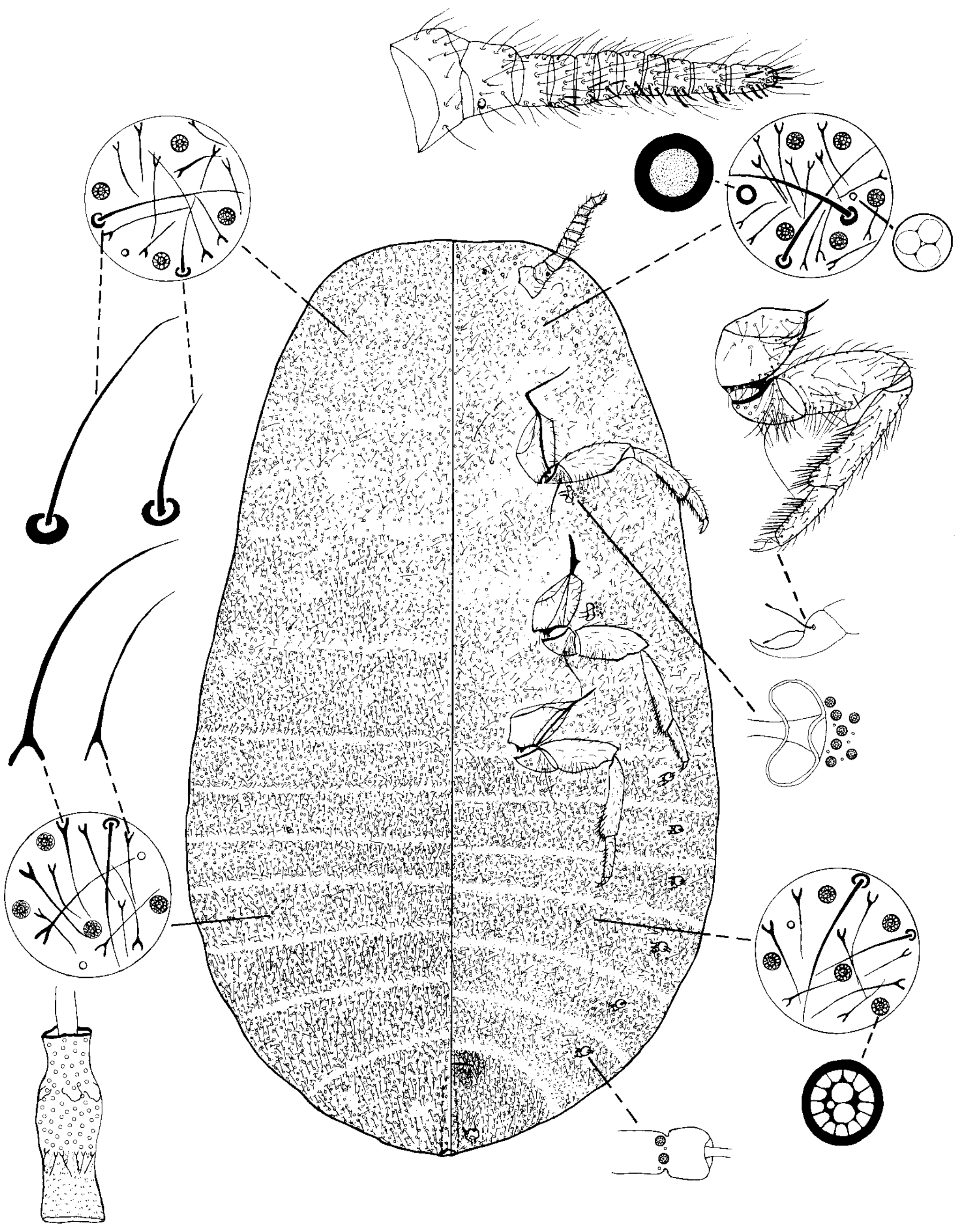


Fig. 12 *Coelostomidia deboerae*, adult female.

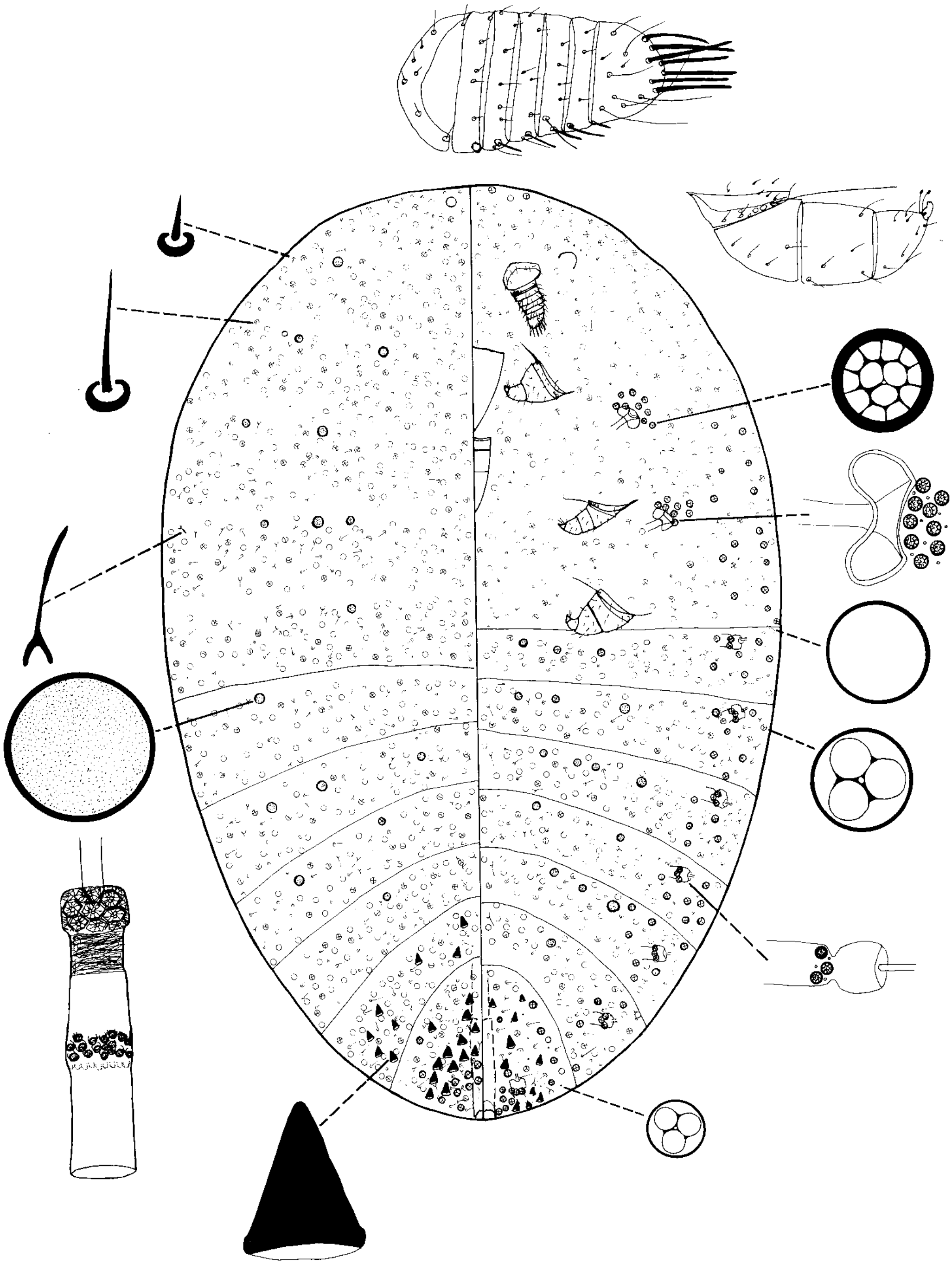


Fig. 13 *Coelostomidia deboerae*, 2nd-instar female.

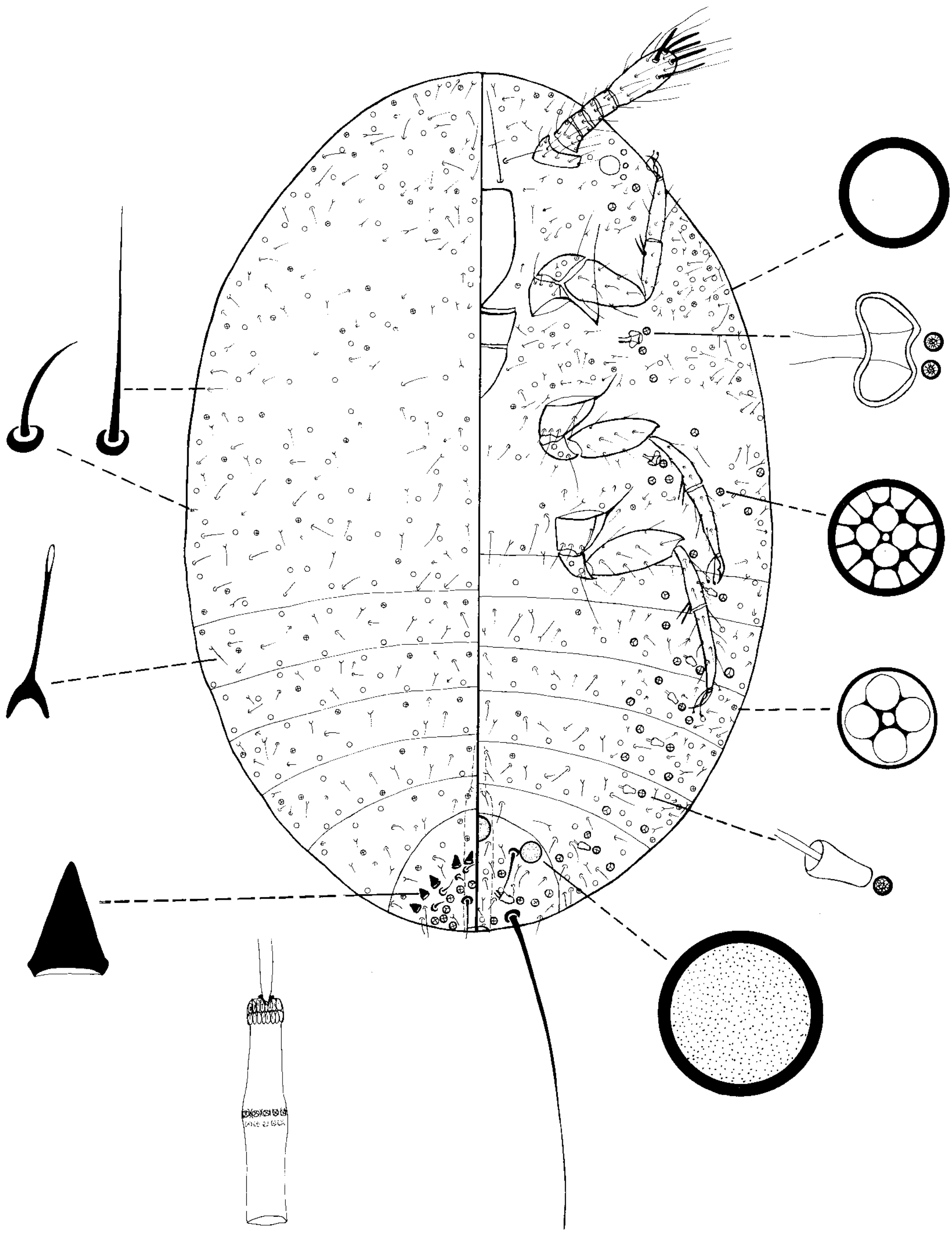


Fig. 14 *Coelostomidia deboerae*, 1st instar.

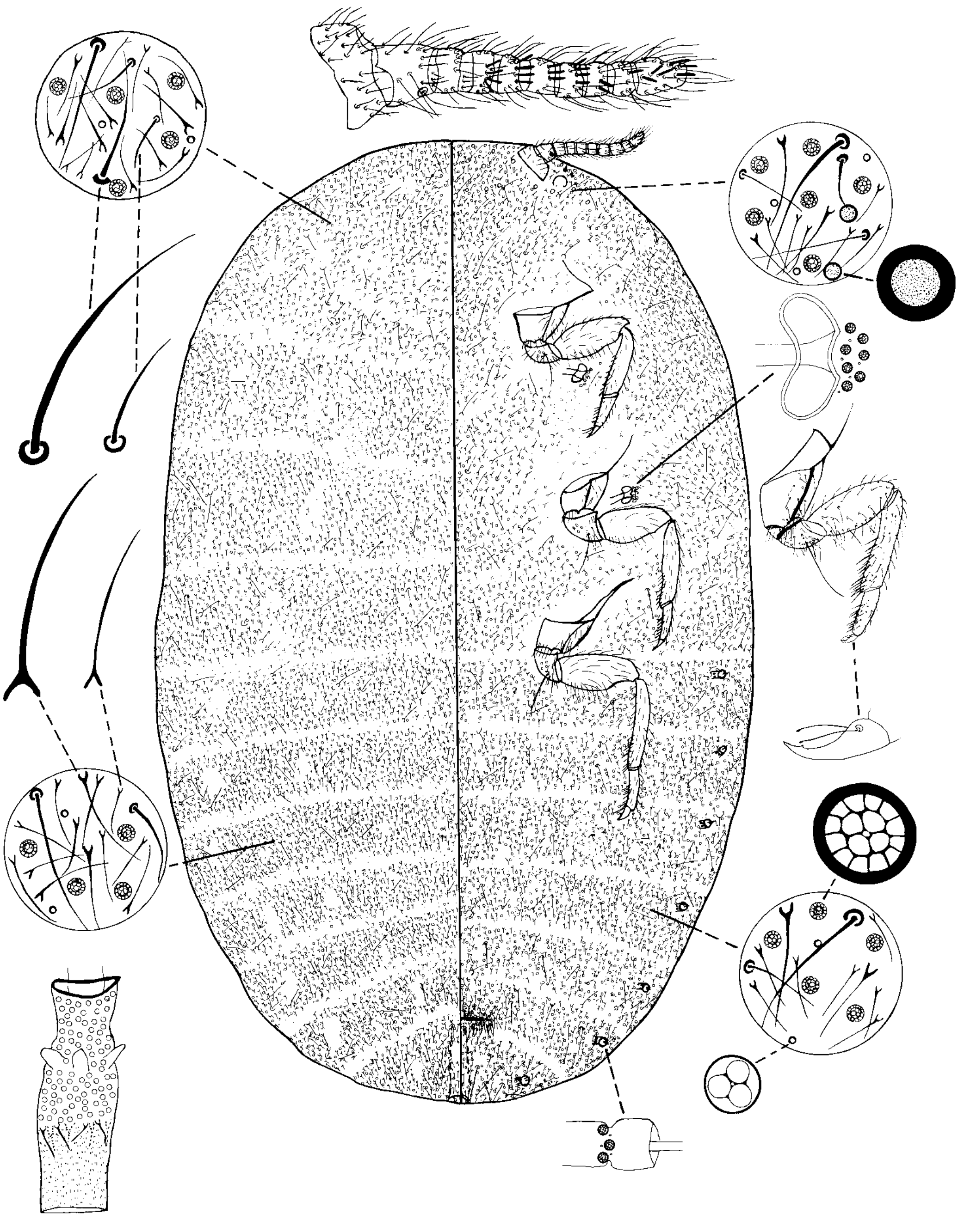


Fig. 15 *Coelostomidia jenniferae*, adult female.

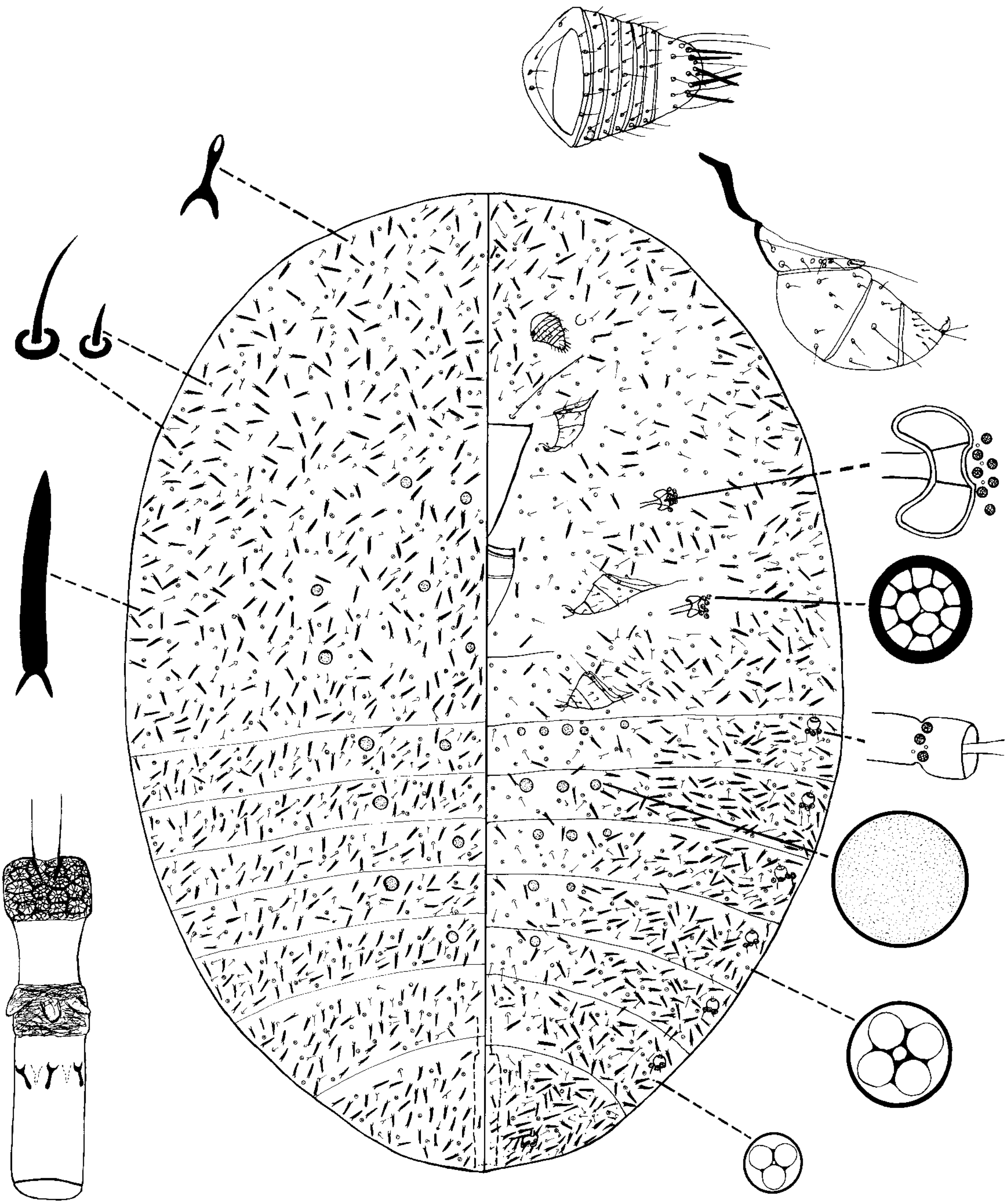


Fig. 16 *Coelostomidia jenniferae*, 2nd-instar female.

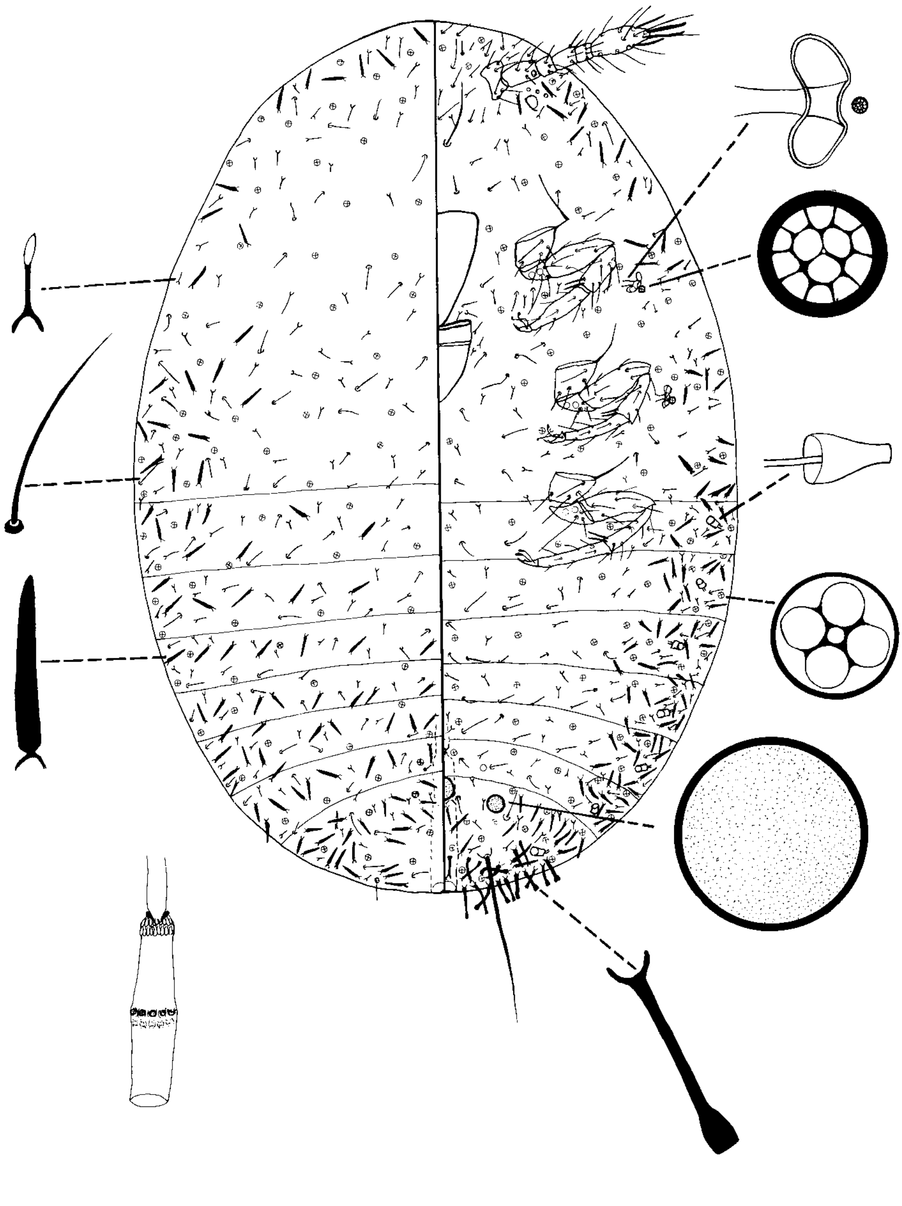


Fig. 17 *Coelostomidia jenniferae*, 1st instar.

