

THREE NOTEWORTHY SCALE INSECTS (HEMIPTERA: COCCOIDEA)
FROM HONG KONG AND SINGAPORE, INCLUDING *CRIBROPULVINARIA*
TAILUNGENSIS, NEW GENUS AND SPECIES (COCCIDAE), AND
THE STATUS OF THE CYCAD-FEEDING *AULACASPIS YASUMATSUI* (DIASPIDIDAE)

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ABSTRACT. – Observations are presented on the current status of the cycad-feeding armoured scale, *Aulacaspis yasumatsui* Takagi (Diaspididae), in Singapore and Hong Kong. A new genus and species of soft scale, *Cribropulvinaria tailungensis* (Coccidae) from *Aporosa dioica* (Euphorbiaceae) is described from Hong Kong, with all stages except prepupa, and the possible relationships of this new genus discussed. The soft scale, *Maacoccus cinnamomicolus* (Takahashi), recently rediscovered in Singapore, has its adult female redescribed. 1st- and 3rd-instar nymphs described for the first time, and a lectotype designated.

KEY WORDS. – Sternorrhyncha, Pulviniariini, Paralecaniini, Diaspidini, Oriental and Austro-oriental fauna.

INTRODUCTION

Scale insects or Coccoidea are sap-sucking insects related to the Psylloidea (jumping plant lice), Aphidoidea (aphids) and Aleyrodoidea (whiteflies). These four superfamilies are collectively known as the Sternorrhyncha, a group characterised by the labium apparently arising from the sternum. The superfamily Coccoidea embraces about 20 families, of which the Diaspididae (armoured scales) is the second largest, with about 1800 described species, and the Coccidae (soft scales) is the third largest, with about 1200 described species (Ben-Dov, 1993). Both families have a worldwide distribution but are most abundant in the tropics and subtropics. A great many coccoid species are significant pests of agriculture and horticulture, directly weakening plants through sap loss and often hindering photosynthesis when sooty mould grows on leaf surfaces soiled by excreted honeydew. In addition to their unsightly appearance, the presence of scale insects on plant material can be a major phytosanitary issue, and quarantine officials are constantly alert to the problem of scales being introduced to new countries through trade. Species are usually held in check by natural enemies, or climate constraints, in their native habitats but introduction to an area without these constraints can result in a major pest outbreak. Such is the case with the

first of the three species discussed in this paper.

During recent visits to Singapore and Hong Kong, the second author collected samples of three noteworthy scale insects. The first, *Aulacaspis yasumatsui* Takagi, is now a recognised diaspid pest of cycads. Infestations of *A. yasumatsui* are rendered highly visible because both the female and male tests are creamy to brilliant white, with large populations giving the foliage a whitish-grey, almost mildewed, appearance. Takagi (1977) illustrated its morphology and Howard et al. (1999) provided a photograph of an infested plant and a photomicrograph of a slide-mounted female. At the time of writing good photographs of *A. yasumatsui* were also present on the following Internet sites: <http://doacs.state.fl.us/~pi/enpp/ento/aulacaspis.html> and http://www.ftg.org/horticulture/n_cycadscale.html, the latter accompanying an article, by Mike McLaughlin, aptly entitled "What's this white stuff on my cycad?". The status of *A. yasumatsui* in Hong Kong and Singapore is compared with its recent spread to Florida and Hawaii. The other two noteworthy scales treated here are both coccids, or soft scales, one being the rare *Maacoccus cinnamomicolus* (Takahashi), previously known from only two specimens and here redescribed from a series of optimum specimens from Singapore, and the second a new genus from Hong Kong.

All available instars of both species are described, including the male of the new genus, *Cribropulvinaria*.

MATERIALS AND METHODS

Material discussed in this paper is deposited in The Natural History Museum, London (BMNH); Agriculture, Fisheries & Conservation Department, Tai Lung Farm, NT, Hong Kong Special Administrative Region (HKDA); and National Parks Board, Botanic Gardens, Singapore (SBG). All specimens that were slide-mounted were prepared using a method similar to that described by Ben-Dov & Hodgson (1997) and Hodgson & Henderson (2000). Each drawing shows the dorsal surface on the left side and the ventral surface on the right side; the vignettes showing the enlarged structures are not to scale. All measurements refer to the greatest length (i.e. diagonally across coxa, etc). The terminology used is as in Hodgson & Henderson (2000) for adult females, Giliomee (1967) for adult males and Williams (1997) for the immature stages, with a few minor amendments. With the exception of Figure 9, all illustrations were prepared by the first author.

PEST STATUS OF AULACASPIS YASUMATSUI TAKAGI

The description of this armoured scale (collected from a species of *Cycas* in Bangkok, Thailand, in 1972) appeared as a short appendix in *Insecta Matsumurana* (Takagi, 1977). At that time, the principal interest in this armoured scale was its presence on an unusual host plant, the first *Aulacaspis* species recorded on a cycad. It was not implicated as a pest at the time of its description and it was not until the 1990s that its potential to become a serious pest became evident. In Hong Kong, in 1992, *A. yasumatsui* occurred in sufficient numbers to cause 70-100 percent mortality of infested *Cycas revoluta* plants, without evidence of parasitism (Clive Lau, HKDA, pers. comm.; voucher material in BMNH). Tang et al. (1997) reported that an un-named parasitic wasp controlled *A. yasumatsui* in Thailand but that an absence of parasitoids could lead to the scale assuming pest proportions. Dry specimens from Yasumatsu's original 1972 collection (BMNH) have parasitoid emergence holes and this clear evidence of parasitism supports the theory that Thailand is the natural domicile of this insect. The Oriental Region has been stated to be its likely native habitat (Heu & Chun, 2000) but, nonetheless, the early records of economic impact were also from the Oriental Region.

The second author visited Hong Kong in late 1999, and Singapore in early 2000, and found *A. yasumatsui* to be present in both cities, but having a markedly different effect in each. In Hong Kong, high levels of plant morbidity were still evident, with obviously dead cycads spoiling the appearance of amenity planting. In Singapore, several *Cycas rumphii* trees were observed with moderate populations of *A. yasumatsui*, somewhat patchily distributed over the plants.

However, in Singapore there was definite evidence of parasitism of the scales and the trees did not appear to be suffering ill effects. Close-by, potted *C. revoluta* plants were found to be sparsely affected by another diaspid, *Pseudaulacaspis cockerelli* (Cooley), but had no infestation of *A. yasumatsui*. The lesser impact of *A. yasumatsui* in Singapore may bear out Howard et al.'s (1999) statement that populations in south-east Asia were only found in areas with a pronounced dry season: possibly Singapore's year-round humid climate is not particularly favourable for *A. yasumatsui*, but some biological control by parasitoids is also clearly relevant.

Howard et al. (1999) reported the discovery of *A. yasumatsui* in Florida in 1996, that it was present on 22 cycad species in the State, causing serious problems in botanical gardens, parks and elsewhere, and they suggested the common name "cycad aulacaspis scale". Howard et al.'s paper presented extensive biological observations on populations which were not under effective control and were, consequently, highly damaging or lethal to their hosts. No fewer than 19 other species of armoured scales had been recorded previously from cycads in Florida, notably on *Cycas revoluta* and *Zamia integrifolia*, but none of these were known to cause significant damage to cycads (Dekle, 1976).

Howard et al. (1999) also reported that achieving chemical control of *A. yasumatsui* in Florida was unusually difficult and was patchy in its effectiveness. However, two natural enemies from the Orient were introduced into southern Florida through a co-operative venture between the Tropical Research & Education Center (Florida) and the National Biological Research Center (Thailand). These natural enemies were *Cybocephalus binotatus* Grouvelle (Coleoptera: Nitidulidae) and *Coccobius fulvus* (Compere & Annecke) (Hymenoptera: Encyrtidae), and present indications are that their introduction has been particularly successful (Howard & Weissling, 1999).

The cycad aulacaspis scale, discovered in Hawaii in 1998, on *Cycas revoluta* on the island of Oahu (Heu & Chun, 2000), was probably accidentally introduced from Florida through legal importation of cycads. Heu & Chun used an alternative common name "sago palm scale", but this is misleading because true sago is a palm, *Metroxylon sagu*, not a cycad. As with the first reports from Florida, Heu & Chun stated that no parasitoids were then known from *A. yasumatsui* in Hawaii.

At the time of writing, the known distribution of this insect comprises: Thailand (Takagi, 1977; BMNH), southern China, including Hong Kong (Howard & Weissling, 1999; Heu & Chun, 2000; BMNH; HKDA), Singapore (BMNH, SBG), Hawaii (Heu & Chun, 2000), southern USA (Howard et al., 1999; Howard & Weissling, 1999), Cayman Islands & US Virgin Islands (Howard & Weissling, 1999) and Puerto Rico (Halbert, 2000). CABI/EPO (2000) have prepared a distribution map for this pest species.

DESCRIPTIONS OF SOFT SCALES (COCCIDAE)

Cribropulvinaria, new genus (Coccidae, Pulvinariini)

Type species: *Cribropulvinaria tailungensis*, new species

Generic diagnosis. – **Female:** with 4 stages. **Adult female:** a soft scale belonging to the coccid tribe Pulvinariini, with a woolly ovisac secreted from 4 types of ventral tubular duct, all found in mediolateral areas of abdomen; with antennae reduced to 2 segments; legs entirely absent; marginal setae spinose, in a continuous marginal band several setae deep, extending up anal cleft margin on dorsum; stigmatic setae not differentiated from marginal setae; stigmatic clefts shallow; dorsum with a complete submarginal band of cribriform plates; dorsal setae absent; spiracles large; pregenital disc-pores mainly 6-locular, in a broad band medially and mediolaterally on abdomen; anal plates with 4 spinose setae. **Third-instar female:** similar to adult female but with no ventral tubular ducts, no multilocular disc-pores on abdomen and fewer marginal setae and cribriform plates on dorsum. **Second-instar female:** with highly reduced legs and with only 3-segmented antennae; tubular ducts and multilocular disc-pores absent; marginal spinose setae in a single row, but also extending up dorsal margins of anal cleft; anal plates each with 4 stout spinose setae; dorsum with 2 pairs of large cribriform plates, 1 pair on head and another posteriorly on abdomen. **First-instar (sexes probably not separable):** a rather atypical coccid crawler, separable from other known crawlers by - absence of long apical setae on anal plates, but each plate with 3 spinose setae; anal plates already withdrawn onto dorsum at anterior end of anal cleft; long spinose marginal setae; absence of stigmatic setae but with each stigmatic area with a slight cleft and a slight sclerotisation, and absence of trilobular pore on dorsum of head.

Male: with 5 stages. **Second-instar male:** rather similar to second-instar female but differs in having: slightly larger legs, each with a distinct claw; antennae with perhaps 6 or 7 ring-like segments; a continuous marginal band of ventral tubular ducts; rather more marginal spinose setae; dorsum with a submarginal band of cribriform plates, with 8 on each side; a marginal band of dorsal tubular ducts, quite different in form to ventral tubular ducts. **Prepupa:** none available. **Pupa:** a typical coccid pupa, but with no spiracular disc-pores; with very short rounded lobes on abdominal segment VII and VIII; with 2 ante-anal setae, well-developed wing-buds, no dorsal setae on abdominal segments V, VI and VII, and the penial sheath wider than long. **Adult male:** a fairly typical, large and robust, adult male coccid but characterised by: almost complete absence of hair-like and fleshy setae on body; only 2 pairs of simple eyes; slight indications of a postoccipital ridge; proepisternum + cervical sclerite unusually broad; scutum laterad of scutellum reticulated; area surrounded by mesopostnotum laterally and scutellum anteriorly partly reticulated; abdominal sternites and tergites all strongly sclerotised; pleurites unsclerotised; glandular pouch and glandular pouch setae present; legs and antennae

very hirsute, mainly with short fleshy setae; mesepisternum and mesepimeron with dense groups of short fleshy setae; hamulohalteres absent; aedeagus short, only slightly longer than basal rod.

Comment. – Hodgson (1994), in his revision of the genera within the Coccidae, considered that some 18 or 19 soft scale genera could be placed within the tribe Pulvinariini, in the subfamily Coccinae. The main characters of this tribe were considered to be (i) the production of a woolly ovisac by the ovipositing female, this protruding from beneath the posterior end of the abdomen; (ii) the presence of ventral tubular ducts of at least 3 or 4 types, including a small duct with a fine inner ductule (which generally forms a submarginal band) and a larger duct with the inner and outer ductules of subequal width (which is typically present on the head and thorax); (iii) absence of a woolly test covering the dorsum; (iv) frequently without dorsal tubular ducts; (v) presence of spinose dorsal setae; (vi) legs well developed with a tibio-tarsal articulatory sclerosis; (vii) absence of pocket-like sclerotisations, and (viii) shallow, unsclerotised stigmatic clefts. *Cribropulvinaria* has all of these characteristics except that it lacks dorsal setae, and the legs and antennae are reduced or absent. Many characters of *Cribropulvinaria* are typical of the subfamily Myzolecaniinae (reduced limbs, presence of cribriform plates, marginal setae in more than 1 row, pregenital setae all short) but this subfamily never produces a woolly ovisac and only has 1 type of ventral tubular duct (if present at all).

The key to genera belonging to the Pulvinariini in Hodgson (1994: 80), based on adult female characters, can be modified to include *Cribropulvinaria* as follows:

- 1a. Legs and antennae highly reduced or absent; with a submarginal band of cribriform plates; dorsal setae absent; pregenital disc-pores present mediolaterally as well as medially on abdomen. *Cribropulvinaria* Hodgson & Martin
 – Legs and antennae well developed; cribriform plates absent; dorsal setae present; pregenital disc-pores not present mediolaterally on abdomen. 1b
 1b. As for 1 in original key.