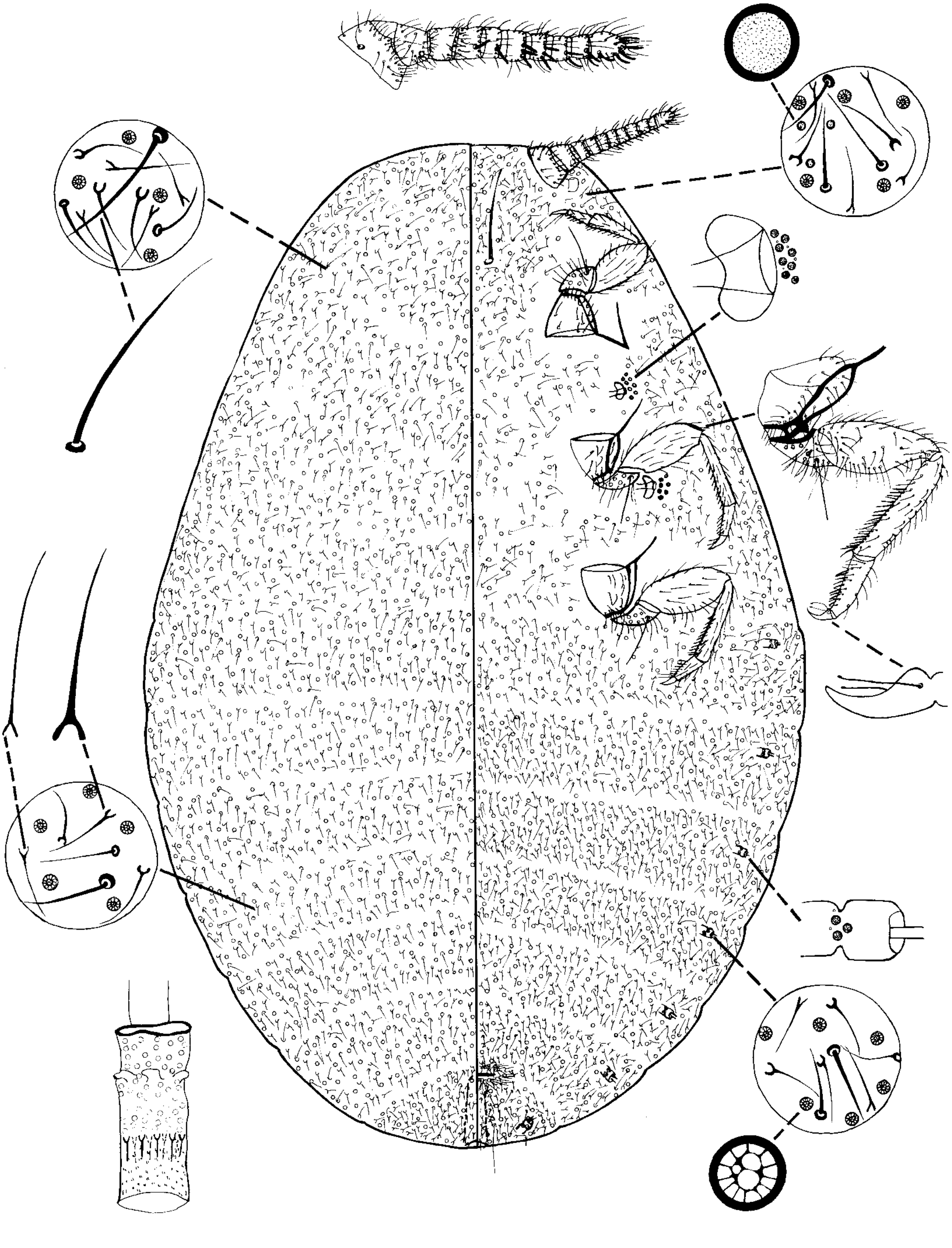


Fig. 18 *Coelostomidia montana*, adult female.

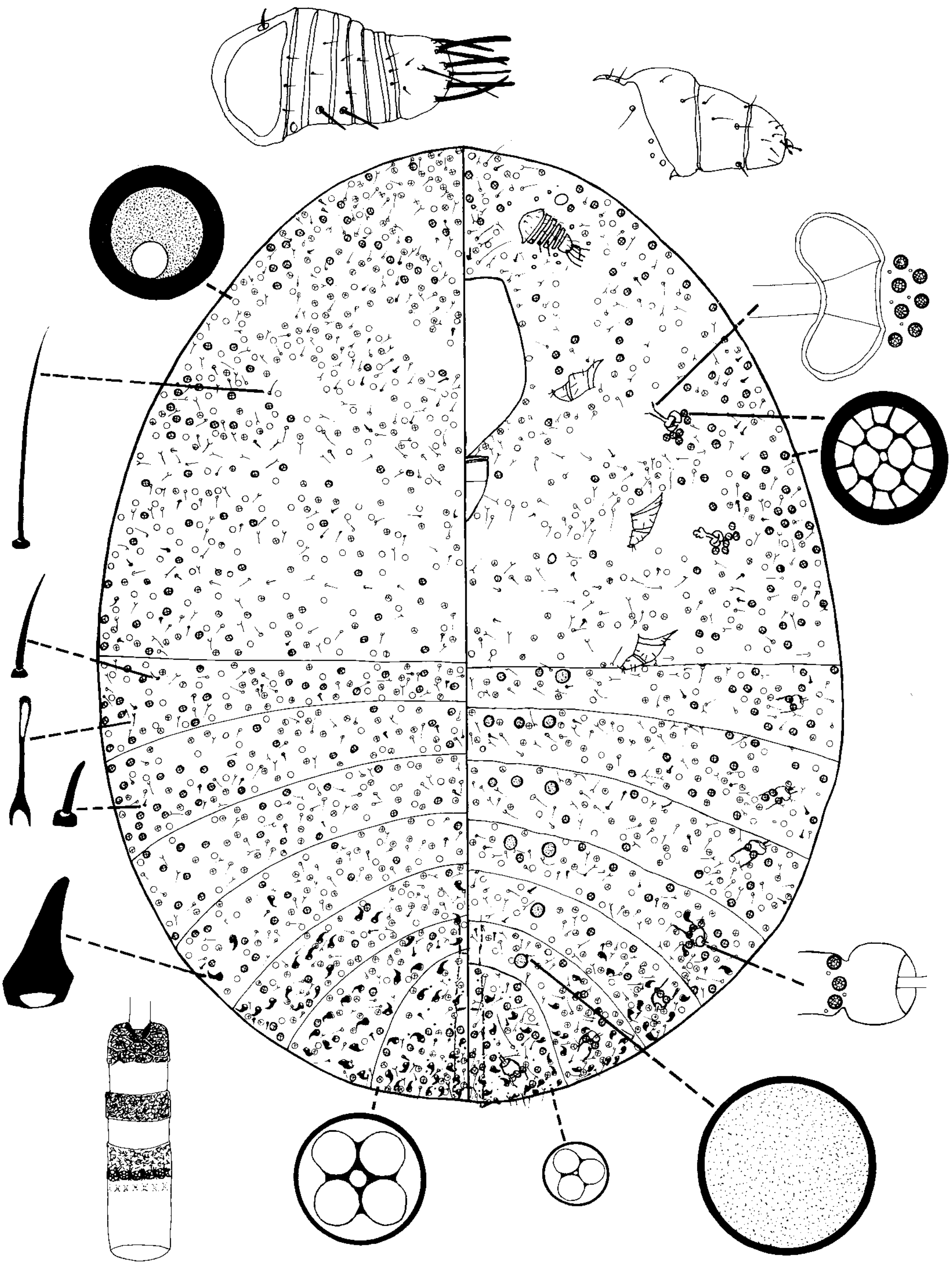


Fig. 19 *Coelostomidia montana*, 2nd-instar female.

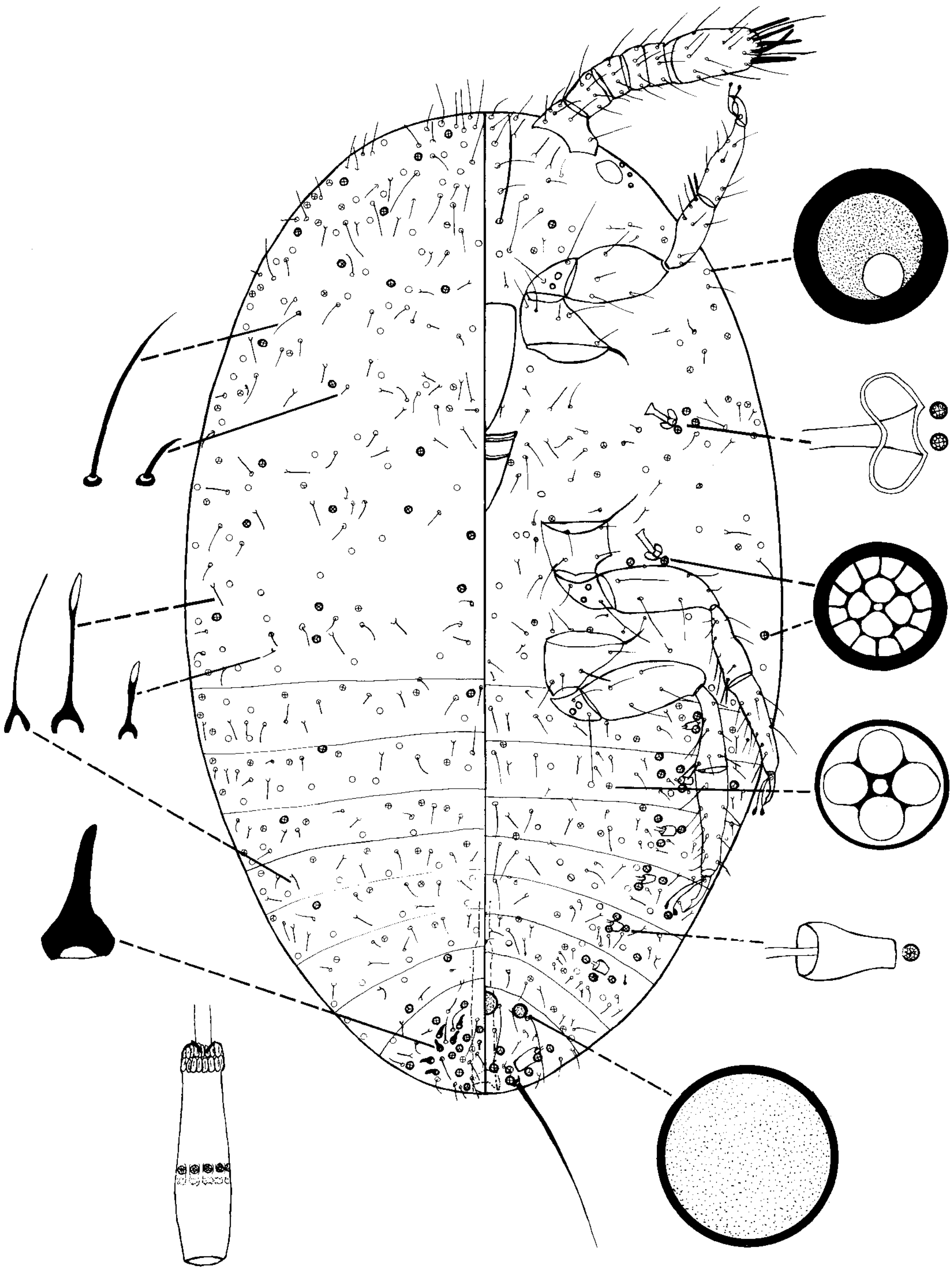


Fig. 20 *Coelostomidia montana*, 1st instar.

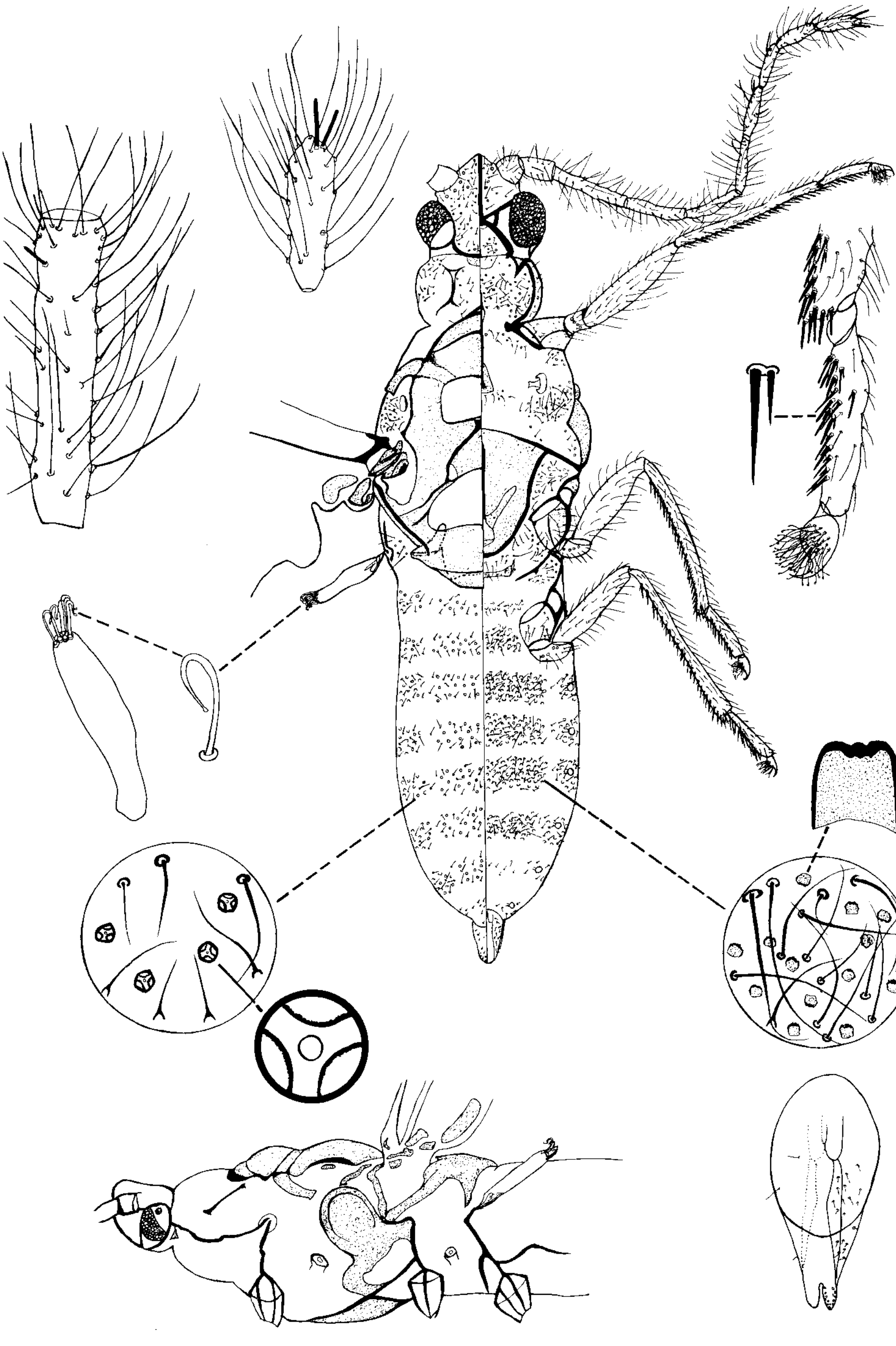


Fig. 21 *Coelostomidia montana*, adult male.

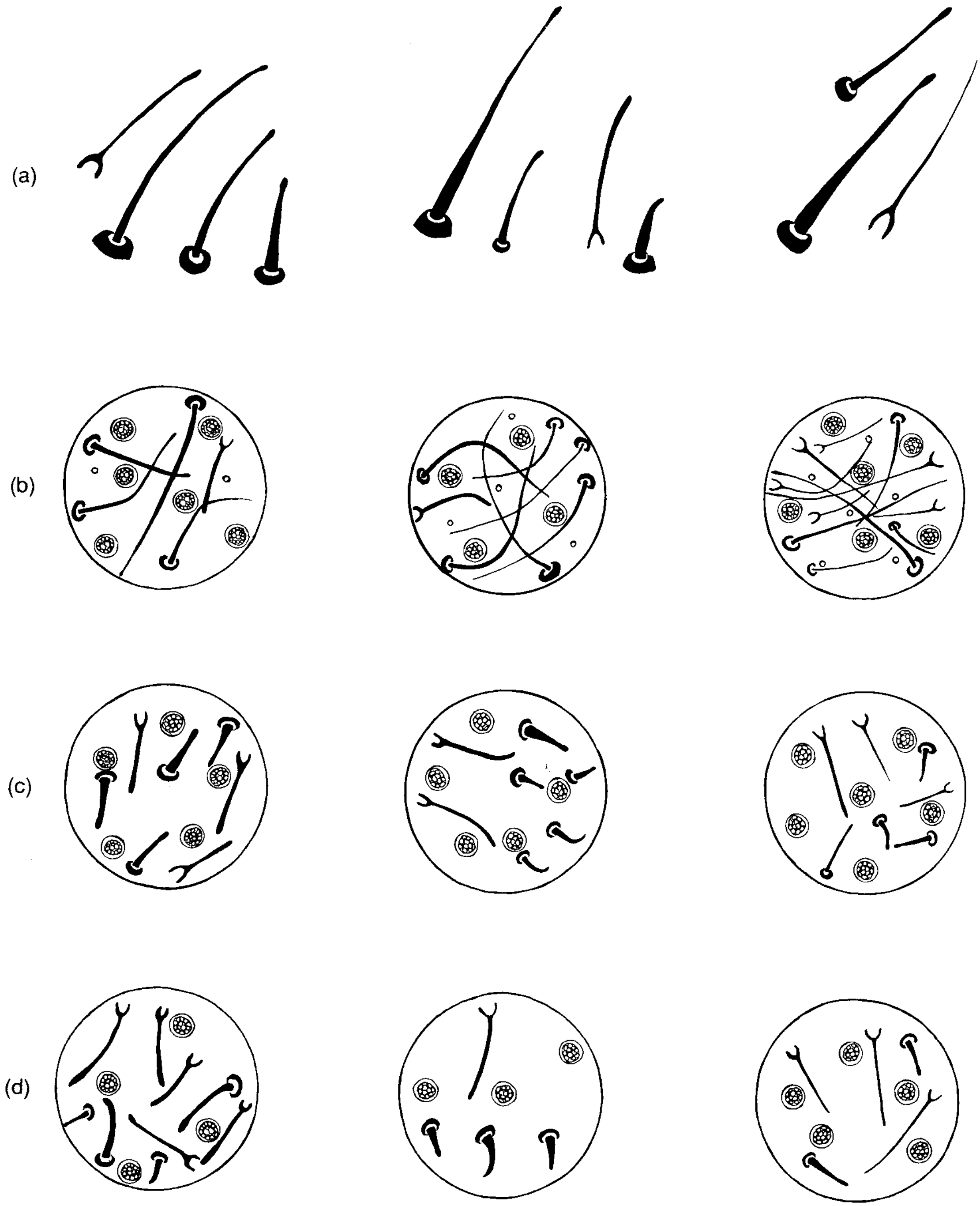


Fig. 22 *Coelostomidia montana*, *C. wairoensis*, and *C. zealandica*, pupa: (a) anal lobe setae; (b) derm, head venter; (c, d) derm, abdomen, venter and dorsum.

(a)

(b)

(c)

(d)

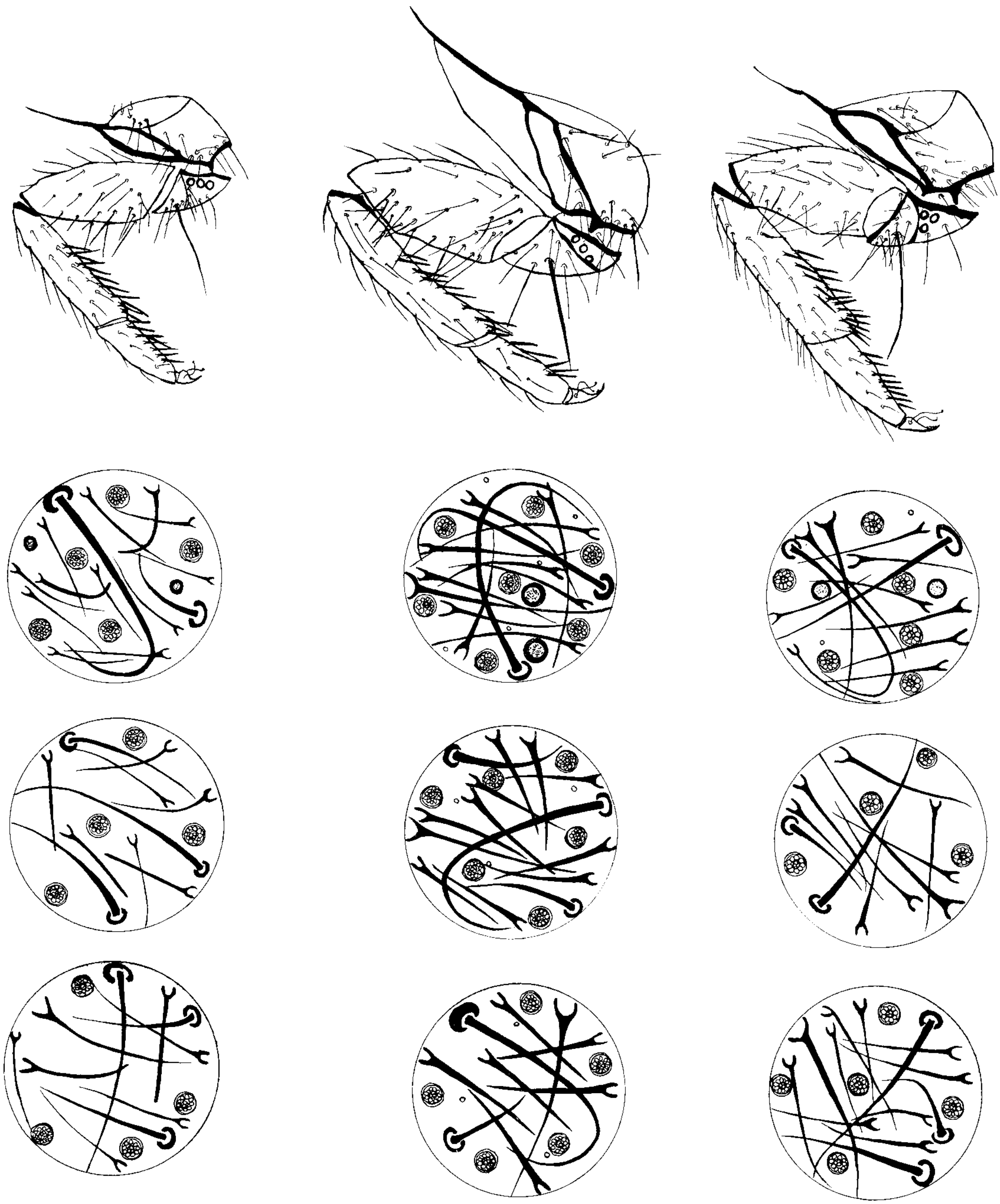


Fig. 23 *Coelostomidia montana, C. pilosa,* and *C. zealandica,* prepupa: (a) leg; (b) derm, head venter; (c, d) derm, abdomen, venter and dorsum.