Name derivation. – *cribro-* from *cribrum* (L., a sieve), referring to the presence of cribriform plates, and *-pulvinaria* after the genus *Pulvinaria*.

Cribropulvinaria tailungensis, new species
(Figs. 1-7)

ADULT FEMALE (Fig. 1)

Described from 3 adult females in excellent condition.

Colour in life uncertain; colour of dried material dark brown, with a dusting of white wax over dorsum and with a marked fringe of wax filaments around whole margin, these generally slightly longer abdominally. Mature female with a white, felted, ovisac emerging from beneath abdomen, about 1.5 mm long on the available dry specimen.

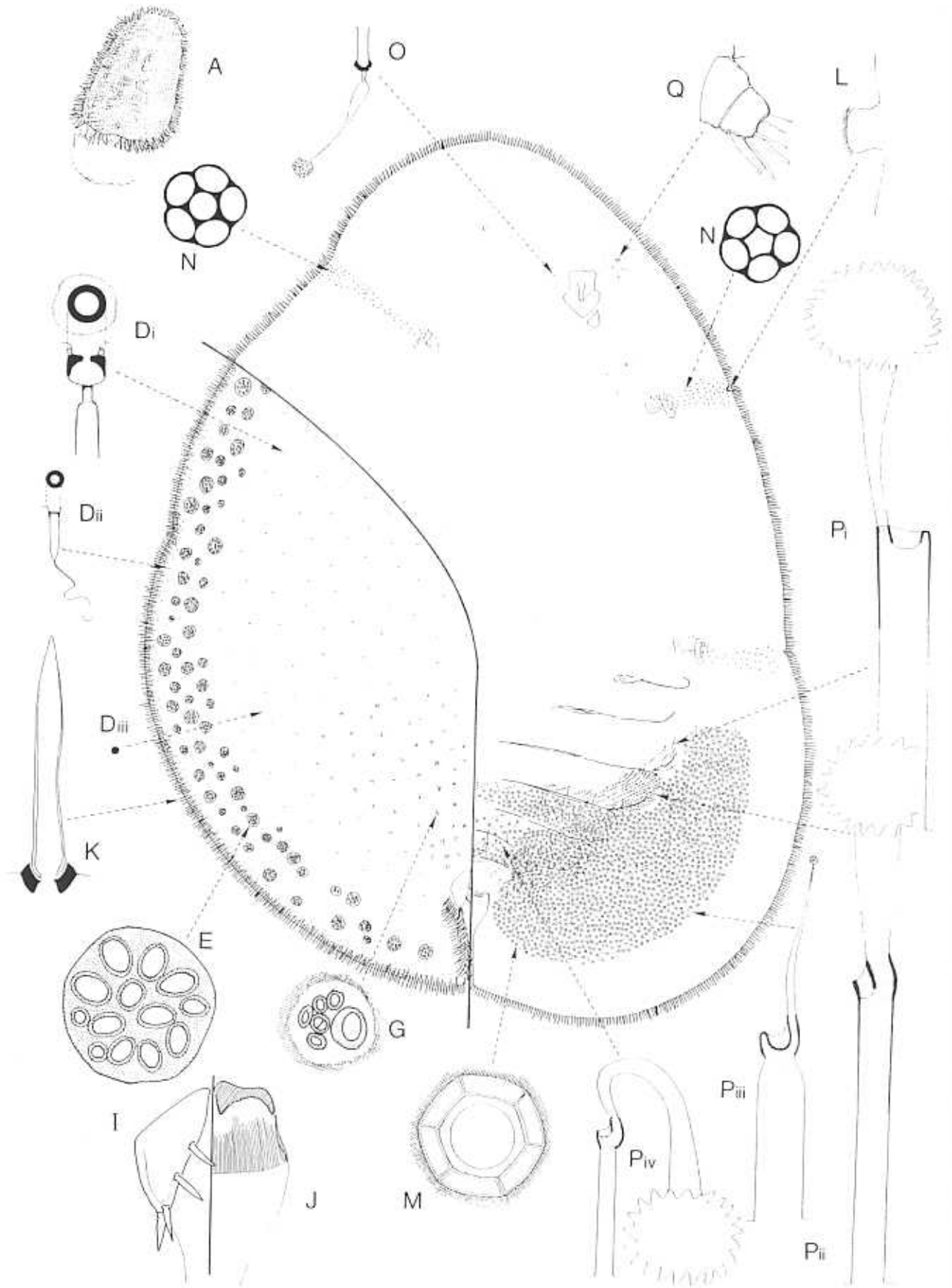


Fig. 1. *Cribropulvinaria taiungensis*, new species. Adult female. In this figure and in Figs. 2-4, 7-8 and 10-11 inclusive, A = appearance in life; B = dorsal setae; C = dorsal microductule; D = dorsal pores; E = cribriform plates; F = "ghost" cribriform plates; G = preopercular pores; H = dorsal tubular ducts; I = general view of anal plates; J = general view of anal area; K = marginal setae; L = stigmatic cleft; M = pregenital/preanal disc-pores; N = spiracular disc-pores; O = ventral microduct; P = ventral tubular ducts; Q = antenna; R = spiracle; Sm = metathoracic leg (or part of); Sp = apex of prothoracic leg.

Mounted material. – quite large, 3-5 mm long and 2.5-4 mm wide, the outline more or less egg-shaped, slightly asymmetrical. Stigmatic clefts absent or very shallow; anal cleft short, about 0.09 of total body length.

Dorsum. – signs of asymmetry slight; derm slightly to heavily sclerotised at maturity, without areolations, Dorsal setae absent. Dorsal pores of probably 3 types: (i) a small, round, sunken pore, with a short, broad, inner ductule - distributed throughout; (ii) a much smaller, sunken, round pore, with a moderately long inner ductule possibly without a glandular end - distributed throughout but also in a distinct submarginal band just dorsad of marginal spines; (iii) a minute pore - infrequent throughout. Preopercular pores: small tight groups of 1-6 pores, each group generally composed of 1 pore subequal in size to pore type (i) above, along with 4-5 much smaller pores - in a broad group anterior to anal plates and extending anteriorly to almost level with posterior spiracles and laterally to about half-way to margin. Cribriform plates heavily sclerotised, somewhat variable in size but most plates with about 8-20 inner pores - abundant in a submarginal ring 3-4 plates wide round entire dorsum. Dorsal tubular ducts, dorsal tubercles and pocket-like tubercles absent. Anal plates probably each approximately triangular, 126-132 μm long and 161-168 μm wide; each with 4 strong spines, 3 along inner margin plus an apical spine, all subequal in length or with apical spine slightly longer (37-45 μm long). Anogenital fold without setae along either anterior or lateral margins; anal ring with 6 long setae. Anal cleft distinct with parallel margins and with a broad band of marginal spines extending along entire cleft and part-way round posterior margin of anal plates. Eyespots apparently absent.