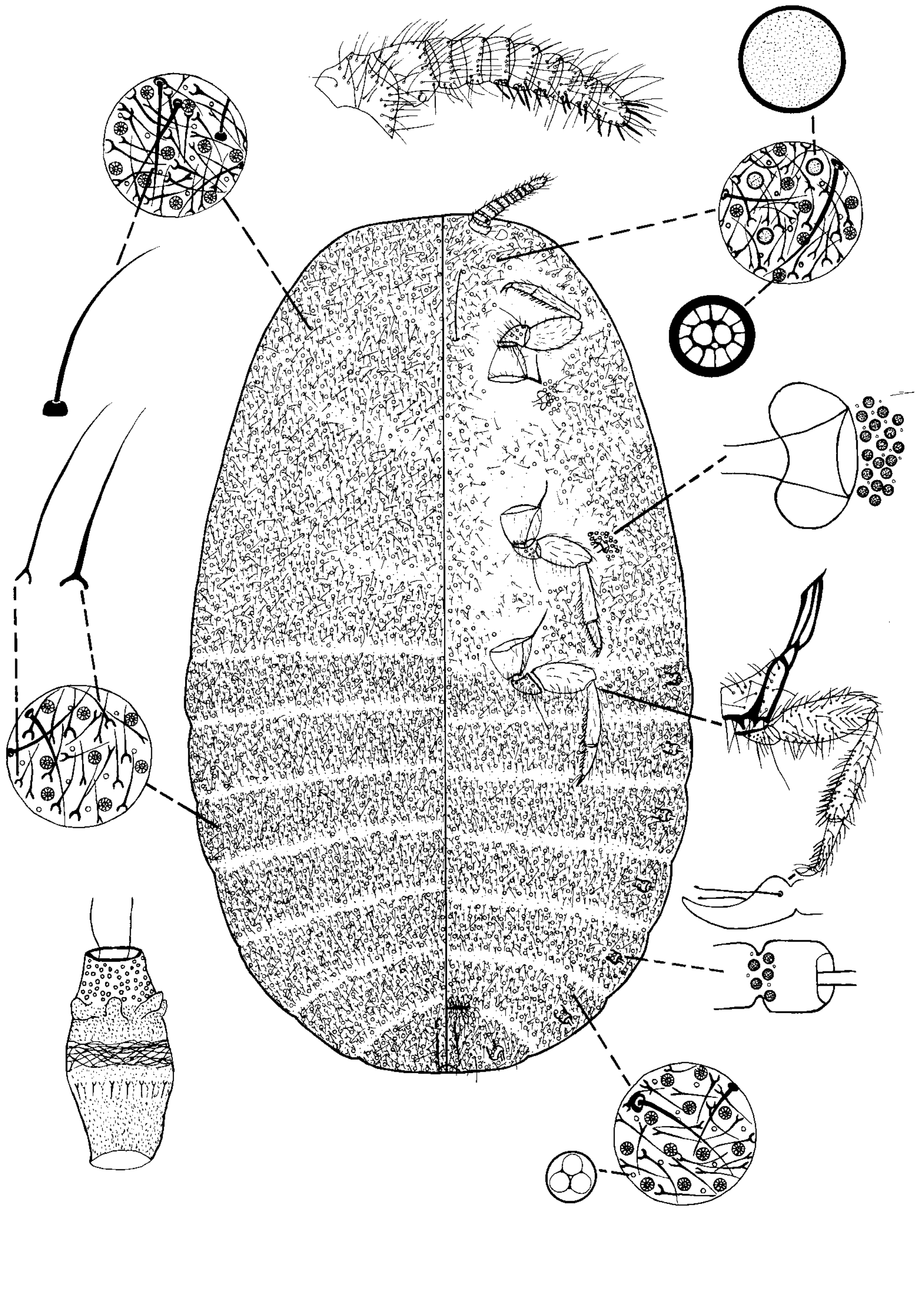


Fig. 24 *Coelostomidia pilosa*, adult female.

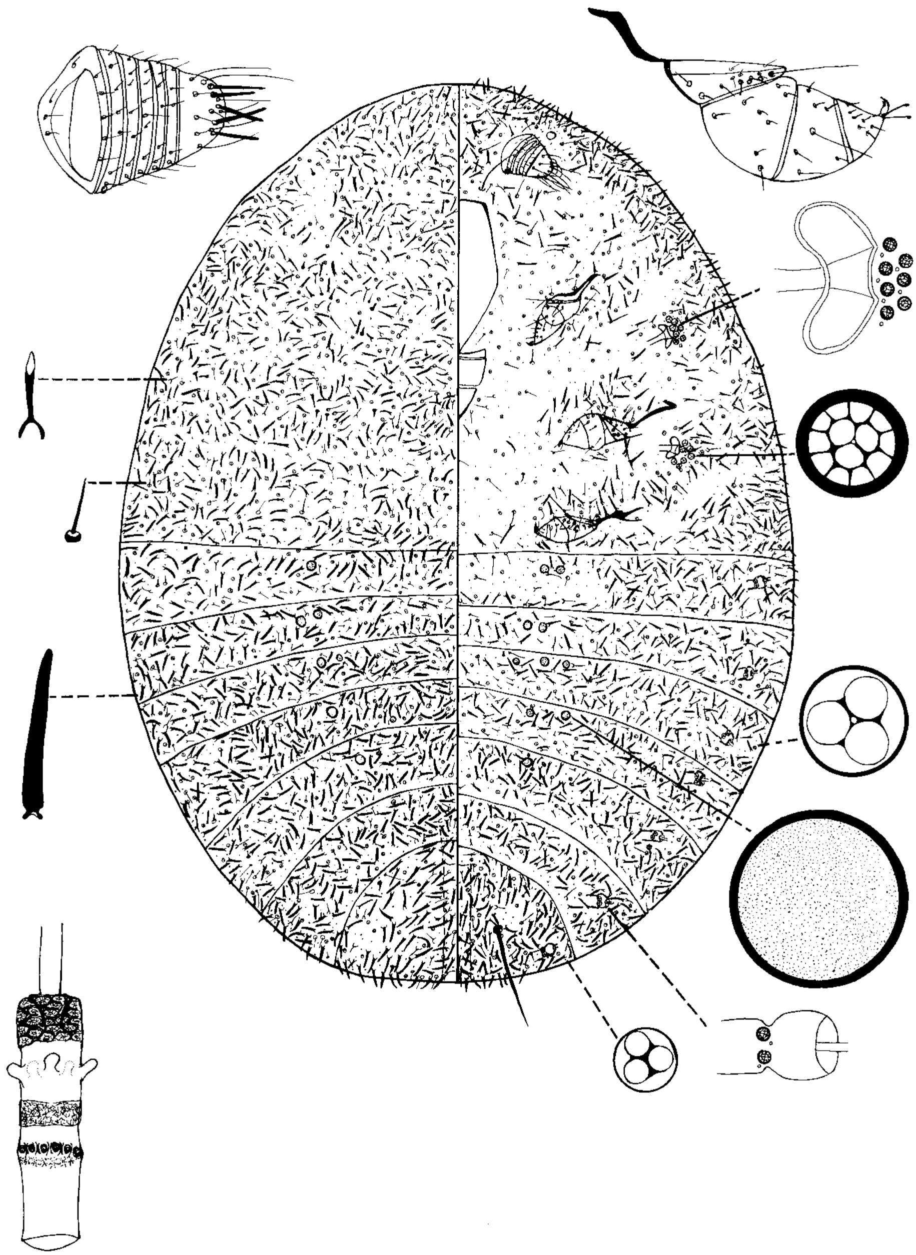


Fig. 25 *Coelostomidia pilosa*, 2nd-instar female.

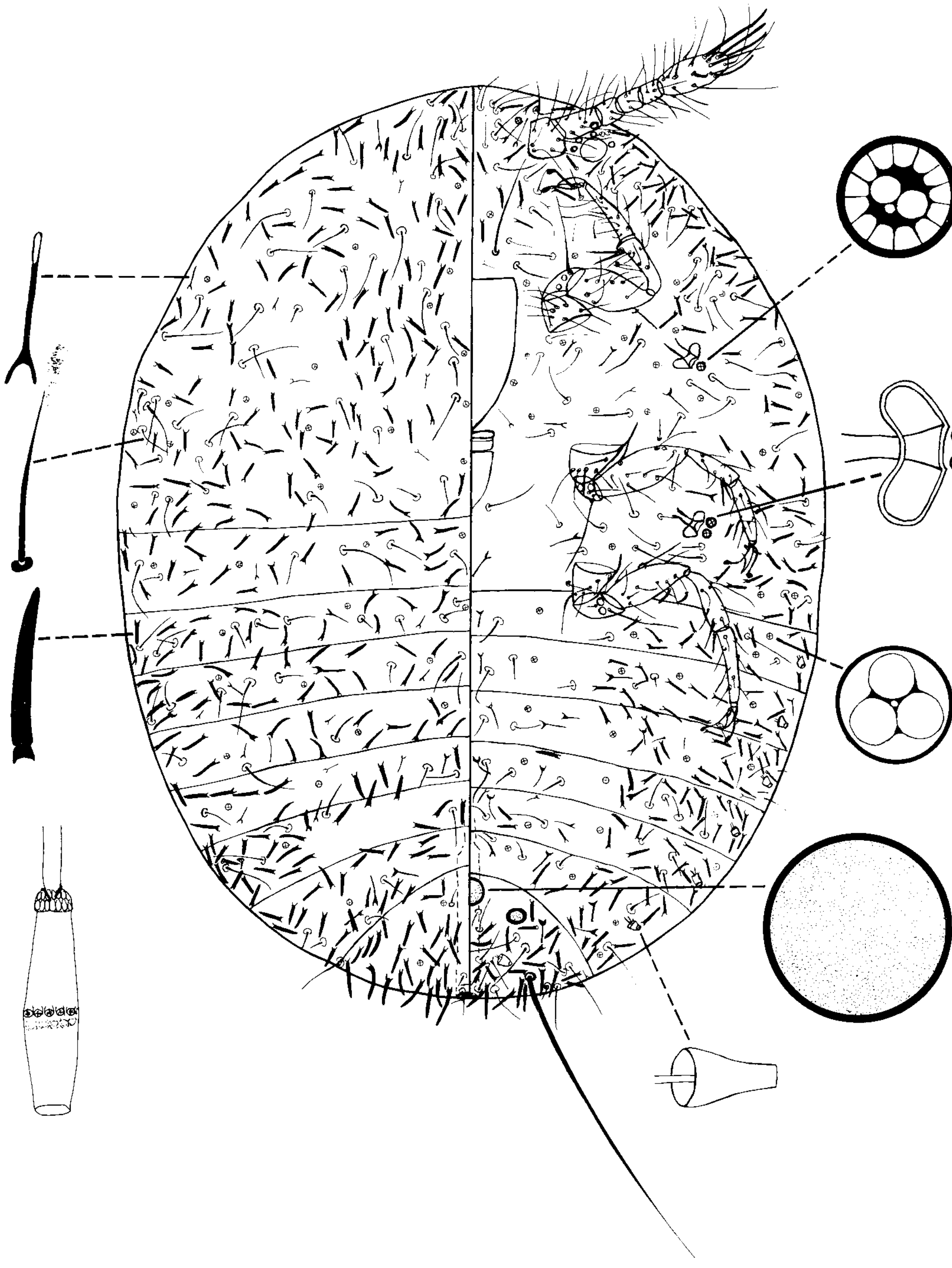


Fig. 26 *Coelostomidia pilosa*, 1st instar.

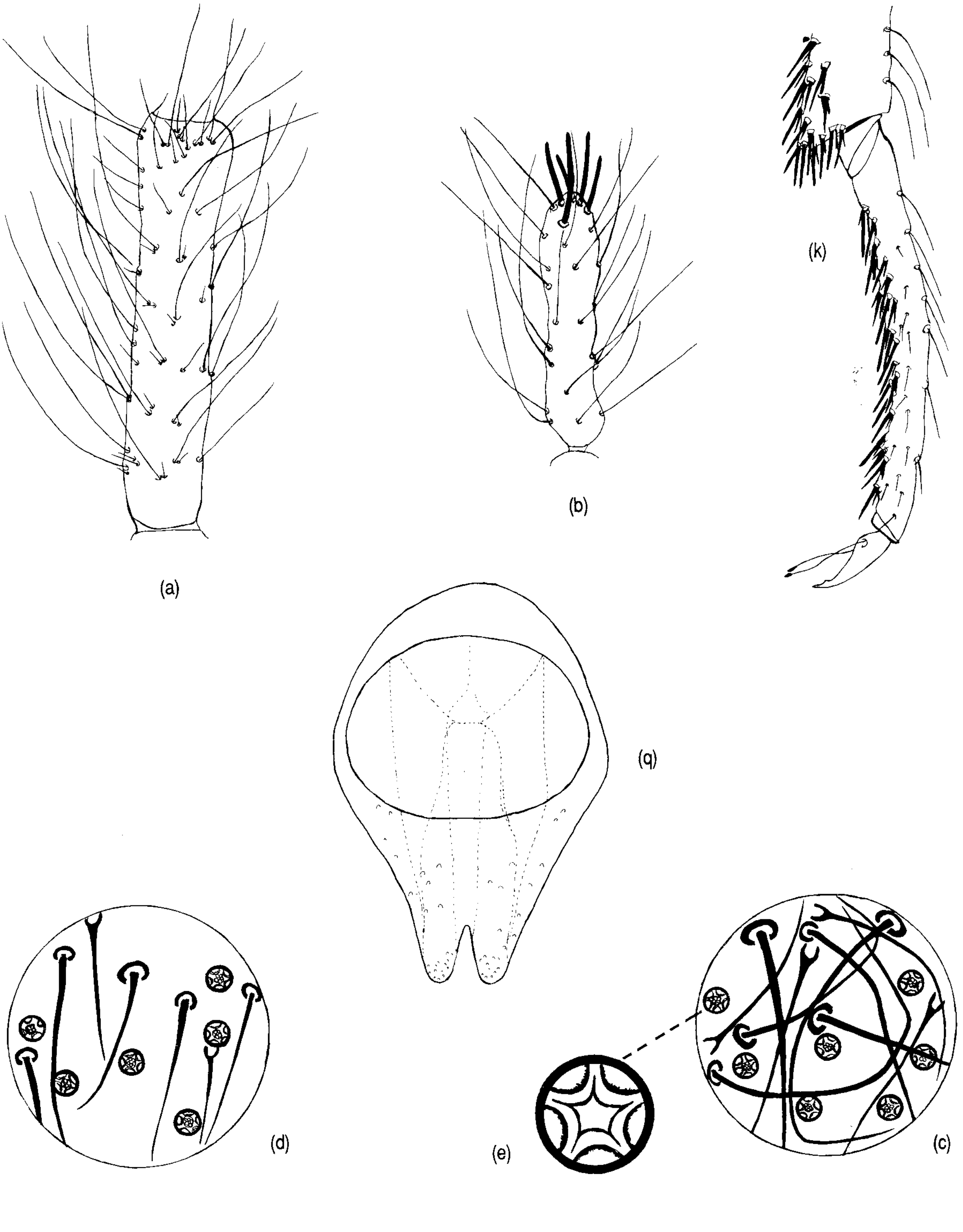


Fig. 27 *Coelostomidia pilosa*, adult male: for identity of elements, see Fig. 5.

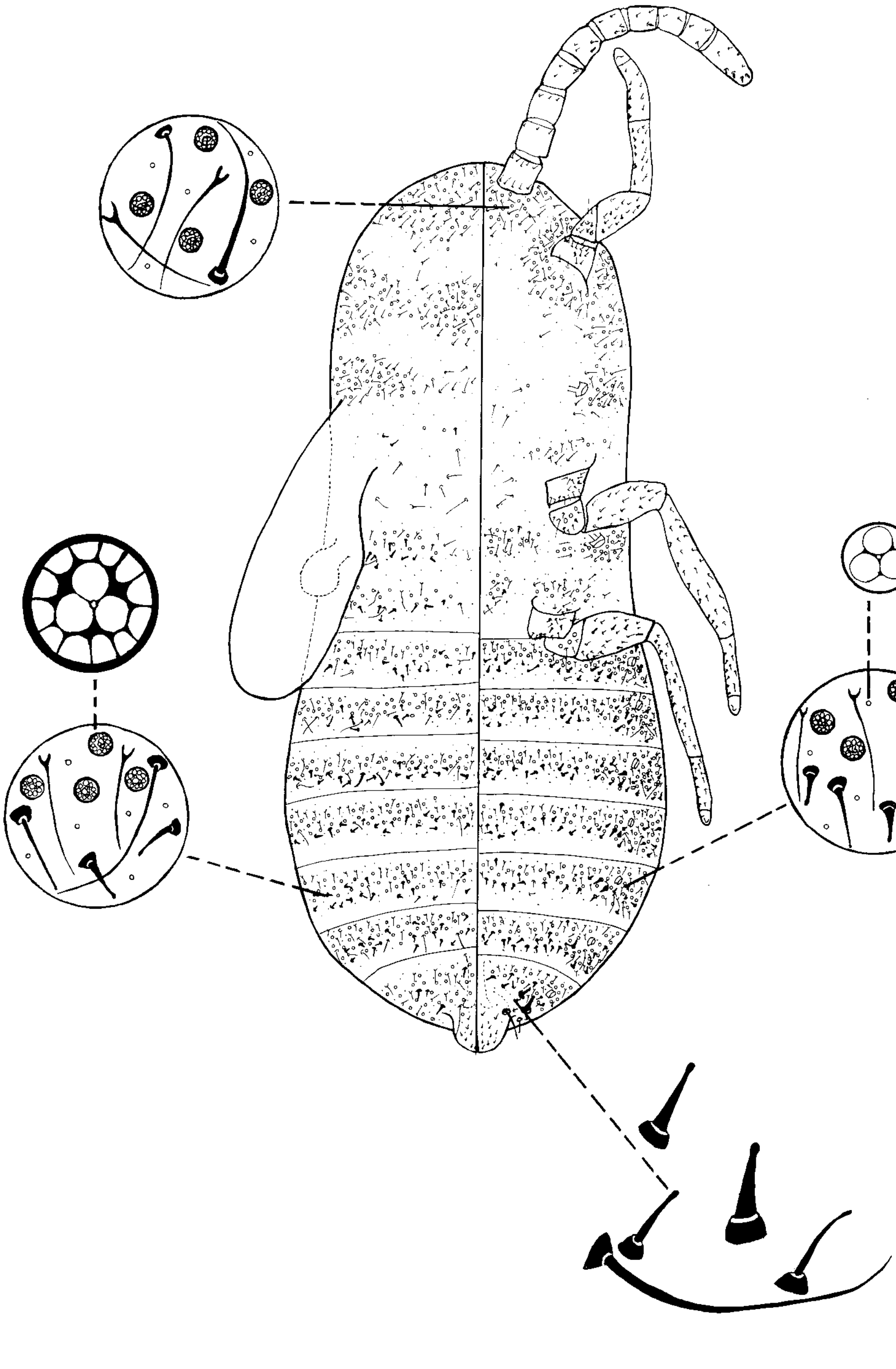


Fig. 28 *Coelostomidia pilosa*, pupa.

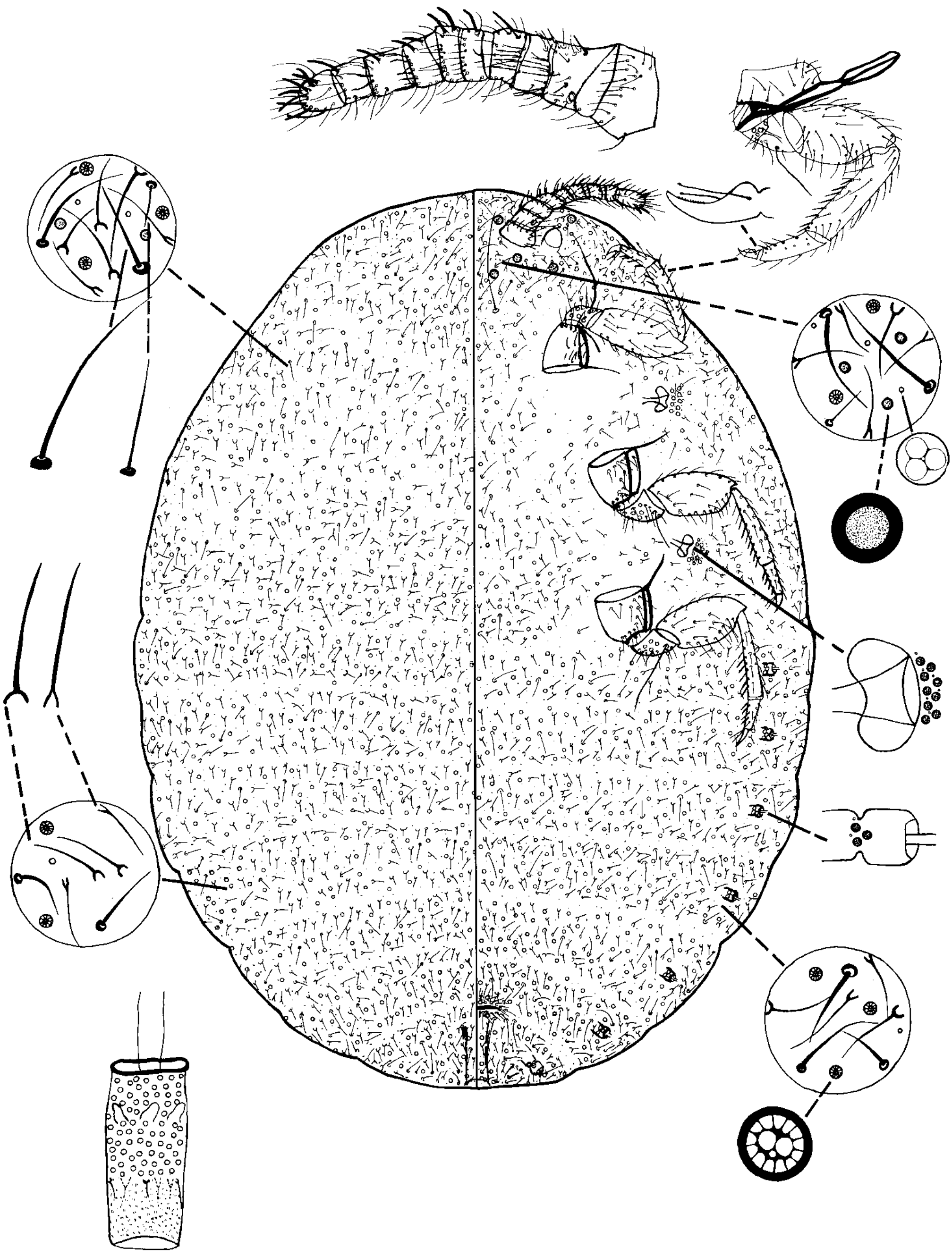


Fig. 29 *Coelostomidia wairoensis*, adult female.

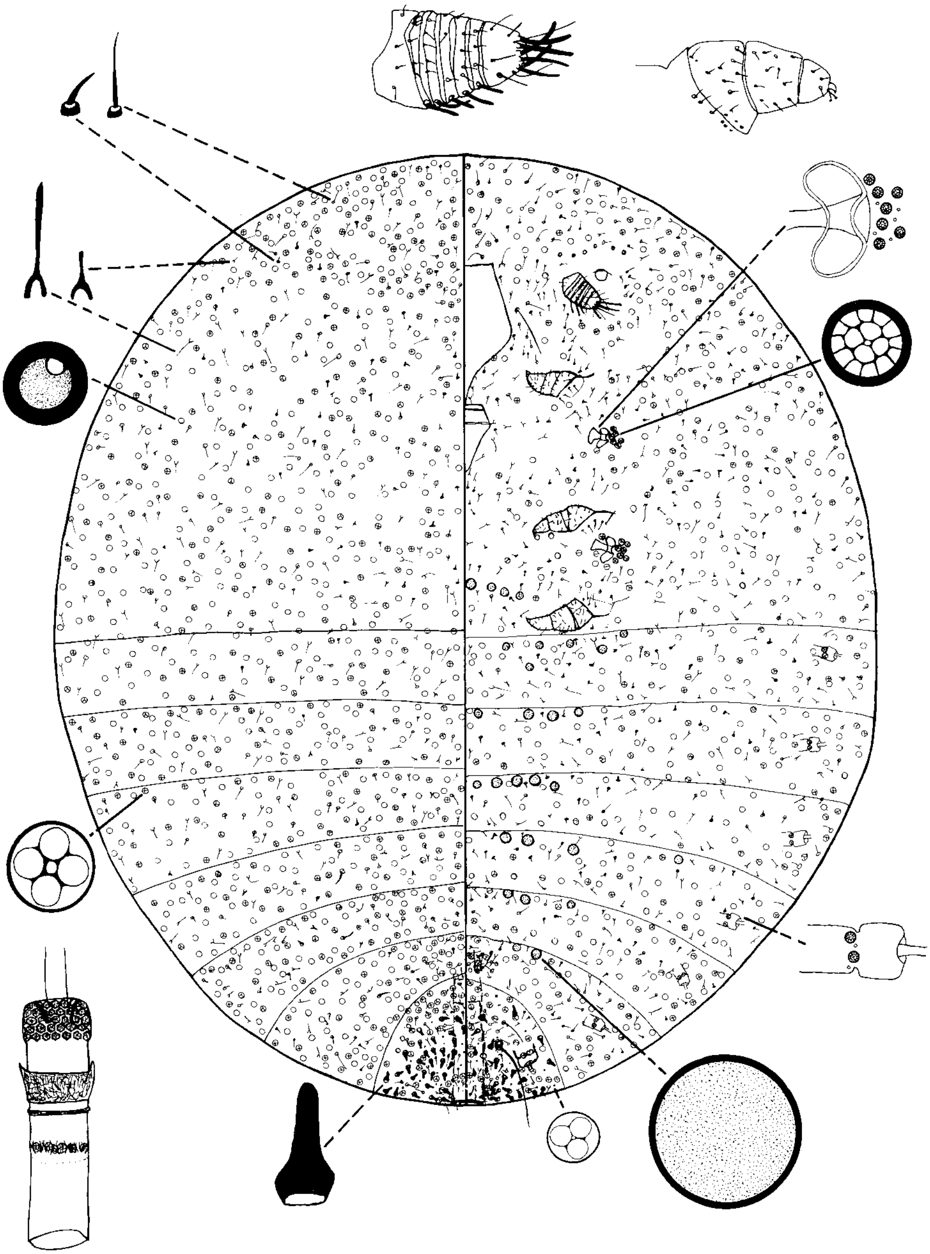


Fig. 30 *Coelostomidia wairoensis*, 2nd-instar female.

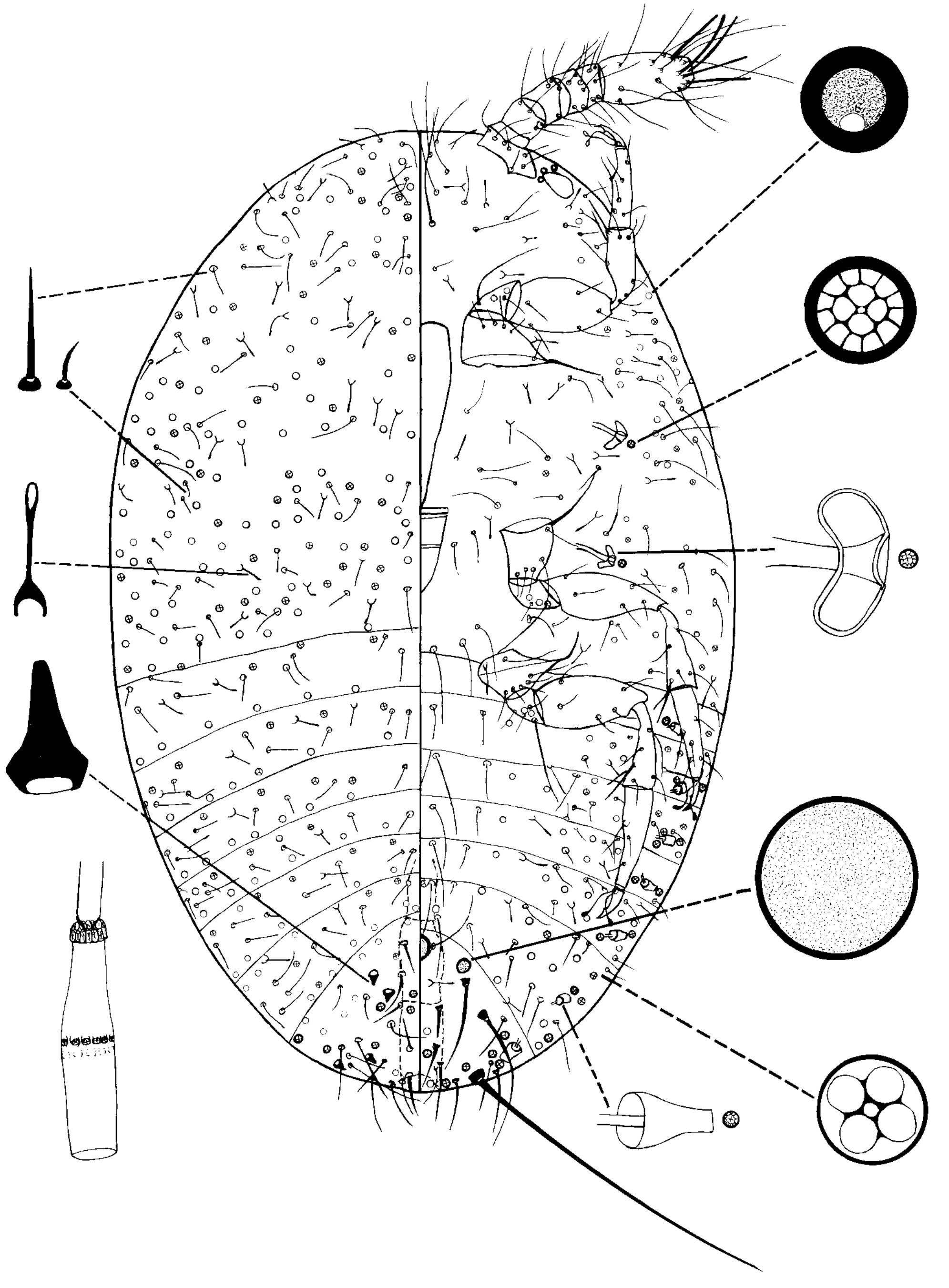


Fig. 31 *Coelostomidia wairoensis*, 1st instar.

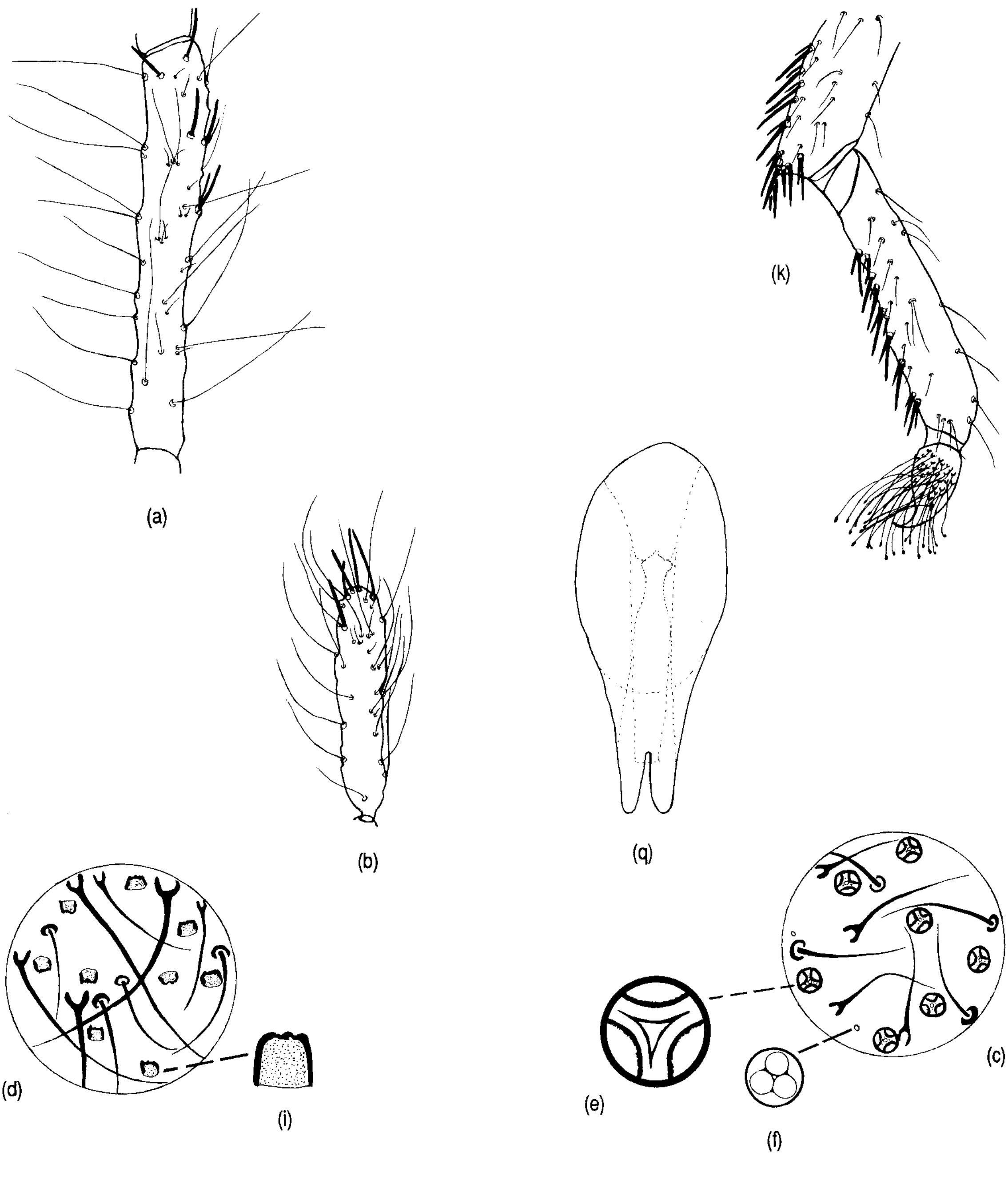


Fig. 32 *Coelostomidia wairoensis*, adult male: for identity of elements, see Fig. 5.

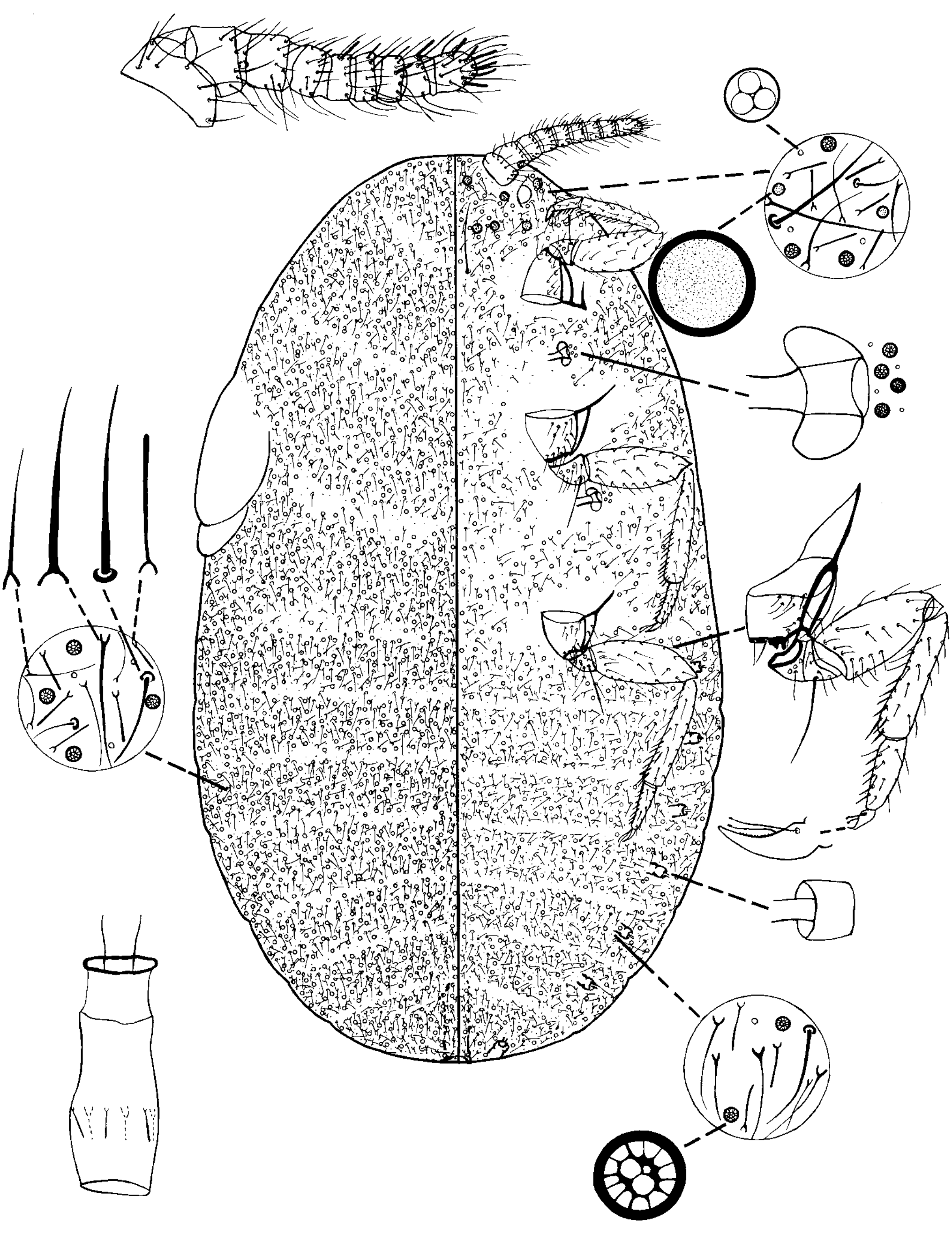


Fig. 33 *Coelostomidia wairoensis*, prepupa.

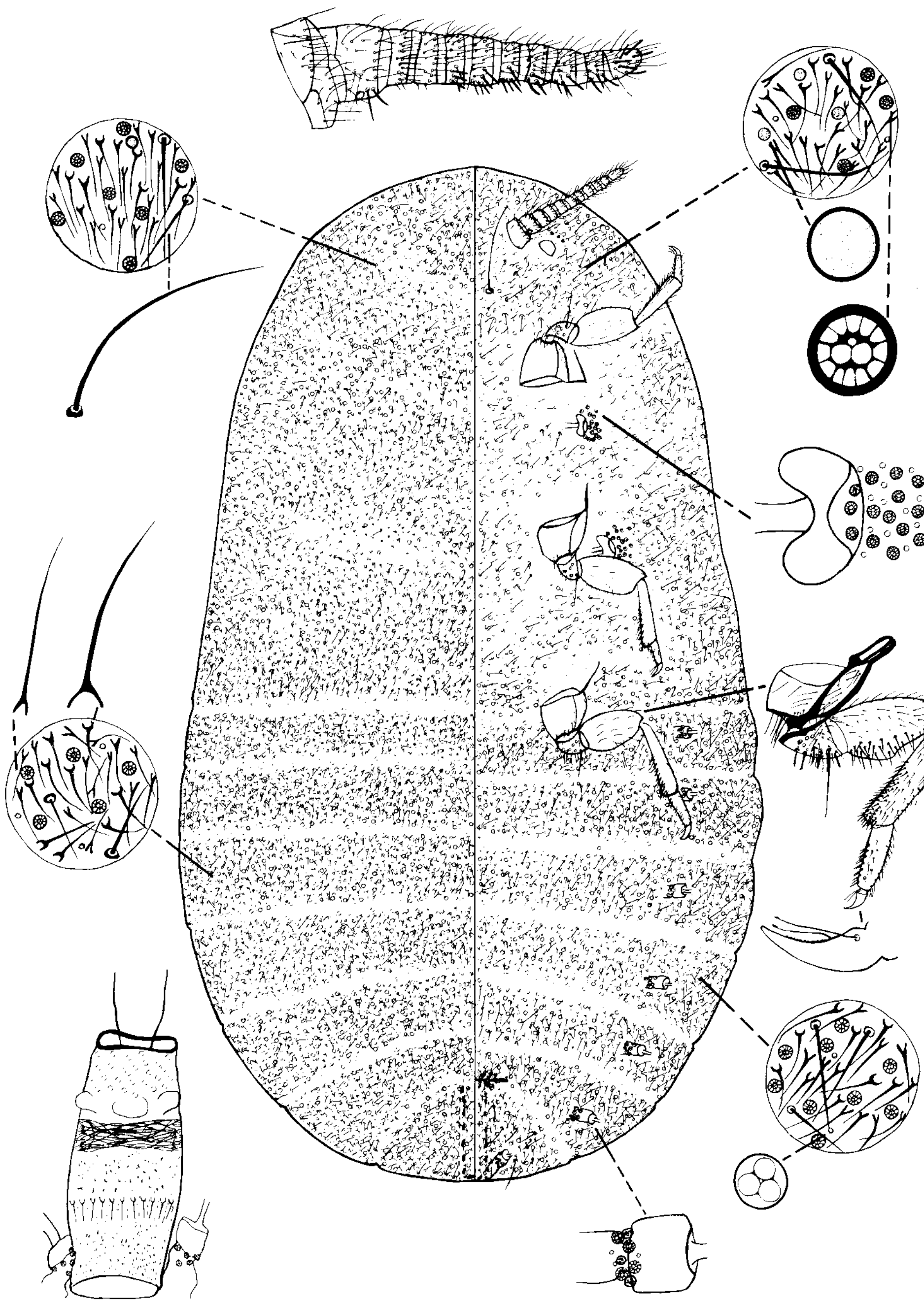


Fig. 34 *Coelostomidia zealandica*, adult female.

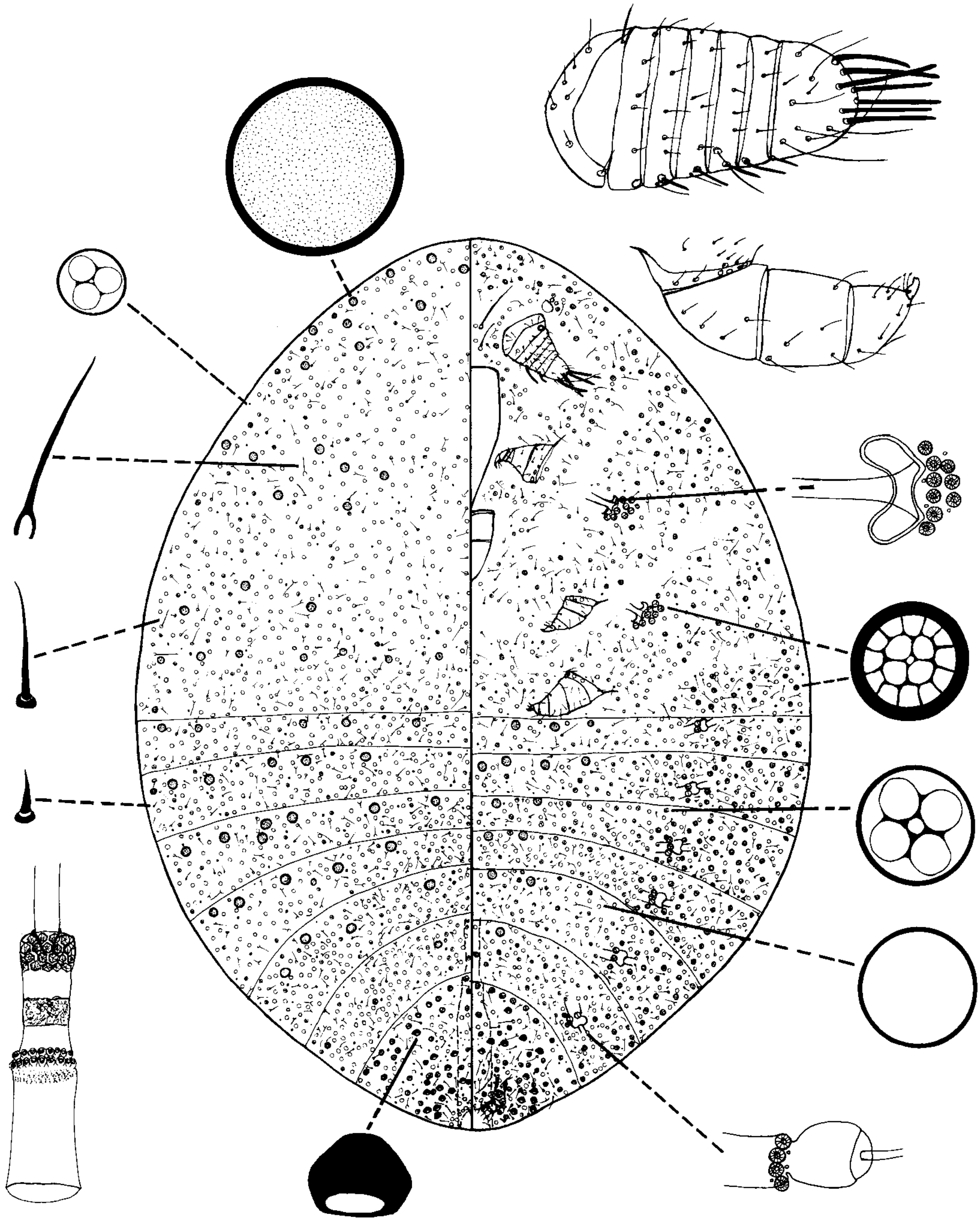


Fig. 35 *Coelostomidia zealandica*, 2nd-instar female.