Margin. – marginal setae long, spinose, sharply pointed, slightly waisted - abundant in a marginal band about 2 spines deep anteriorly and up to 3 spines deep posteriorly; about 90-100 present between stigmatic clefts on shortest side; each 28-45 μm long and with a well-developed basal socket. Stigmatic clefts present but very small and shallow, indicated by a shallow depression with short parallel sides; stigmatic spines, if present, undifferentiated from marginal spines.

Venter. – derm membranous, segmentation on abdomen very clear. Appendages showing distinct asymmetry, with mouthparts, leg protuberances (when visible), antennae and spiracles all closer to margin on one side of body than on other. Pregenital disc-pores with 6 or 7 outer loculi and a large, round, inner loculus - extremely abundant medially across abdominal segments V, VI and VII, although becoming less frequent in middle of each segment; also extremely abundant in a very large group between mediolateral folds and margin, from about segment III posteriorly to about mid point of anal cleft. Spiracular disc-pores with 5 outer loculi - in broad bands between spiracle and margin, with about 50-60 disc-pores in each anterior band and 70-90 in each posterior band; also with 0-4 quinquelocular disc-pores near antennae and occasionally laterad to mouthparts.

Ventral microducts quite large, with a slightly bulbous inner ductule and a distinct, quite large glandular end - frequent throughout. Preantennal pores absent. Ventral tubular ducts restricted to abdomen, of 4 types: (i) with a broad outer ductule and a narrower inner ductule and an exceptionally large glandular end - medially on segments IV and V and perhaps occasionally laterad to mediolateral folds on these 2 segments; (ii) a duct with a narrower and much longer outer ductule, an equally broad or even broader inner ductule and an exceptionally large glandular end - in an obvious and dense group near mediolateral folds on segment IV, a few in similar position on segment III, also a few laterad to mediolateral folds on these 2 segments; (iii) a duct with a broad outer ductule, a much thinner inner ductule and a minute (or no) glandular end - abundant in area laterad to mediolateral folds where pregenital disc-pores present, extending posteriorly from segment III (maybe occasionally II) to mid-way up anal cleft, also a few present medially on segment V and possibly IV and VI as well; (iv) a duct with a much shorter and narrower outer ductule, a broad inner ductule and an exceptionally large glandular end - medially on segments V, VI and VII and in a band just laterad to mediolateral folds on these segments and segment VIII. Ventral setae - small setae frequent throughout venter; long pregenital setae absent; with a group of small setae on segment VIII on either side of vulva. Antennae extremely reduced, perhaps 27-32 μm long, each composed of about 2-3 segments, with 1 seta on basal segment and with about 5 fleshy setae and 2-3 hair-like setae on terminal segment. Mouthparts displaced to one side but normally developed; labium twisted through 90° and pointing laterally. Spiracles each with a large peritreme (width of each peritreme: anterior 94-113 μm wide, posterior 105-126 μm) and with a proportionately small muscle plate. Legs reduced to small protuberances, or absent. Vulva opening anteriorly on segment VIII.

Comment. – *Cribropulvinaria tailungensis* is here considered to belong to the Pulvinariini because it produces a short, felted ovisac from beneath the body, secreted by a complex of 4 types of ventral tubular ducts, a character-state restricted to the tribe Pulvinariini. *Cribropulvinaria tailungensis* also shares with typical Pulvinariini a few other characters, namely the ovisac not covering the dorsum, and the absence of dorsal tubular ducts and pocket-like sclerotisations. However, it differs from most or all other genera currently included in the Pulvinariini in the presence of (i) cribriform plates, (ii) a double band of spinose marginal setae (character shared only with *Tectopulvinaria*), (iii) large spiracles; in the absence of (iv) large pregenital setae and (v) dorsal setae; and (vi) in having reduced legs and antennae. Most of the latter characters are major features of the Myzolecaniinae (see Hodgson, 1994). However, the distribution of the pregenital disc-pores and the presence of the 4 types of ventral tubular duct make it quite unlike any currently known species in the Myzolecaniinae.

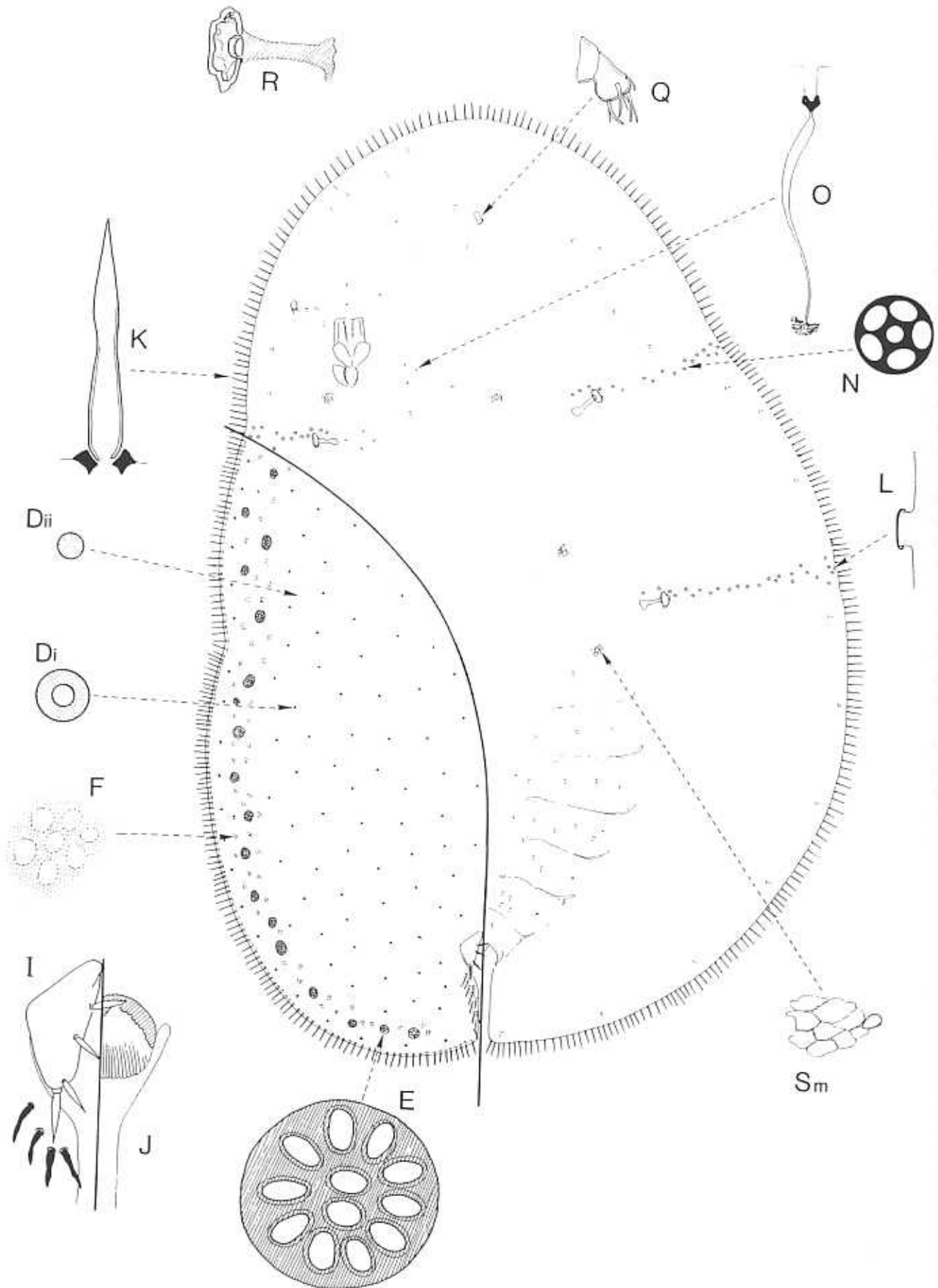


Fig. 2. *Cribropulvinaria tailungensis*, new species. Third-instar female nymph. For lettering, see Fig. 1.