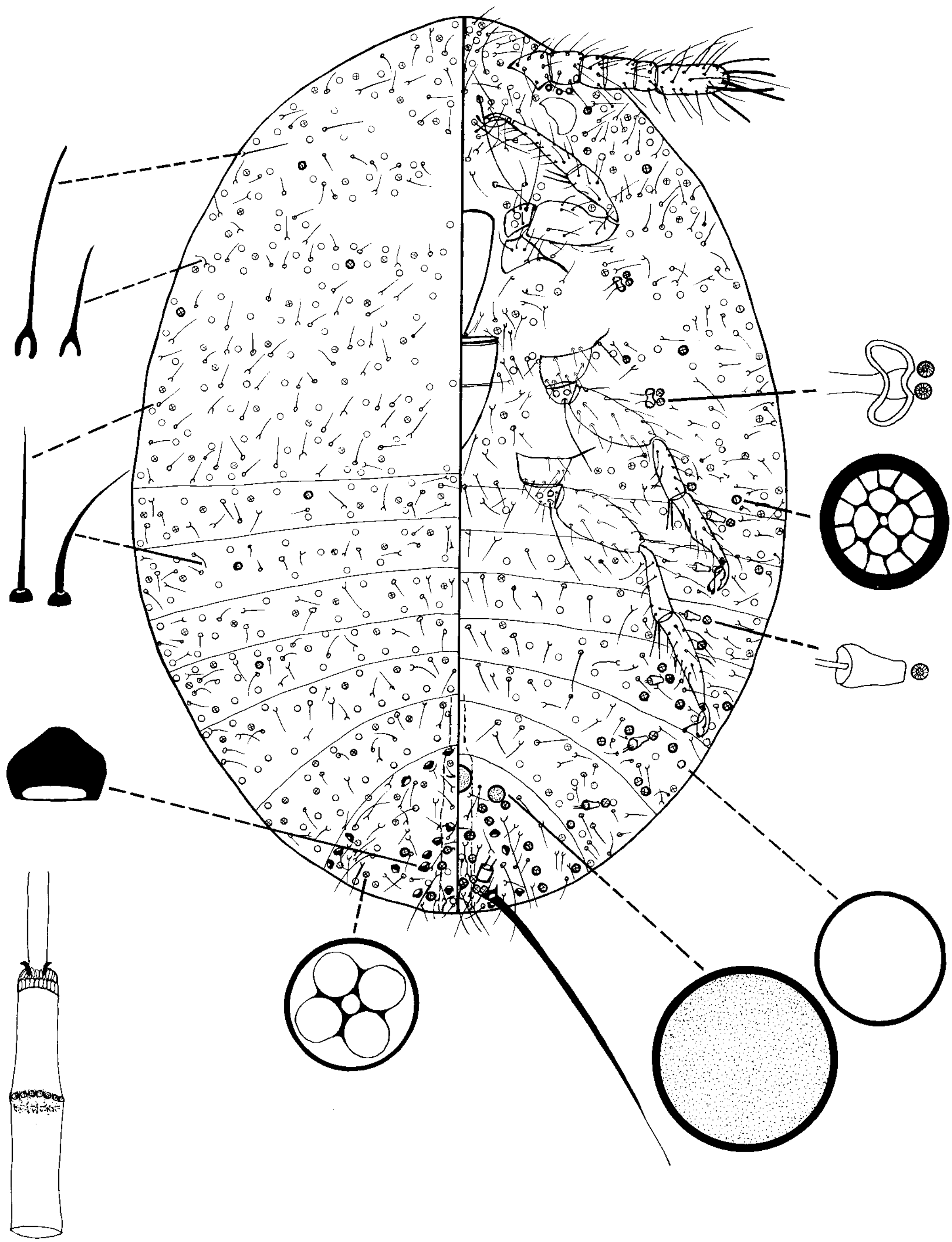


Fig. 36 *Coelostomidia zealandica*, 1st instar.

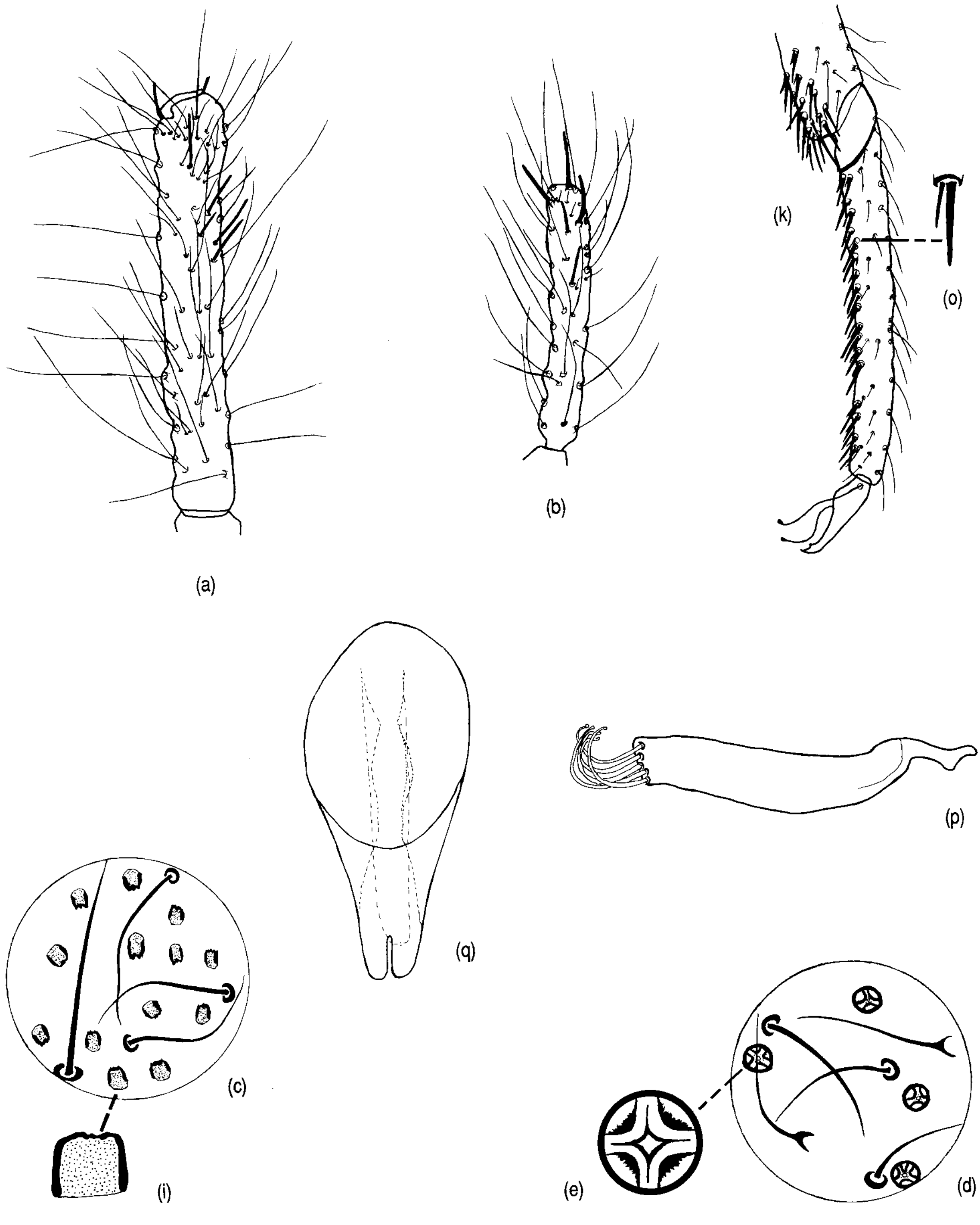


Fig. 37 *Coelostomidia zealandica*, adult male: for identity of elements, see Fig. 5.

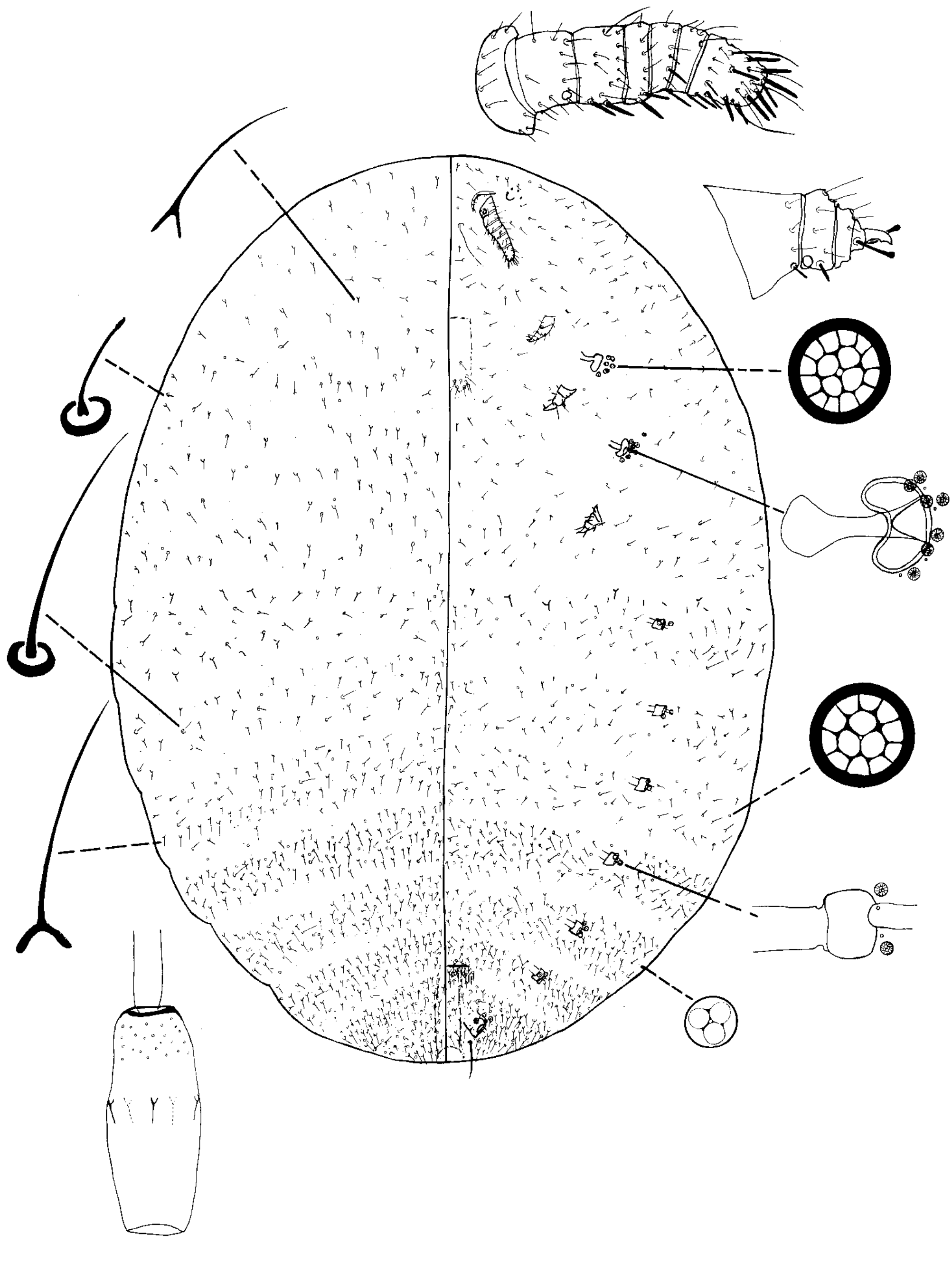


Fig. 38 *Ultracoelostoma assimile*, adult female.

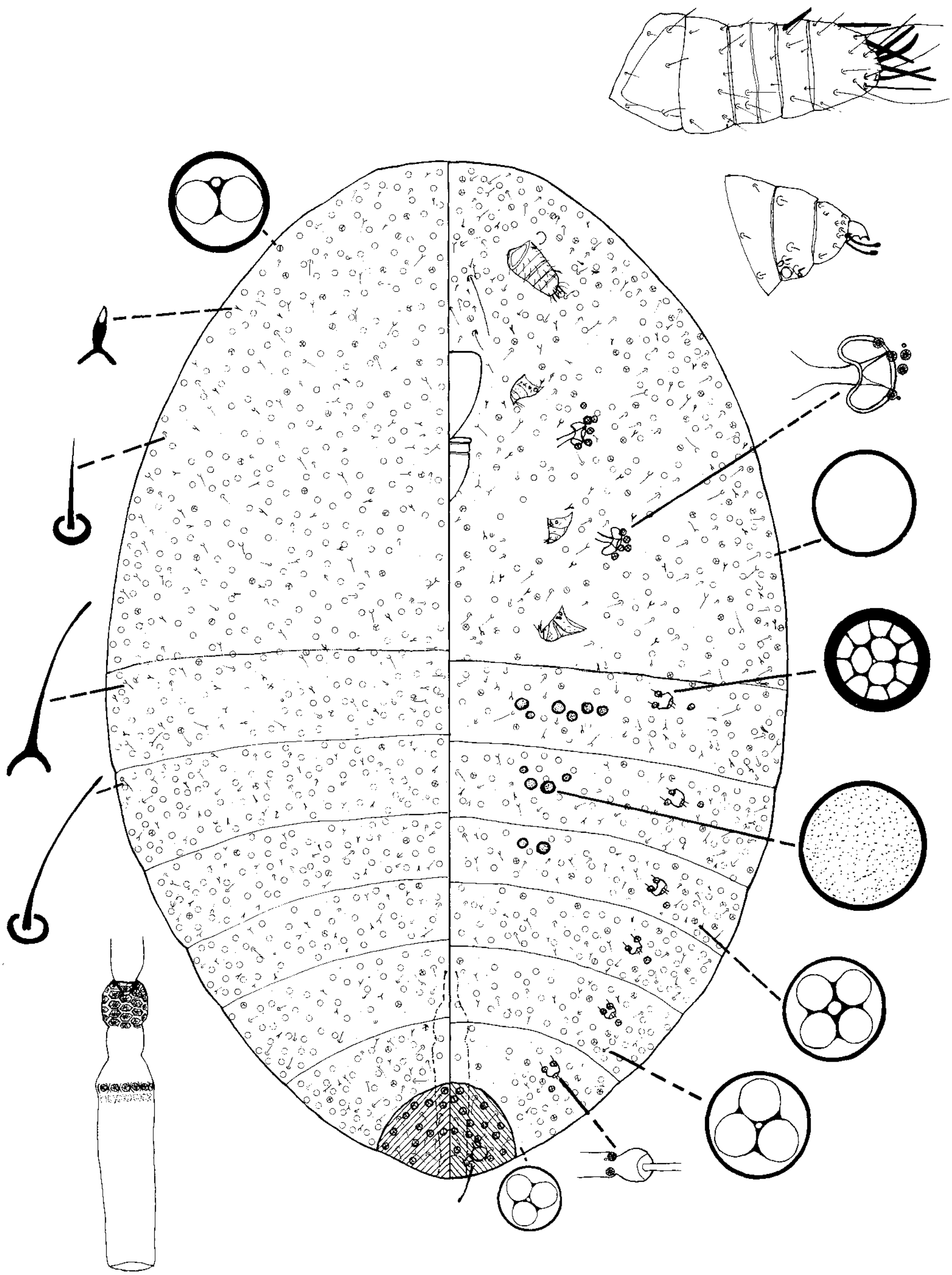


Fig. 39 *Ultracoelostoma assimile*, 2nd-instar female.

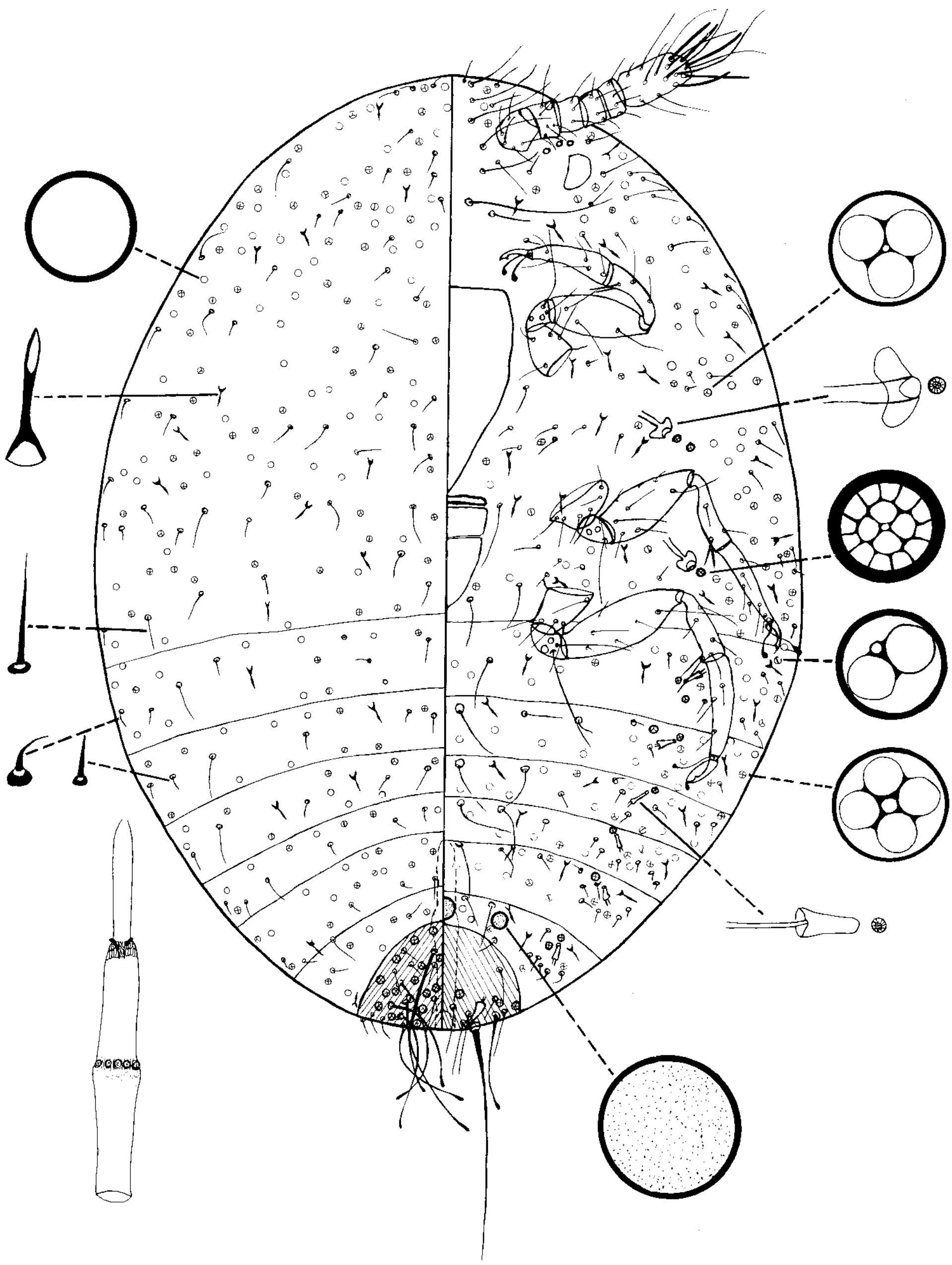


Fig. 40 *Ultracoelostoma assimile*, 1st instar.

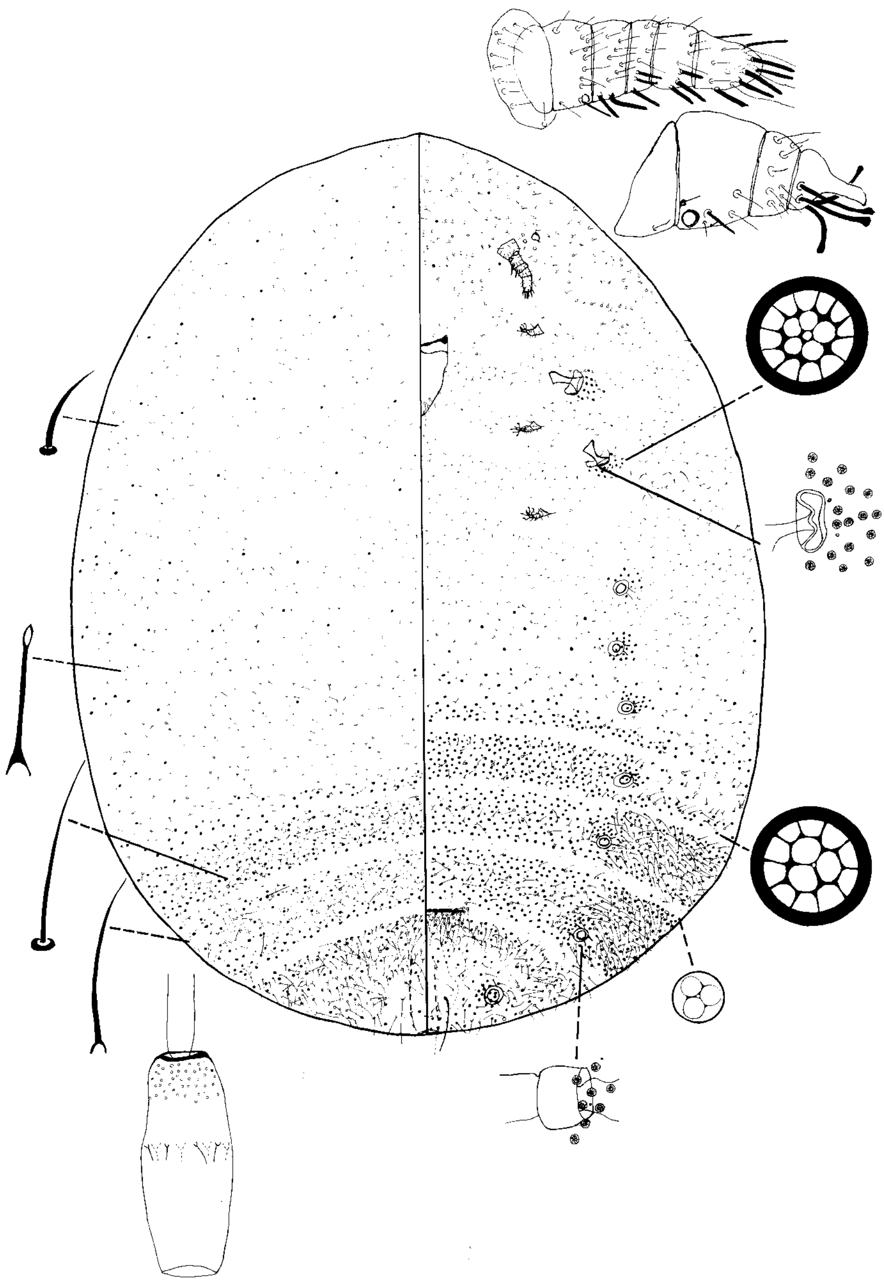


Fig. 41 *Ultracoelostoma brittini*, adult female.

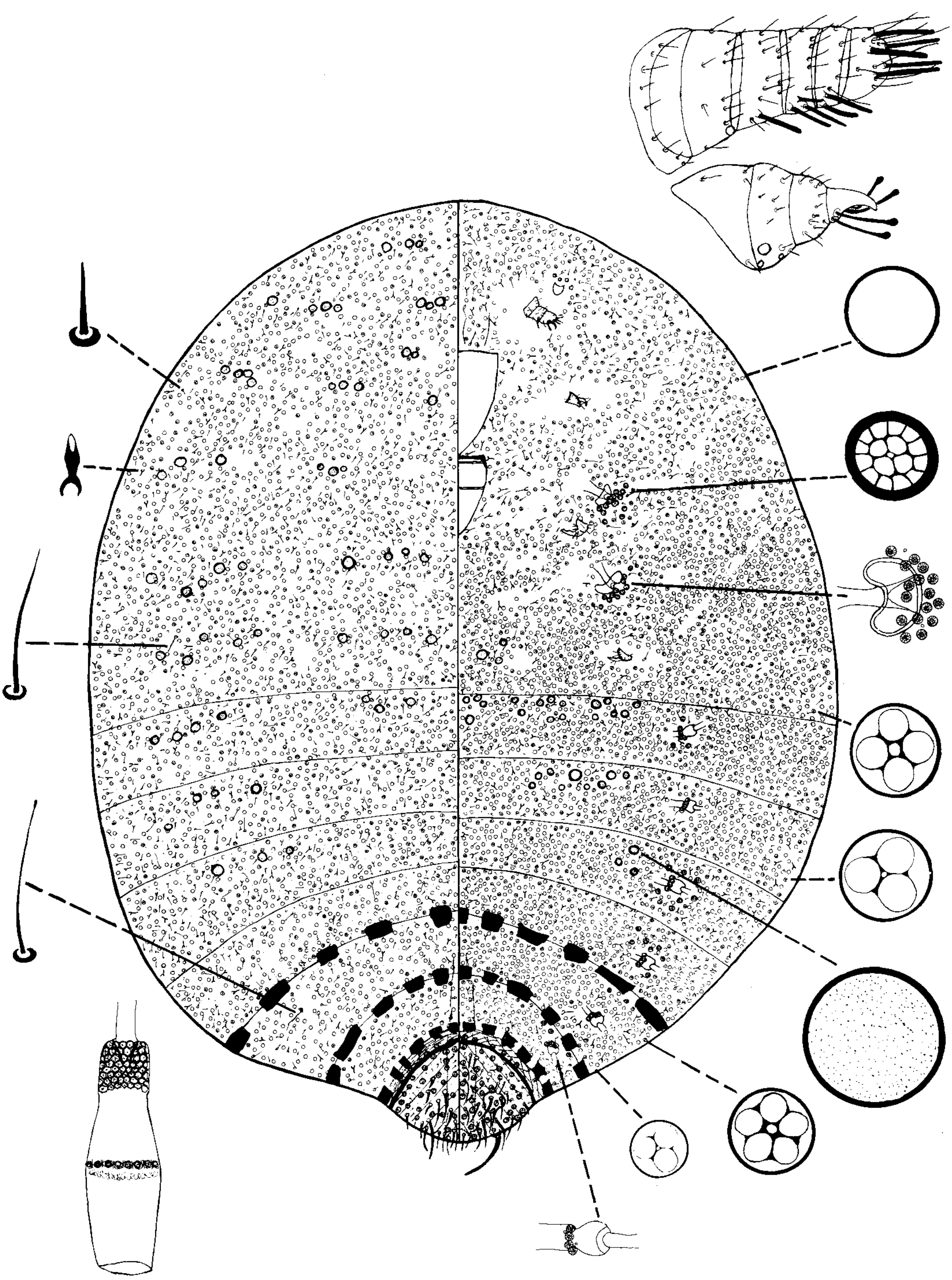


Fig. 42 *Ultracoelostoma brittini*, 3rd-instar female.