THIRD-INSTAR FEMALE (Fig. 2)

Described from 2 specimens in good condition.

Unmounted material. – without a glassy test, outline slightly asymmetrical; dorsum covered in a thin powdery wax and with a marked marginal ring of white wax filaments.

Mounted material. – outline rather pear-shaped, showing clear signs of asymmetry; length 2.5 mm, width 1.9 mm, with a short anal cleft about 0.11 of body length; stigmatic clefts very shallow.

Dorsum. – derm membranous, without signs of segmentation. Dorsal setae absent. Dorsal pores of perhaps 2 types: (i) a moderate-sized open pore - apparently randomly distributed medially, and perhaps also present in a submarginal band laterad to cribriform plates, and (ii) a much smaller pore - similarly distributed to (i) but perhaps most common marginally and submarginally. Dorsal tubular ducts, preopercular pores and dorsal tubercles absent. Cribriform plates generally fairly small, each comprising about 5-30 small pores - with about 12 plates on each side of abdomen, 4-6 on each side of thorax and 13 on head. In addition, "ghost" cribriform plates (see F on Fig. 2) present as groups of pale incipient loculi within submarginal band of cribriform plates (possibly precursors of cribriform plates later to appear on adult), more abundant than cribriform plates but hard to count. Anal plates together more or less quadrate, 83 μ m long and 112 μ m wide, each with 4 stout spines, 3 along inner margin and 1 rather longer spine apically, length of latter 39 μ m. Anal fold without setae. Anal cleft short, with 10-14 stout marginal spines along each margin on dorsum; anal ring with 6 setae. Eyespots absent.

Margin. – marginal setae spinose, sharply pointed, distinctly waisted, with well-developed basal socket; each 23-30 μ m long; in a single line (occasionally tending to be double posteriorly) around margin, with 33-45 laterally between stigmatic clefts. Stigmatic clefts present but very shallow and parallel sided; stigmatic spines not differentiated from marginal spines.

Venter. – derm membranous, segmentation distinct on abdomen. Preanal disc-pores absent. Spiracular disc-pores with mainly 5 outer loculi and with a round inner loculus; with 16-19 disc-pores in each anterior spiracular disc-pore band and 23 in each posterior band. Ventral microducts with a long, fine inner ductule - rather sparse, mainly on head and thorax but with a pair in each abdominal segment mesad to mediolateral folds. Preantennal pores absent. Ventral tubular ducts absent. Ventral setae rather sparse - interantennal setae absent; submarginal band sparse, with 2-3 setae laterally between stigmatic clefts; preanal setae represented by very short setae on preanal segments. Antennae very reduced, each with about 3 very small ring-like segments; length 23-27 μ m; possibly without setae on basal segments but with a fleshy subterminal seta on apical segment plus about 5 fleshy setae and 2 hair-like setae on apex. Mouthparts strongly displaced to one side, with labium

twisted sideways through 90°. Spiracles quite large, width of each peritreme 41-45 μ m. Legs only indicated by a slightly reticulated area on venter.

Comment. – the 3rd-instar female differs from most other known 3rd-instar female Coccidae in the same way as the 2nd-instar, i.e. (i) presence of numerous cribriform plates, (ii) absence or non-differentiation of stigmatic spines, (iii) lack of setae on anal fold, (iv) absence of preanal setae, (v) absence of interantennal setae, and (v) great reduction of legs and antennae.

The "ghost" cribriform plates are here thought to represent the precursors of the cribriform plates in the adult female. They are much more abundant than the sclerotised cribriform pores and are in 2 or 3 rows.

SECOND-INSTAR FEMALE (Fig. 3)

Described from one specimen in good condition.

Unmounted material. – without a glassy test, dorsum covered in thin, powdery wax and with a marked marginal ring of white wax filaments.

Mounted material. – outline ovoid, but showing clear signs of asymmetry; length 1.4 mm, width 0.93 mm; with a short anal cleft, about 0.09 of total length; stigmatic clefts very shallow or absent.

Dorsum. – derm membranous, without signs of segmentation. Dorsal setae absent. Dorsal pores of probably 3 types: (i) a moderate-sized open pore - in 4 lines anterior to anal plates and also scattered fairly commonly over more lateral areas, but not submarginally; (ii) a much smaller, dark-staining pore - throughout, but most abundant in a submarginal band just mesad of marginal spines; (iii) a minute pore - throughout but most common submarginally, difficult to resolve and not figured. Dorsal tubular ducts, preopercular pores and dorsal tubercles absent. Cribriform plates often quite large, each comprising about 29-32 small pores - with 1 pair on abdomen and another on head. Anal plates together probably quadrate, 53 μ m long and 76 μ m wide, each with 4 stout spines, 3 along inner margin and 1 rather longer spine apically, length of latter 25 μ m. Anal fold without setae. Anal cleft short, with 3 stout marginal spines along each margin; anal ring with 6 setae. Eyespots absent.

Margin. – marginal setae spinose, sharply pointed, slightly waisted, with well-developed basal sockets; each 18-22 μ m long; in a single line around margin, with 19-20 laterally between stigmatic clefts. Stigmatic clefts present but very shallow and parallel sided; stigmatic spines not differentiated from marginal spines.

Venter. – derm membranous, segmentation obscure on abdomen. Preanal disc-pores absent. Spiracular disc-pores with 3-6 outer loculi and with a round inner loculus; with 5-6 disc-pores in each spiracular disc-pore band. Ventral

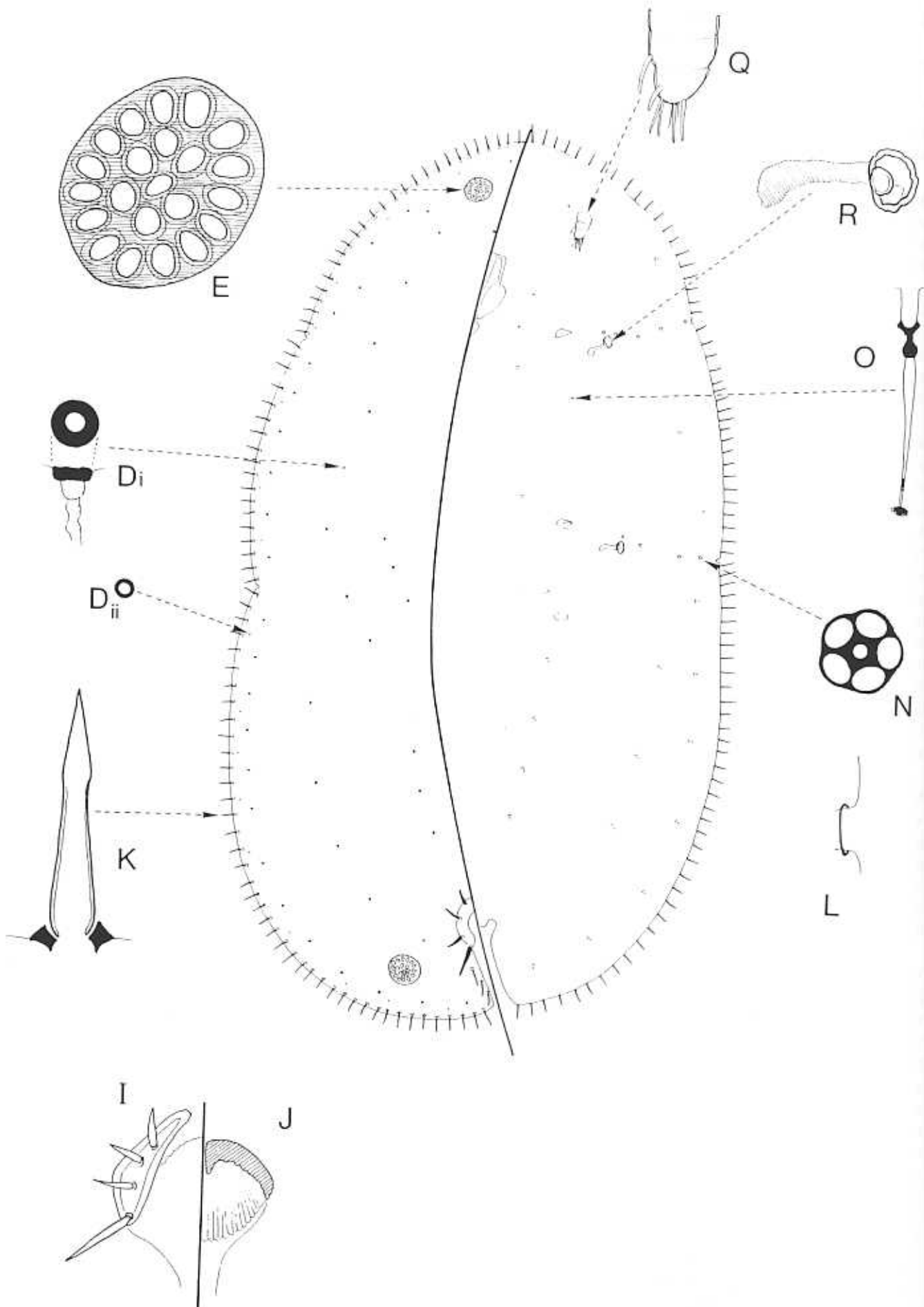


Fig. 3. *Cribropulvinaria tailungensis*, new species. Second-instar female nymph. For lettering, see Fig. 1.

microducts each with a long fine inner ductule - rather sparse, possibly restricted to a few on head and thorax. Ventral tubular ducts absent. Preantennal pores absent. Ventral setae all short and rather sparse - present in a mediolateral line between anal area and metathoracic leg; with a single seta near each leg; without interantennal setae; submarginal band sparse, with 2 setae laterally between stigmatic clefts. Antennae reduced, each with about 3 ring-like segments, without a seta on basal segment but with a fleshy seta on subterminal segment and with about 5 fleshy setae and 2 hair-like setae on apical segment; antennal length 34-38 μm . Mouthparts displaced slightly to one side, with labium twisted sideways through about 90°. Spiracles small, width of each peritreme 16-20 μm . Legs extremely reduced to small folds without any apparent structure.

Comment. - the 2nd-instar female differs from most other known 2nd-instar female Coccidae in (i) presence of cribriform plates, (ii) absence or non-differentiation of stigmatic spines, (iii) lack of setae on anal fold, (iv) absence of preanal setae, (v) absence of interantennal setae and (vi) legs and antennae reduced.

FIRST-INSTAR NYMPH (Fig. 4)

Described from one specimen in good condition.

Unmounted material. - unknown.

Mounted material. - quite large for a 1st-instar nymph, 1.2 mm long and 0.7 mm wide; stigmatic clefts and anal cleft very shallow; with no signs of asymmetry.

Dorsum. - derm membranous. Dorsal setae absent. Dorsal pores small and dark - few, in a submarginal band (about 7 on either side of abdomen and with single pores laterally on thorax and head) and in 2 submedial lines of about 3 pores anterior to anal plates. Trilocular pore near anterior margin absent. Anal plates each probably triangular, but "banana-shaped" when viewed semi-laterally, about 52 μm in combined width and 44 μm long; each plate with 3 setae, 1 spinose seta near anterior end, 1 fine seta on apex (length 8-10 μm long) and a fine seta medially. Anogenital fold without setae. Eyespots apparently absent.

Margin. - marginal setae each 31-35 μm long, stoutly spinose, sometimes slightly constricted about half way along length; with well-developed basal sockets; with 3 setae on each side laterally between stigmatic clefts. Stigmatic spines absent. Stigmatic clefts just visible as very shallow indentations, perhaps slightly sclerotised.

Venter. - derm membranous, segmentation on abdomen absent. Pregenital disc-pores absent. Spiracular disc-pores with perhaps 3-5 outer loculi and no central loculus; with 1-2 in anterior stigmatic bands and 2-3 in posterior bands (in addition, a dorsal pore overlies posterior disc-pore bands). Ventral microducts apparently represented by single ducts between each scape and procoxa, and between each procoxa

and mesocoxa. Ventral setae possibly restricted to a sparse submarginal line, with a single seta laterally between stigmatic clefts. Antennae well developed, 6-segmented, 154 μm long; each scape with 2 setae; each pedicel with 1 long seta and a campaniform sensilla; segment III longest, with 1 moderately long seta; segment IV with a short fleshy seta; segment V with 1 long hair-like seta and 1 short fleshy seta, and segment VI with 5 fleshy setae and perhaps 2 or 3 short hair-like setae plus 1 longer hair-like seta. Mouthparts normally developed and labium not twisted to one side. Spiracles particularly small, width of each peritreme 8-10 μm . Legs well developed, measurements and data for metathoracic leg: coxa 52 μm long, with 2 longish setae and 1 shorter seta on ventral surface; trochanter + femur 97 μm long, each trochanter with 1 long seta on inner margin and 2 short setae on outer margin; each femur with a long seta on outer margin and a smaller seta on ventral surface; tibia and tarsus without an articulatory sclerosis; tibia 55 μm long, with a seta on inner margin (tibia of prothoracic legs with 2 setae, i.e. with an extra seta on ventral surface); tarsus 44 μm long with a stout seta on inner margin and a fine seta on outer margin; without tarsal campaniform pores; tarsal digitules rather long (45 μm), extending past tips of claw digitules (those on prothoracic legs uncertain); claws long and fine (21 μm), each with a distinct denticle and 1 digitule distinctly thicker than other. Anal ring with 6 setae; anal tube quite long.