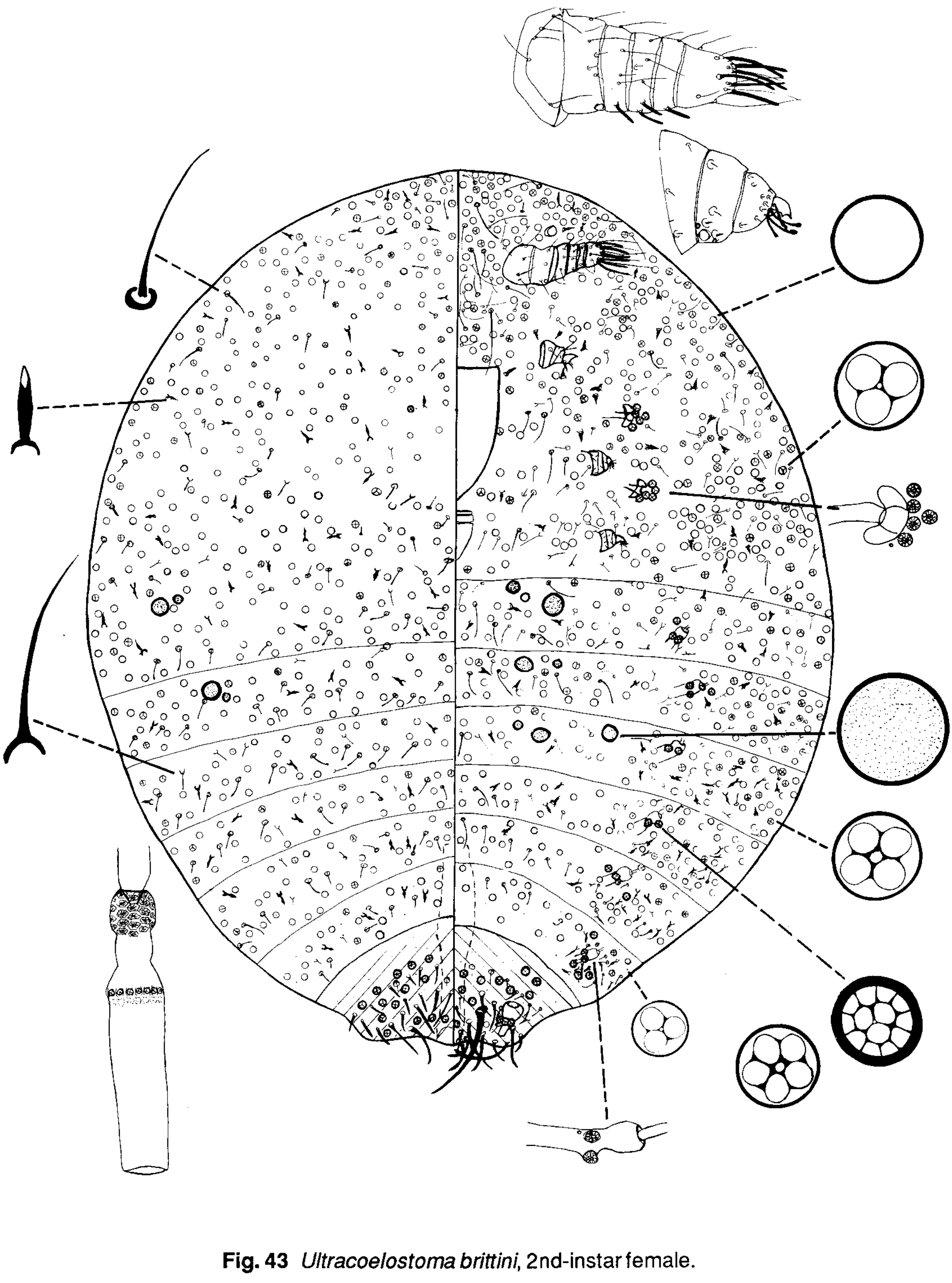


Fig. 43 *Ultracoelostoma brittini*, 2nd-instar female.

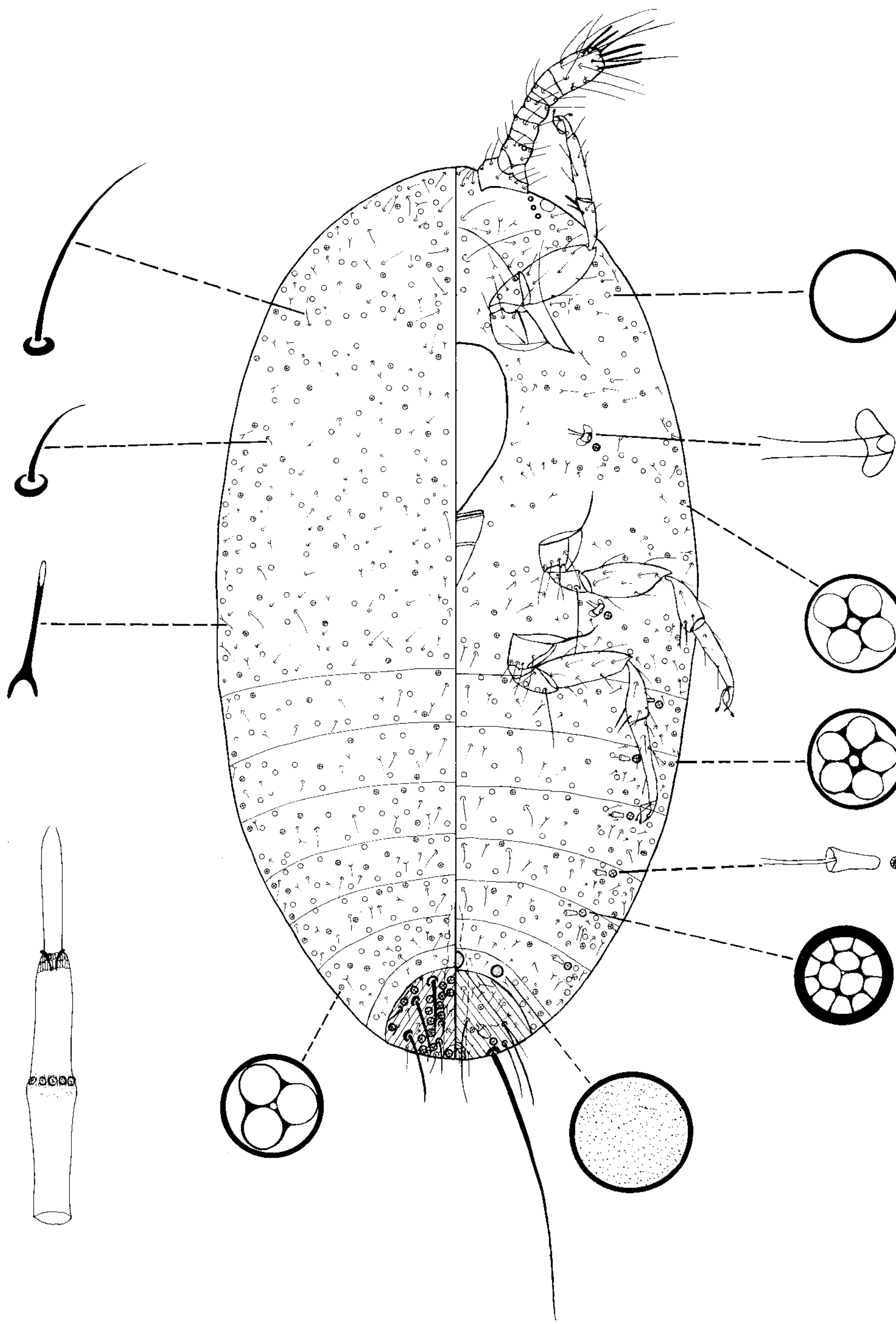


Fig. 44 *Ultracoelostoma brittini*, 1st instar.

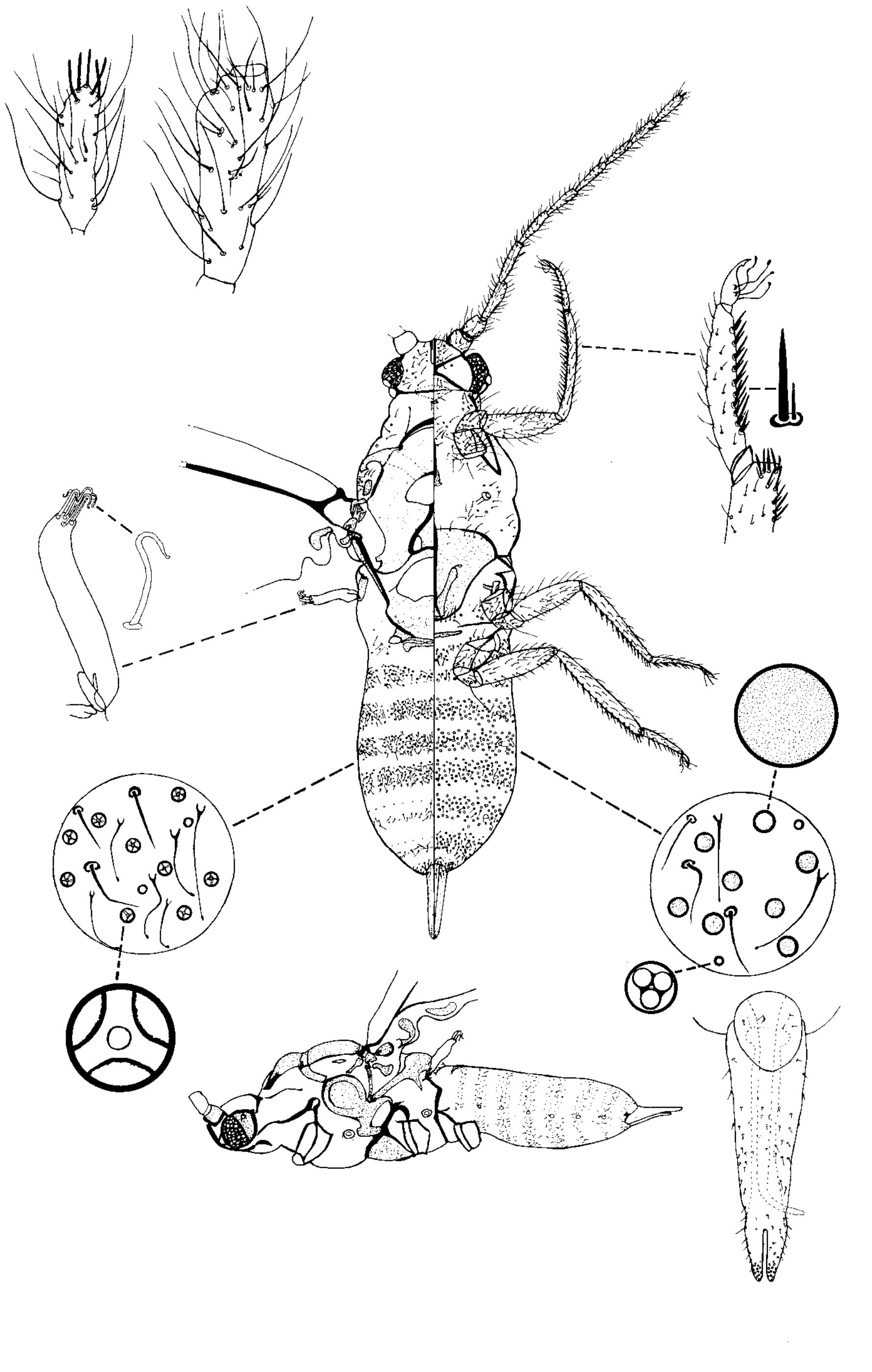


Fig. 45 *Ultracoelostoma brittini*, adult male.

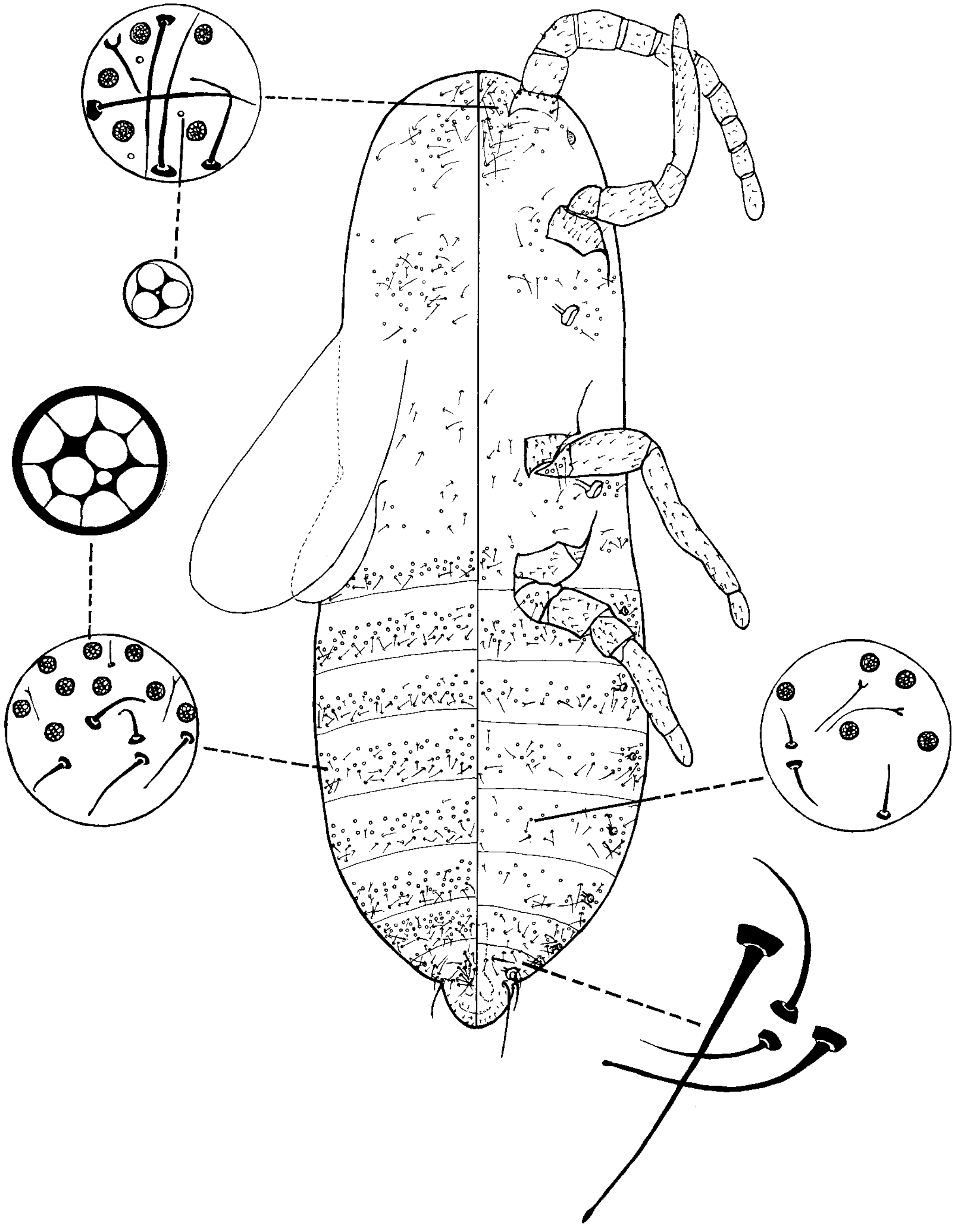


Fig. 46 *Ultracoelostoma brittini*, pupa.

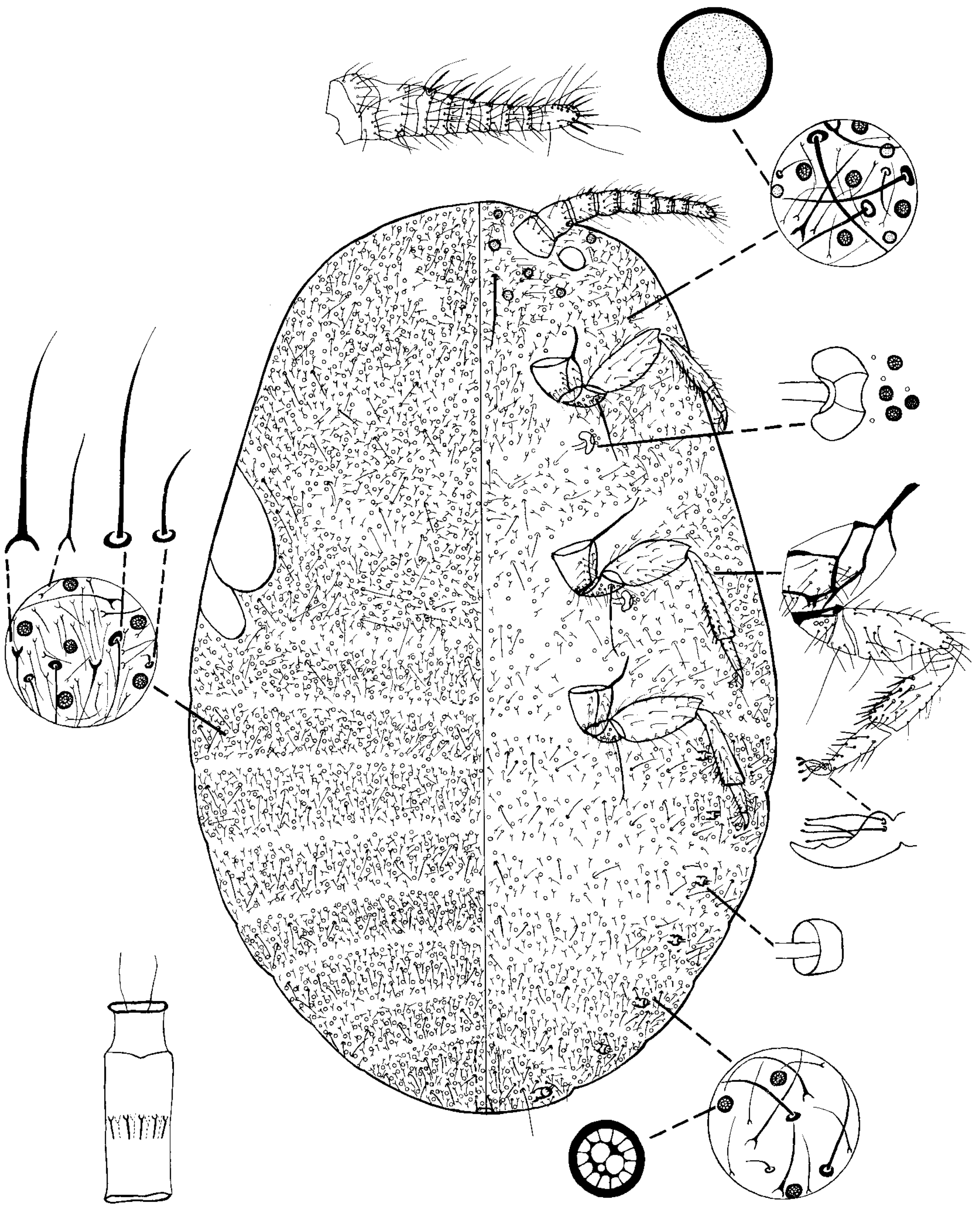


Fig. 47 *Ultracoelostoma brittini*, prepupa.

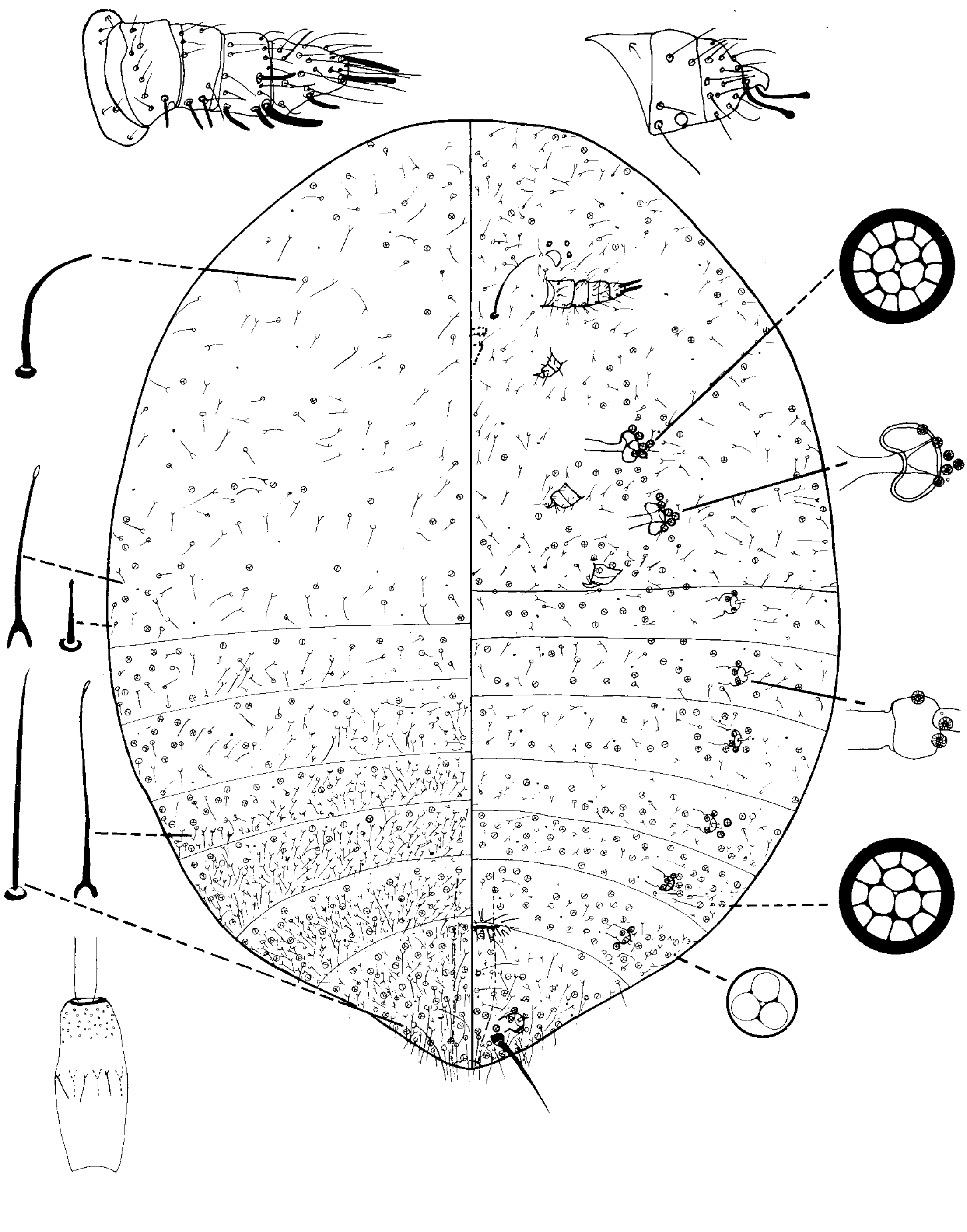


Fig. 48 *Ultracoelostoma dracophylli*, adult female.