Comment. - quite apart from its large size, this is an unusual 1st-instar soft scale for several reasons, notably absence of (i) small trilocular pore anteriorly on dorsum of head, (ii) eyes, (iii) stigmatic setae, (iv) setae associated with anal fold, (v) interantennal and preanal setae, and (vi) dorsal setae; presence of (vii) claw digitules of differing sizes, and (viii) the apical setae on anal plates not differentiated in size from other anal plate setae. This combination of characters is unique, as far as we are aware.

ADULT MALE (Fig. 5)

Described from one specimen in good condition and one in poor condition.

Unmounted material. - unknown.

Mounted material. - large and robust, with rather long antennae (both broken on best specimen but intact in other); rather bald, with almost no body setae, either hair-like (hs) or fleshy (fs); appendages, however, very hirsute, with numerous short fs easily differentiated from hs. When mounted, total body length about 1.96 mm, width at mesothorax about 0.46 mm. Wings large, about 1.5 mm long and 0.75 mm wide. Antennae 1.4 mm long.

Head. - in dorsal view rounded posteriorly, with a convexity carrying median crest anteriorly; in side view, probably with ventral eyes on a pronounced cone; length about 385 μm ; width across genae 394 μm . Almost hairless. Median crest (mc) pronounced and heavily sclerotised dorsally and

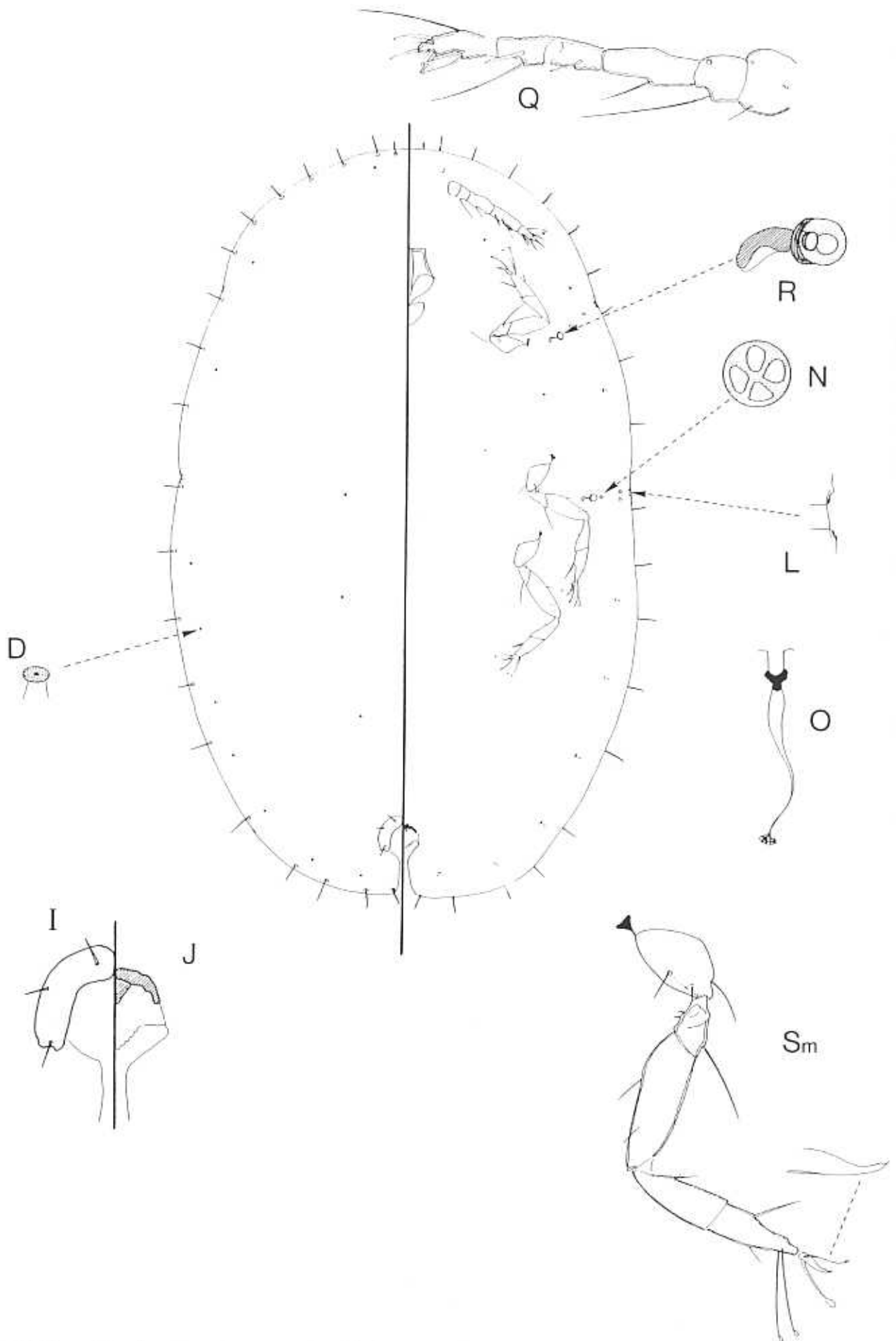


Fig. 4. *Cribropulvinaria tailungensis*, new species. First-instar nymph. For lettering, see Fig. 1.