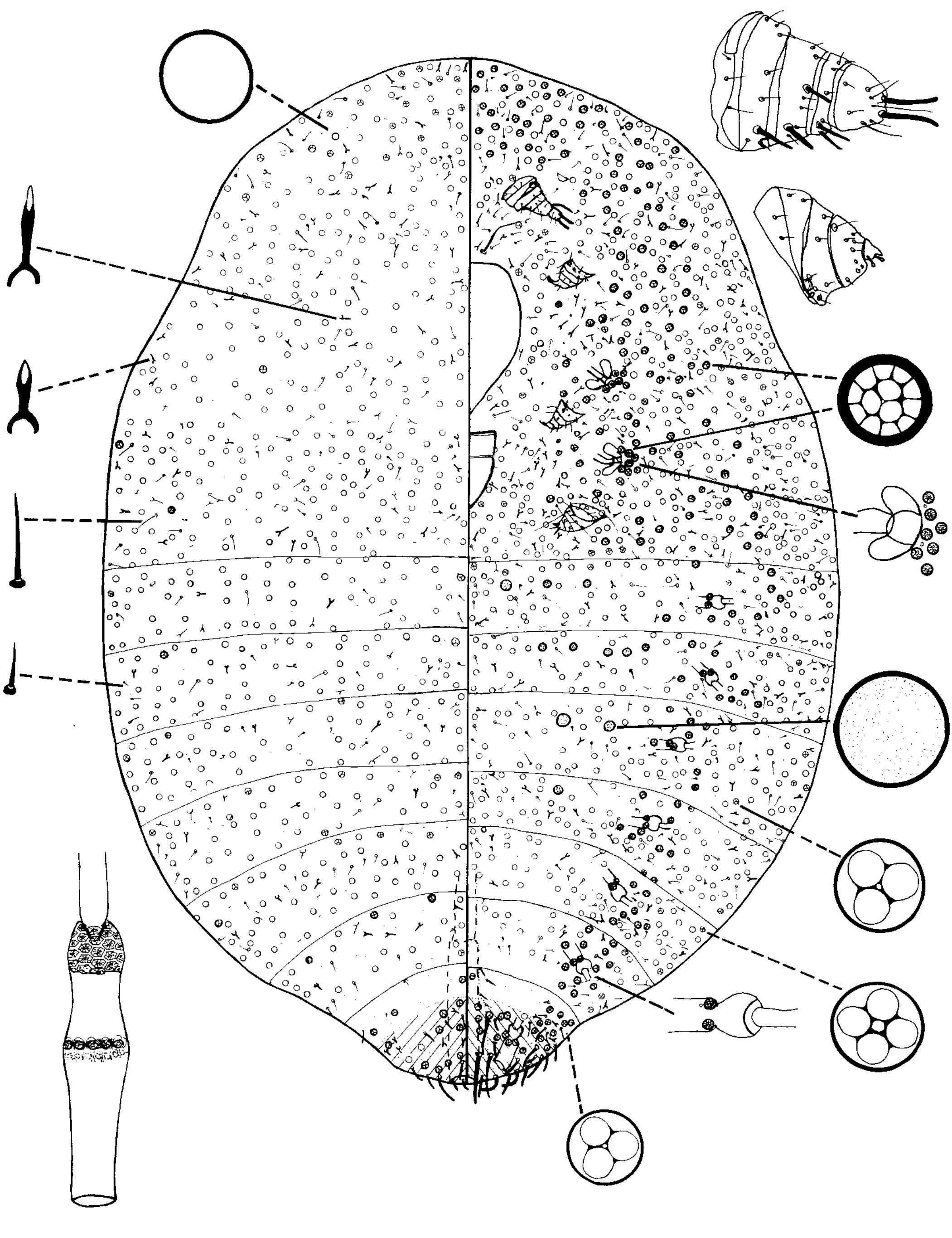


Fig. 49 *Ultracoelostoma dracophylli*, 2nd-instar female.

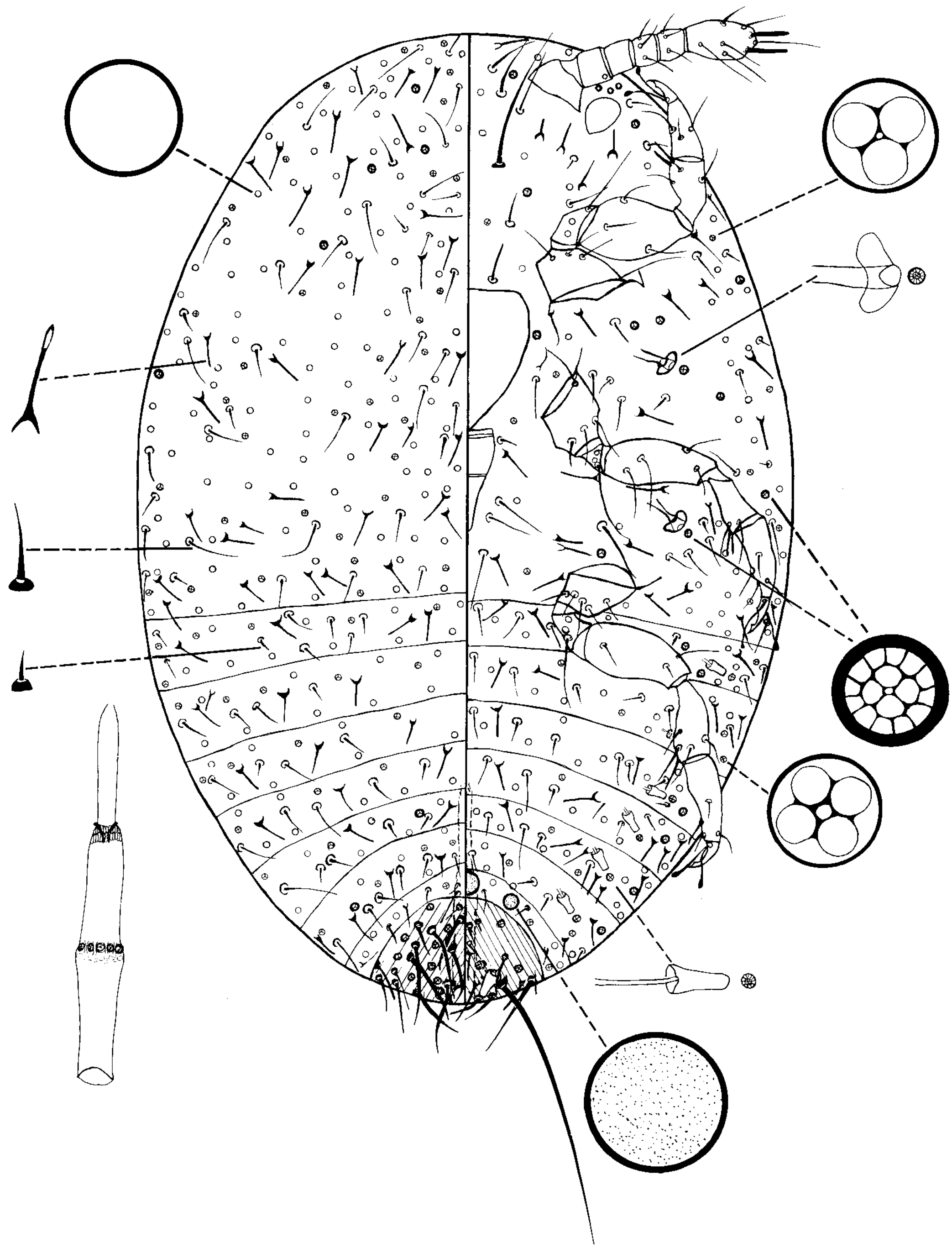


Fig. 50 *Ultracoelostoma dracophylli*, 1st instar.

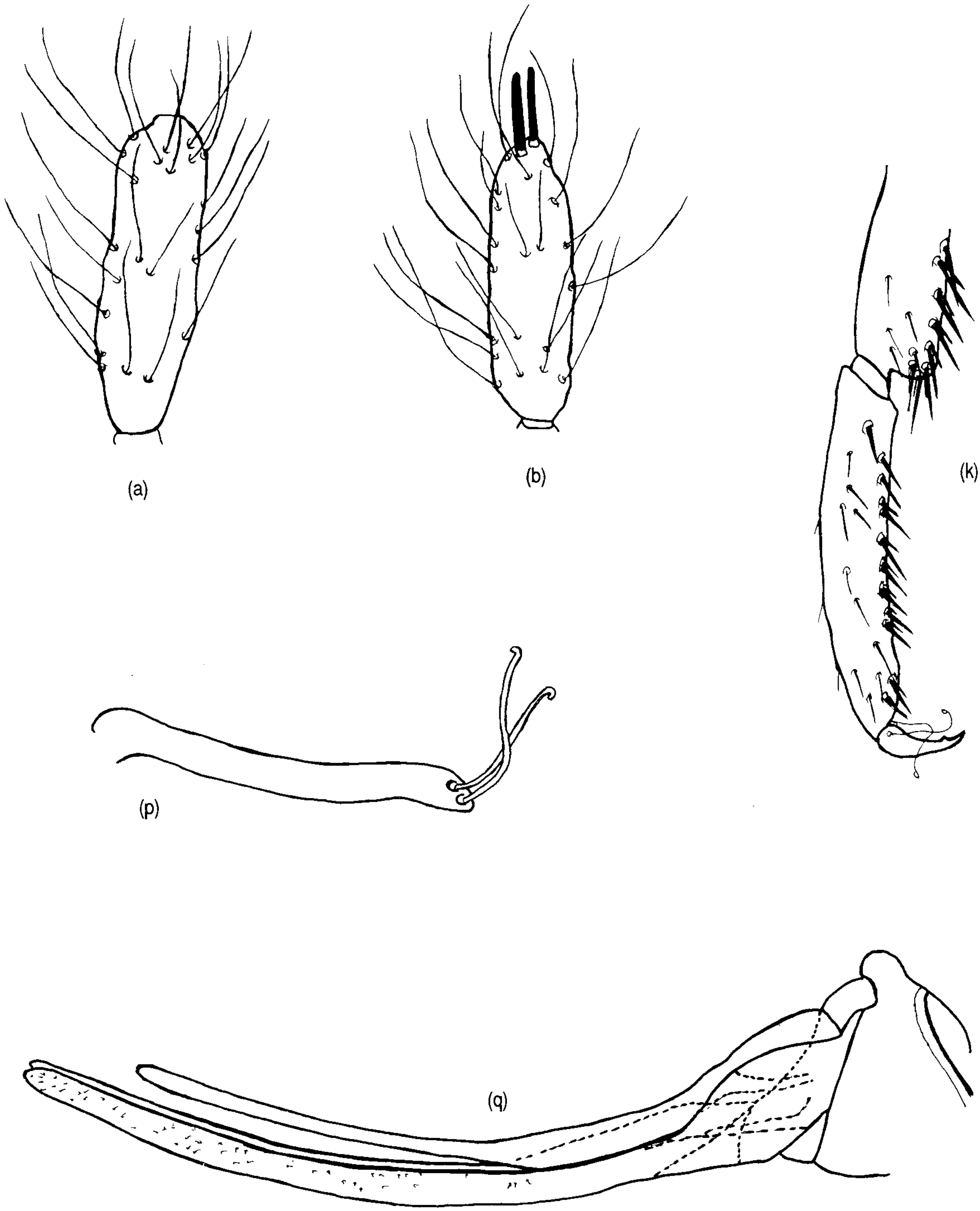


Fig. 51 *Ultracoelostoma dracophylli*, adult male: for identity of elements, see Fig. 5; (q) in lateral aspect.

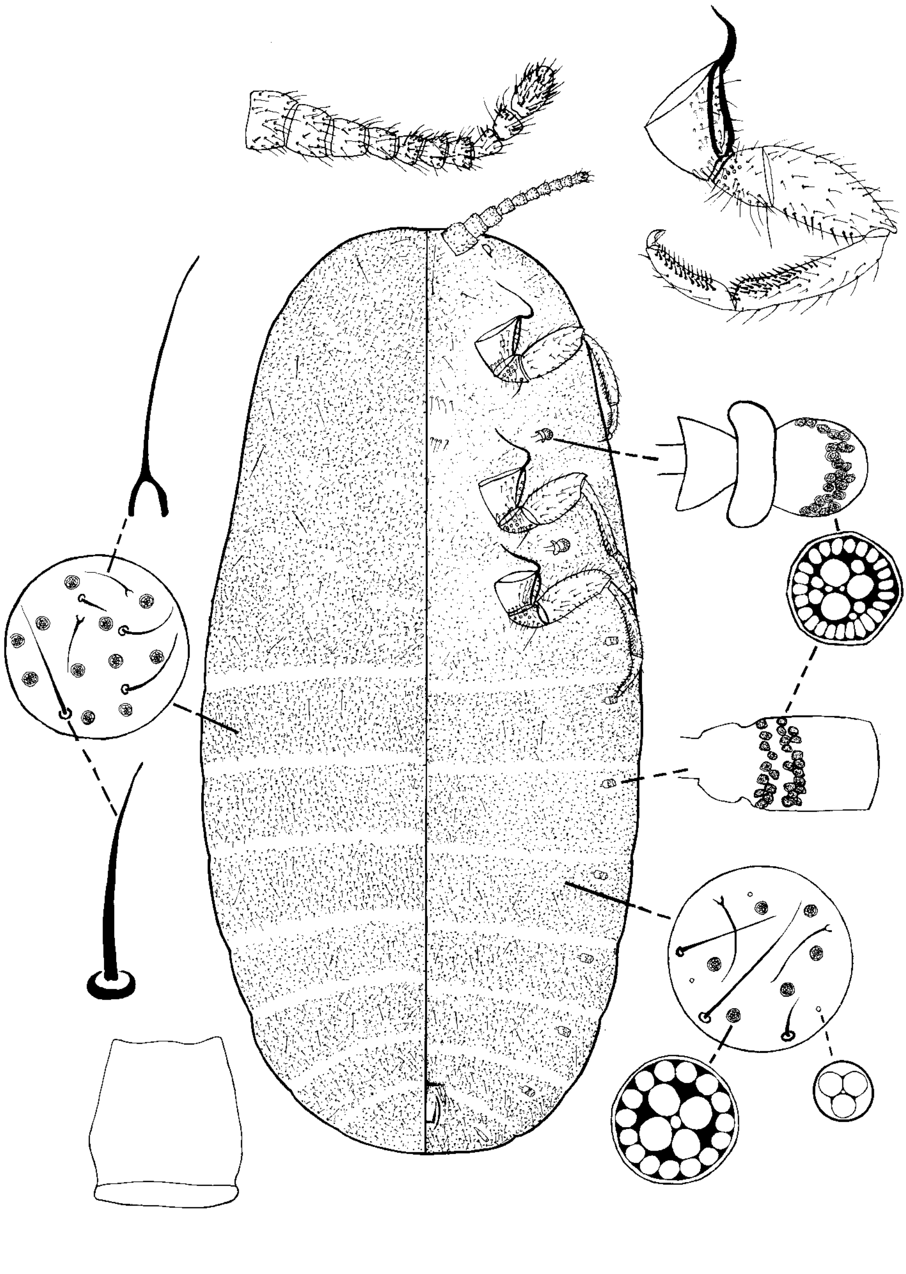


Fig. 52 *Platycoelostoma compressa*, adult female.

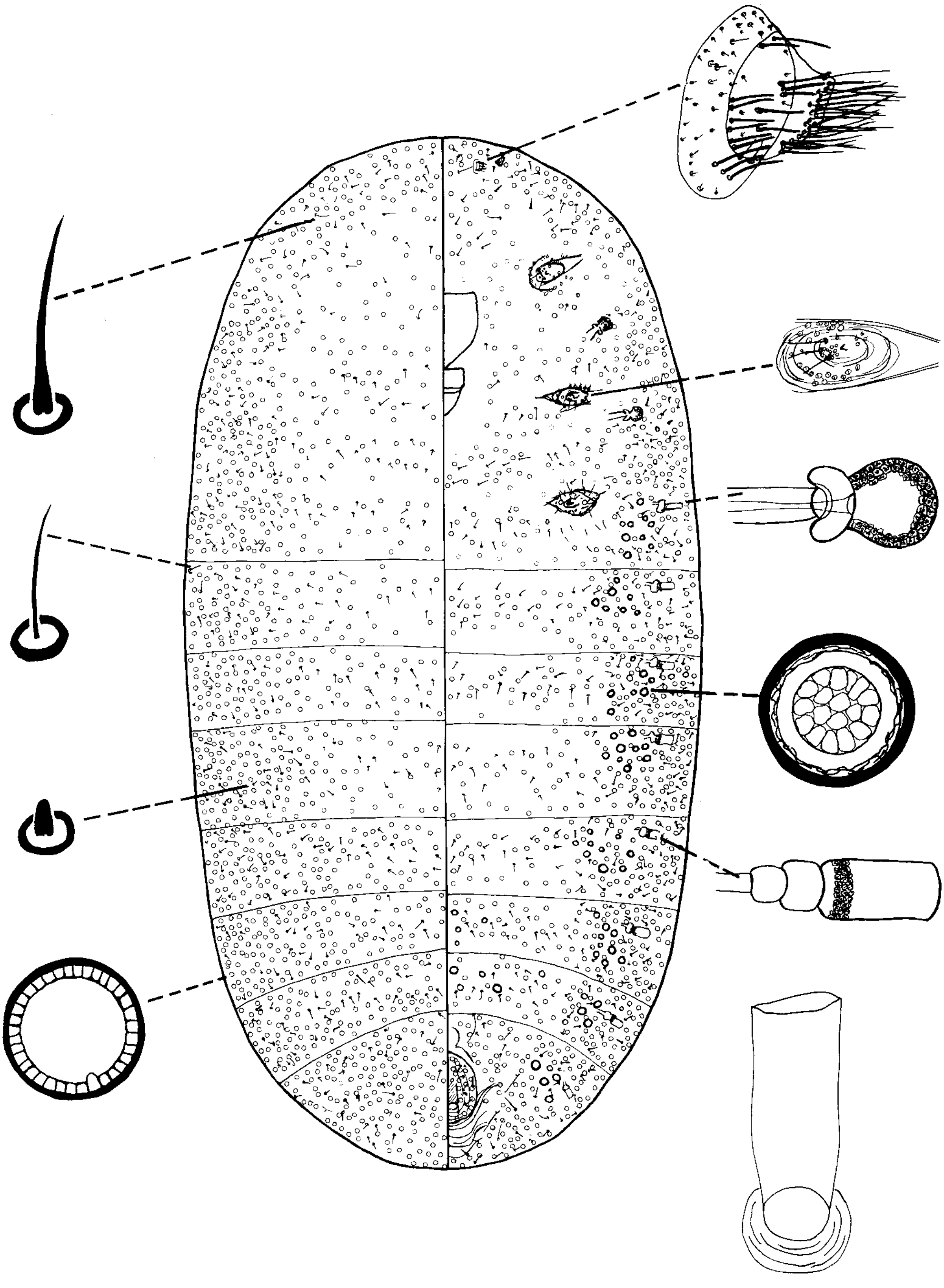


Fig. 53 *Platycoelostoma compressa*, 3rd-instar female.

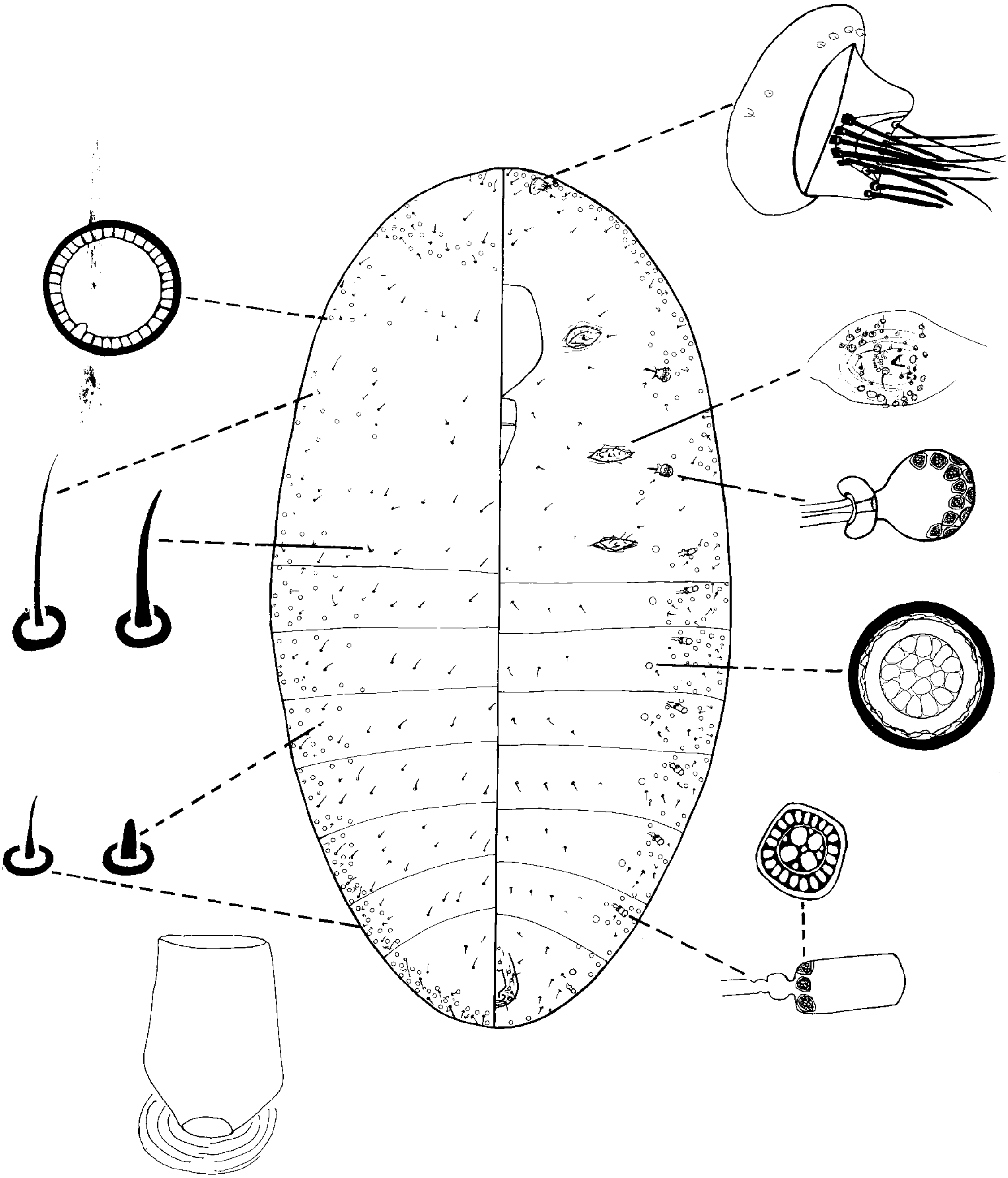


Fig. 54 *Platycoelostoma compressa*, 2nd-instar female.

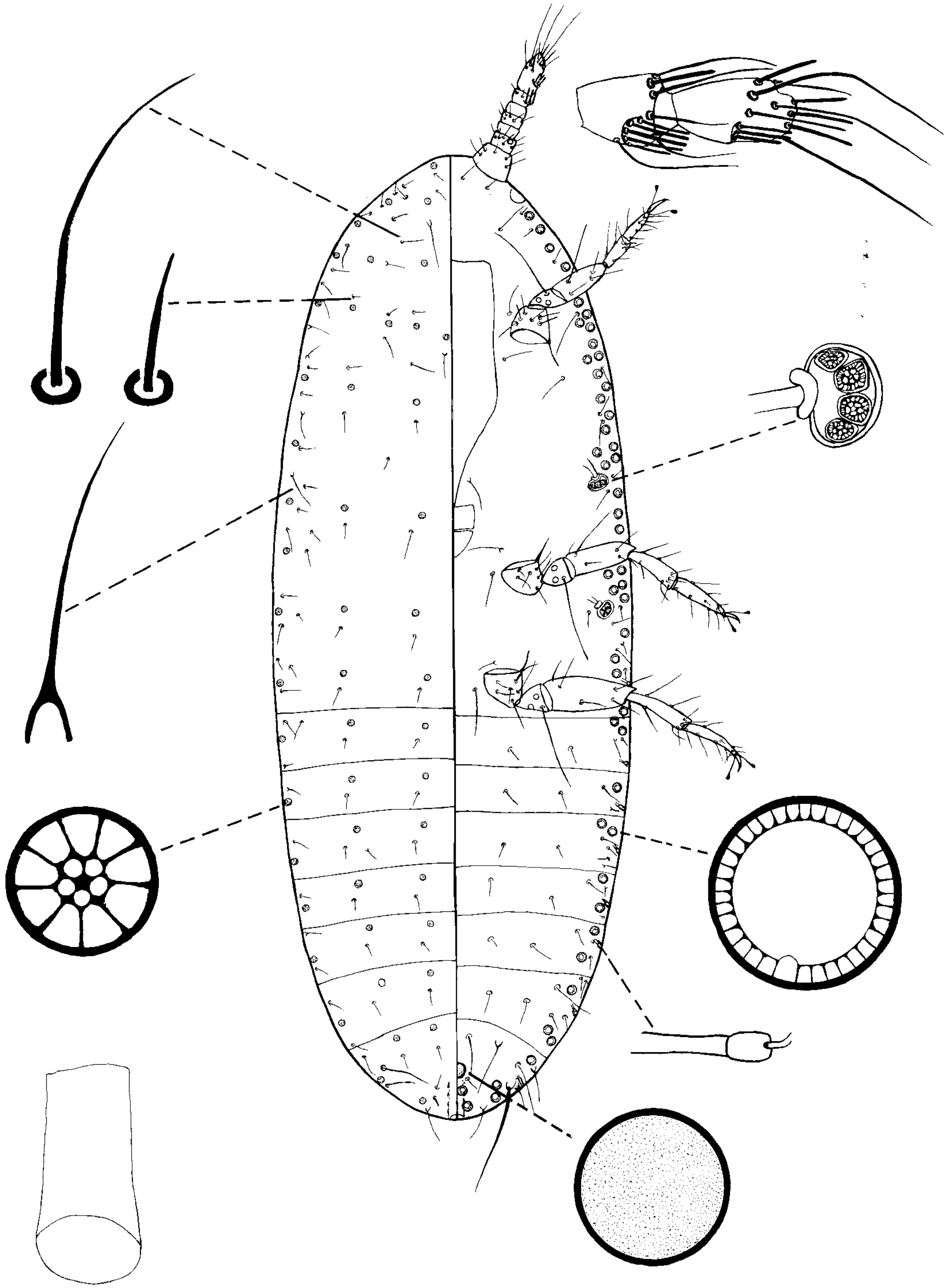


Fig. 55 *Platycoelostoma compressa*, 1st instar.

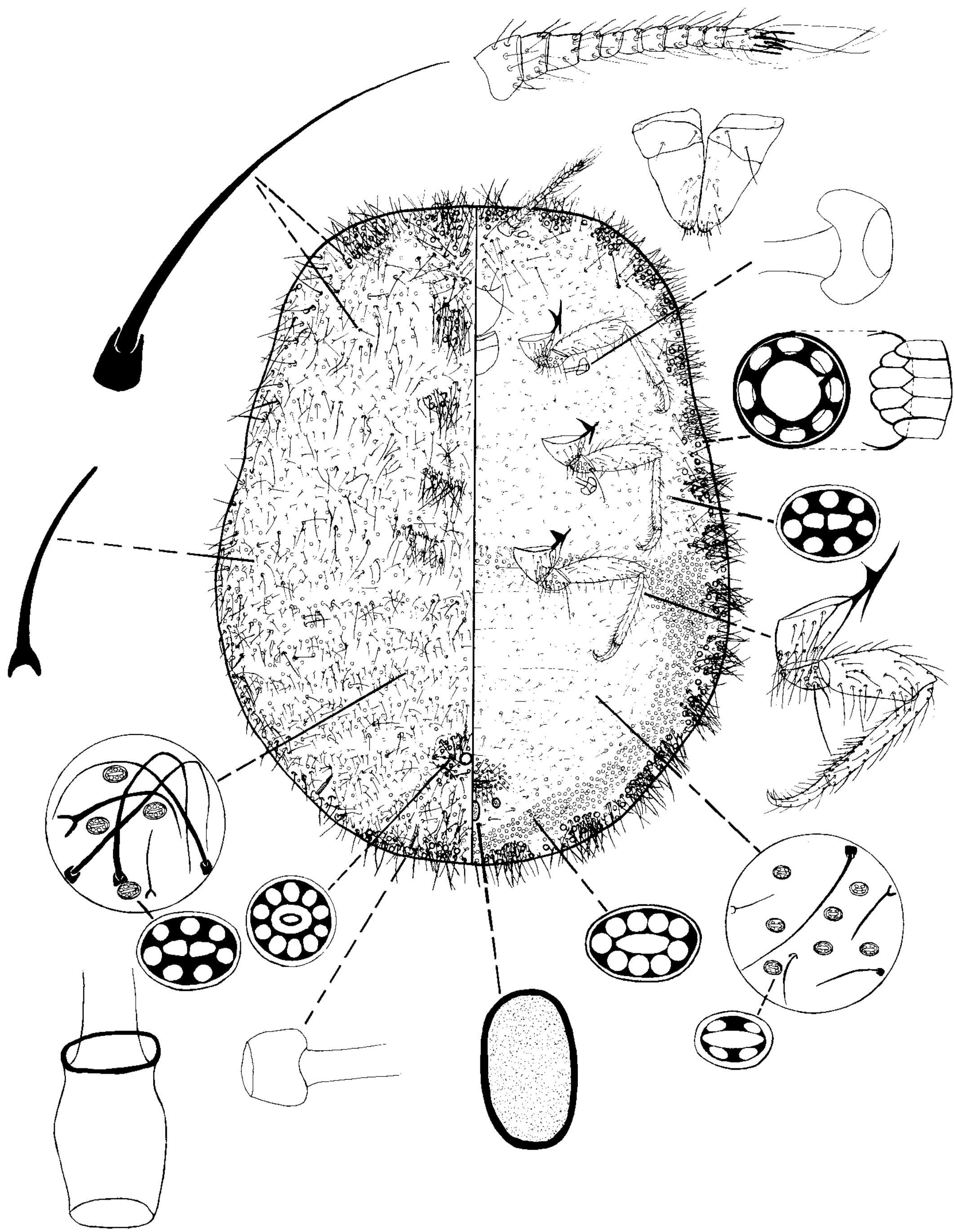


Fig. 56 *Icerya purchasi*, adult female.

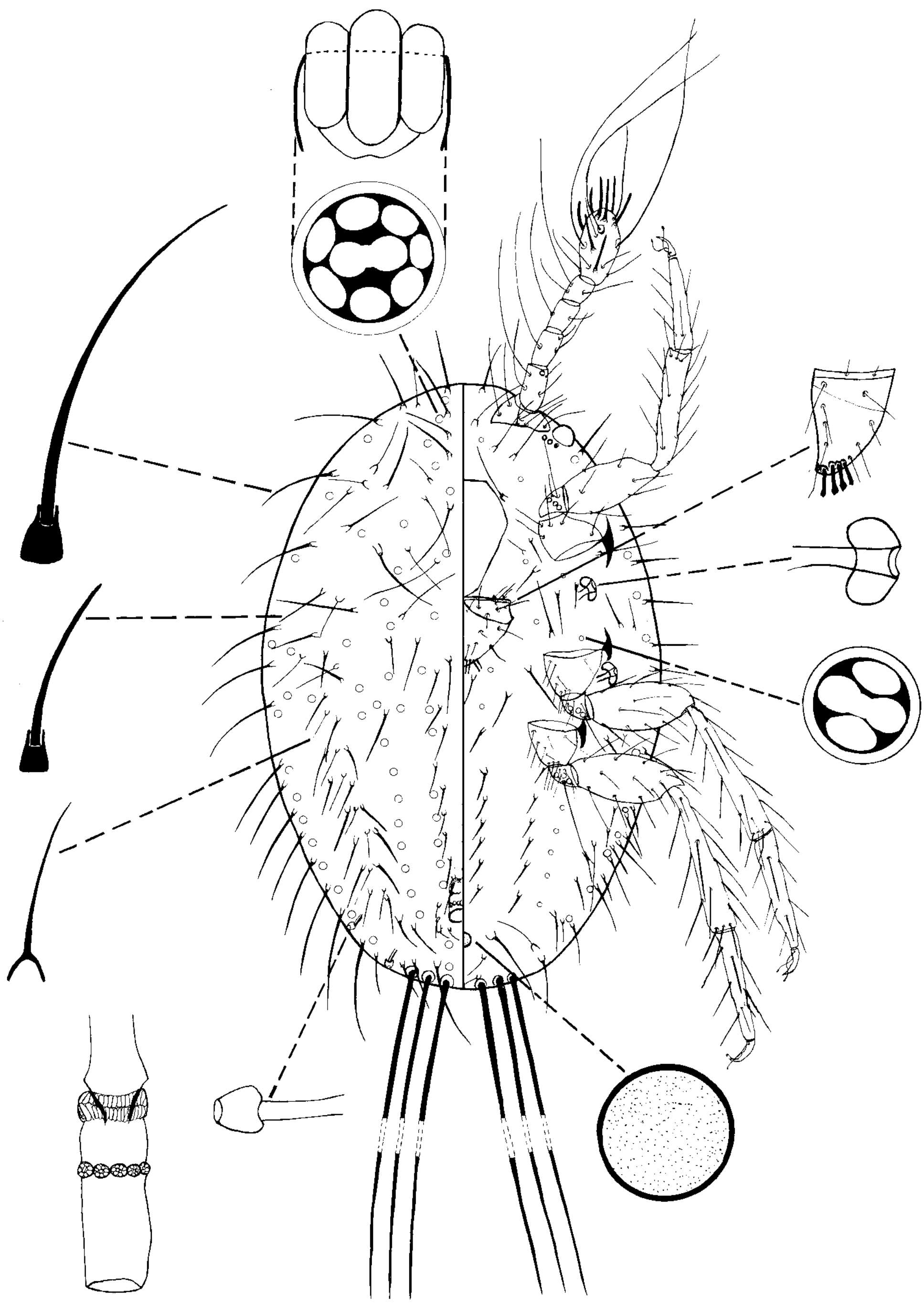


Fig. 57 *Icerya purchasi*, 1st instar.

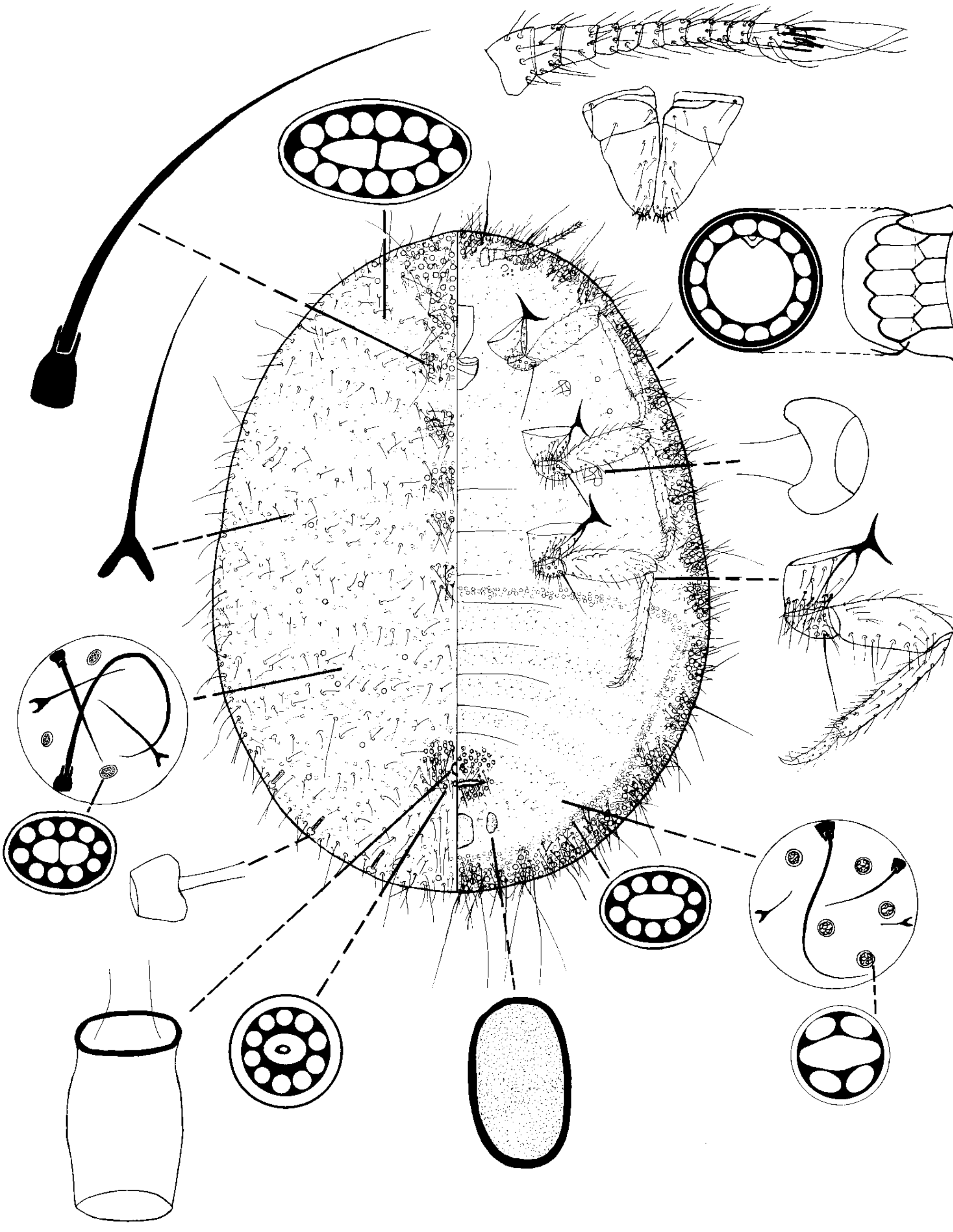


Fig. 58 *Icerya seychellarum*, adult female.

APPENDIX TABLES

Appendix Table 1 Comparison of character states between genera of Margarodidae known from New Zealand (*C, Coelostomidia; U, Ultracoelostoma; P, Platycoelostoma; I, Icerya;* •, present or yes; –, absent or no; r, reduced; /, dorsal / ventral aspect).

Character	*C*	*U*	*P*	*I*
A: Adult females				
Antennae well developed	•	–	•	•
Antennal segments (*n*)	10 or 11	4–7	10	9–11
Antennae reduced	–	•	–	–
Thickened setae on terminal segment	•	•	•	•
Legs well developed	•	–	•	•
Trochantal pores (*n*)	4 or 5	1–3	5	4
Trochantal seta	•	r	•	•
Stout setae on femur	•/–	–	•	–
Stout setae on tibia	•/–	–	•	–
Tarsi 1-segmented	•	•	•	•
Claw digitules:				
present	•	•	•	•
knobbed	•	•	–	–
extend beyond claw	–	•	–	–
Beak present, segments	–	–/•	–	3
Thoracic spiracles:				
Pore in atrium	–	–	•	–
Pores at opening	•	•	–	–
Abdominal spiracles (*n*)	7	7	8	2 or 3
Pores in atrium	•	–	•	–
Pores at opening	–	•	–	–
Minute pores	•/•	•/•	–/•	–/–
Cicatrices:				
on head	–/•	–/–	–/–	–/–
on abdomen	–/–	–/–	–/–	–/•
Open-centred pores	–/–	–/–	–/–	•/•
Ovisac band	–	–	–	•
Anal tube opening:				
apical	•	•	–	–
ventral	–	–	•	–
complex	•	•	–	–
B: Intermediate females				
Antennae well developed	–	–	–	•
Legs well developed	–	–	–	•
Claw developed	–/•	–/•	–	•
Digitules developed	–/•	–/•	–	•
Trochantal hair	•	•	–	•
Trochantal pores	•	•	–	•
Abdominal spiracles (*n*)	7	7	8	2 or 3
spiracles with pores	•/–	•	•	–
Beak:				
segments (*n*)	3	3	2	3
apical setae fine	•	•	•	–
Simple pores	–•/–•	•/•	–/–	–/–
Minute pores	•/•	•/•	–/–	–/–
Simple disc pores	•/•	•/•	–/–	–/–
Complex disc pores	–•/–•	•/•	–/–	•/•
Cicatrices	•/•	–•/–•	–•/–•	–•/–•
Open-centred pores	–/–	–/–	•/•	•/•
Setae	•/•	•/•	•/•	•/•
Derm hairs	•/•	•/•	–/–	•/•
Spines	–•/–•	–/–	–/–	–/–
Modified spines	•/•	–/–	–/–	–/–
Anal area sclerotised	–	•	–	–
Anus:				
dorsal	–	–	–	•
terminal	•	•	–	–
Anal tube:				
simple	–	–	•	•
with medial pores	•	•	–	–
with medial setae	•	–	–	–
C: First instars				
Antennae well developed	•	•	•	•
segments (*n*)	6	6	7	6
Sensory pores each side (*n*)	2	2	2	3
Thoracic spiracle pores (*n*)	1 or 2	1	4–6	–
Abdominal spiracles (*n*)	7	7	8	2 or 3
pores (*n*)	0–2	1	S7•,S8–	–
Beak:				
segments (*n*)	3	3	2	3
apical setae stout	–	–	–	•
Caudal setae (*n*)	2	2	2	6
Long marginal setae	–	–	–	•
Simple pores	•	•	–	–
Complex disc pores	–/•	•	–	•
Cicatrices (*n*)	3	3	1	1
Open-centred pores	–	–	•	•
Spines	•/–	–	–	–
Modified spines	•/–	–	–	–
Anal area sclerotised	–	•	–	–
Anus:				
dorsal	–	–	–	•
terminal	•	•	–	–
Anal tube:				
simple	–	–	•	–
complex	•	•	–	•

Appendix Table 2 Comparison of diagnostic character states between species of *Coelostomidia* known from New Zealand (•, present or yes; –, absent or no; /, dorsal / ventral aspect).

	deboerae	*jenniferae*	*montana*	*pilosa*	*wairoensis*	*zealandica*
A: Adult females						
Antennal segments (*n*)	11	10	10	10	10	11
Claw with denticle	–	•	–	–	–	–
Digitules knobbed	•	•	•	•	•	•
Femur with stout setae	–	–	–	–	–	•
Tibia with expanded tip	•	–	–	–	–	•
Pores on trochanter (*n*)	4	4	4	4 or 5	4	4
Hair on trochanter	•	•	•	•	•	•
Minute pores	•/•	•/•	–/–	•/•	•/•	•/•
Anal tube with:						
setae	•(12)	•	•	•(14)	•	•(26)
lobes	•	•	•	•	•	•
thickening	–	–	–	•	–	•
B: Intermediate females						
Claw with denticle	–	•	–	•	–	–
Last abdominal spiracle close to anus	•	–	–	–	–	•
Modified spines on body	•/•	–/–	•/•	–/–	•/•	•/•
Spines	–/–	•/•	–/–	•/•	–/–	–/–
Cicatrices	•/•	•/•	–/•	•/•	–/•	•/•
Simple pores	•/•	–/–	•/•	–/–	•/•	•/•
Complex disc pores	•/•	–/–	•/•	–/–	•/•	•/•
Anal tube with: derm hairs	–	•	–	–	–	–
lobes	–	•	–	•	–	–
minute pores	•	•	•	•	–	•
collar of thick tissue	•	•	•	•	•	–
C: First instars						
Spiracular pores (*n*):						
thoracic	2	1	2	2	1	2
abdominal	12	–	1	–	1	1
Last abdominal spiracle:						
large	–	–	–	–	–	•
close to anal tube	–	–	–	–	–	•
Modified spines on last abdominal segment	–/•	–/–	–/•	–/–	–/•	•/•
Spines on body	–/–	•/•	–/–	•/•	–/–	–/–
Simple pores	•/•	–/–	•/•	–/–	•/•	•/•
Complex disc pores	•/•	–/–	•/•	–/–	•/•	•/•

TAXONOMIC INDEX

All nominal taxa covered in the text are indexed, regardless of their status in taxonomy. The suffix 'k' denotes the page on which a species is keyed, and 'm' a distribution map. Page numbers in bold type indicate the start of major descriptive sections; italic type, pages on which a taxon is figured.

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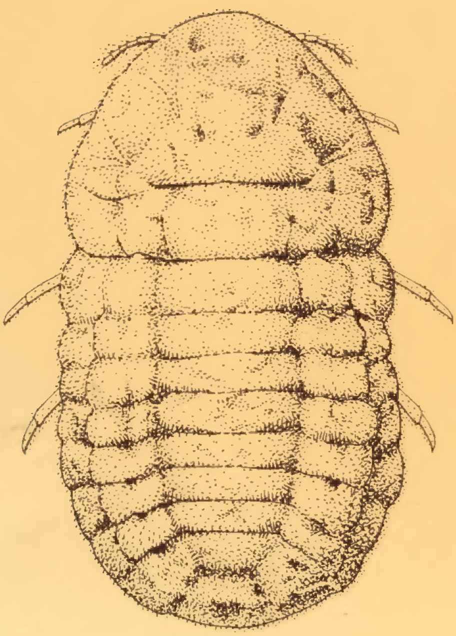

Margarodidae
(Insecta: Hemiptera)

C. F. Morales

CHECKLIST OF TAXA

INTRODUCTION

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DESCRIPTIONS

ILLUSTRATIONS

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