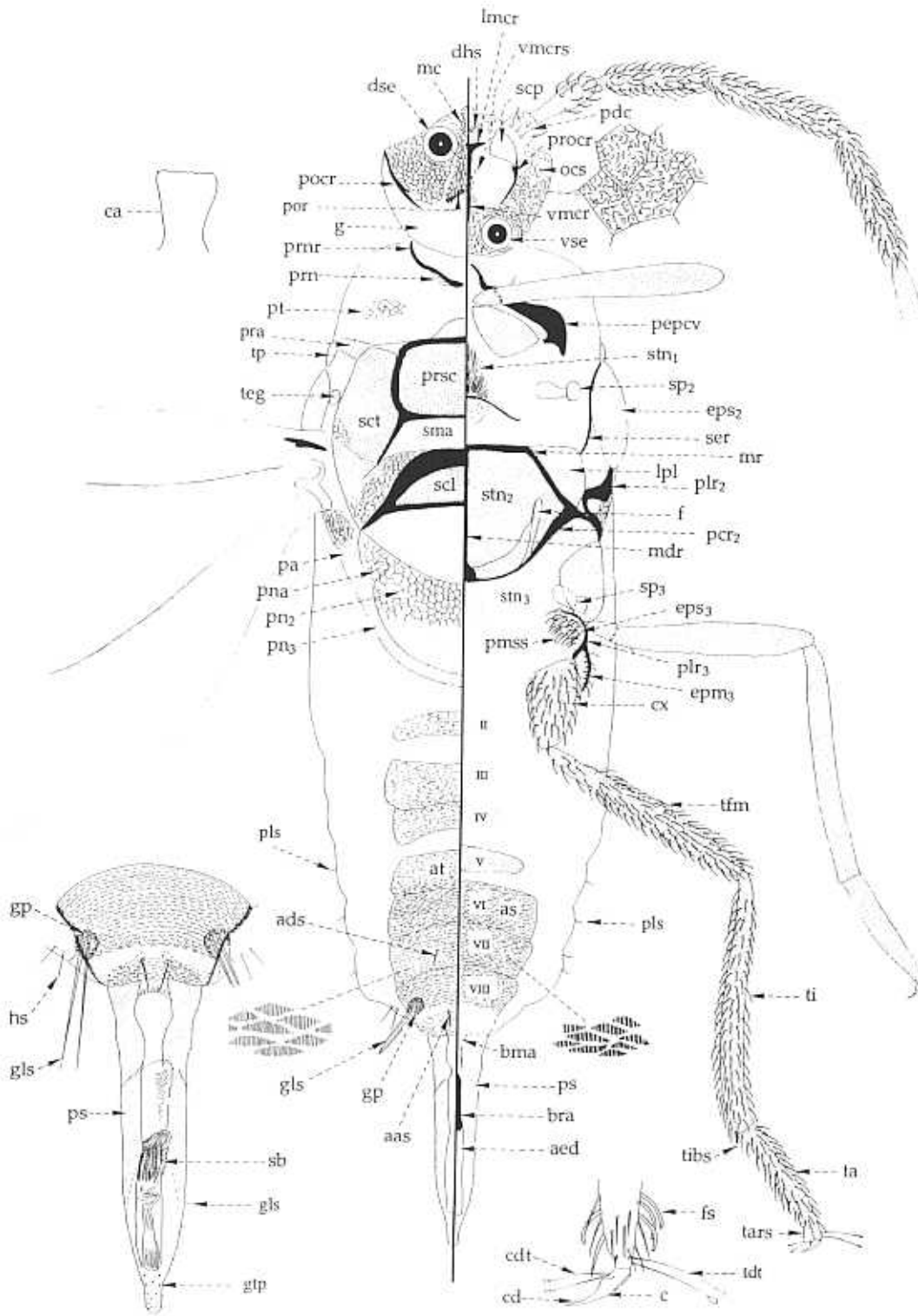


Fig. 5. *Tribolium tulumgensis* Hodgson & Martin. Adult male. Where aas = antennal setae; ads = dorsal abdominal setae; aed = aedeagus; as = abdominal sternites; at = abdominal tergites; avs = abdominal ventral setae; bma = basal membranous area; bra = basal rod; ca = cranial apophysis; cd = claw denticle; cdt = claw digitule; cx = coxa; dhs = dorsal head setae; dps = dorsal pleural setae; dse = dorsal simple eye; epm₃ = metepimeron; eps₂ = mesepisternum; eps₃ = metepisternum; f = furca; fs = fleshy seta; g = gena; gls = glandular pouch setae; gp = glandular pouch; gtp = sensillae on penial sheath; gts = setae on penial sheath; hs = hair-like setae; lmer = lateral arm of midcranial ridge; lpl = lateropleurite; mc = median crest; mdr = median ridge; mr = marginal ridge; ocs = ocular sclerite; pa = postalare; pcr₂ = precoxal ridge of mesothorax; pdc = pedicel; pepcv = proepisternum + cervical sclerite; pl_{vii} = lobe on abdominal segment VII; pl_{viii} = lobe on abdominal segment VIII; plr₂ = mesopleural ridge; plr₃ = metapleural ridge; pls = pleural setae; pmss = posterior metaspiracular setae; pn₂ = mesopostnotum; pn₃ = metapostnotum; pna = postnotal apophysis; pocr = postocular ridge; por = postoccipital ridge; prn = lateral pronotal sclerite; prnr = pronotal ridge; procr = preocular ridge; prsc = prescutum; ps = penial sheath; pt = post-tergite; scl = scutellum; scp = scape; set = setum; ser = subepisternal ridge; sma = membranous area of scutum; sp₂ = mesothoracic spiracle; sp₃ = metathoracic spiracle; stn₁ = prosternum; stn₂ = mesosternum; stn₃ = metasternum; ta = tarsus; tars = tarsal spur; tdt = tarsal digitule; teg = tegular; tfm = trochantofemur; ti = tibia; tibs = tibial spur; tp = triangular plate; vmcr = ventral midcranial ridge; vmcrs = setae on either side of ventral midcranial ridge; vps = ventral pleural setae; vse = ventral simple eye; wb = wing-bud.

widening posteriorly where it is heavily sclerotised, resembling a postoccipital ridge (por); with 2-3 pairs of hs dorsal head setae (dhs); less heavily sclerotised anteriorly. Mid-cranial ridge: absent dorsally; ventrally (vmcr) narrow but well-defined, extending posteriorly as far as ocular sclerite; with a narrow reticulated margin; with 0-1 hs ventral mid-cranial ridge setae (vmcrs). Preocular ridge (procr) distinct and extending posteriorly about two-thirds of way to midcranial ridge. Genae (g) large and membranous: presence of polygonal reticulations uncertain; without genal setae. Eyes: 2 pairs of large, round, simple eyes, 1 pair dorsally (dsc) and 1 pair ventrally (vse), subequal in size, width 53-57 μm . Ocelli perhaps absent. Ocular sclerite (ocs) heavily sclerotised and polygonally reticulated, each reticulation with numerous short sinuous inner ridges. Postocular ridge (pocr) extending medially almost to median crest. Dorsal ocular setae absent. Ventral head setae absent. Development of preoral ridge (pror) unknown. Cranial apophysis (ca) with an undivided apex; length about 66 μm .

Antennae. – both broken on specimen in otherwise best condition, but ten segments present on both sides of the poor (fungal) specimen. Scape (scp): 56 μm long and 58 μm wide, presence of setae uncertain. Pedicel (pdc): 44-50 μm long and 56-58 μm wide, with about 3 fs + 2 hs. Segments III-VI about 33-37 μm wide; length of fs 34-36 μm ; lengths (μm): III: 112-118; IV: 192-199; V: 222-238; VI: 235; VII: 197; VIII: 160; IX: 115; X: 95; approximate number of setae per segment: III: 17-20 fs + 3-4 hs + 1 sensilla basiconica; IV: 45-56 fs + 3-5 hs; V: [unclear]; VI: 52 fs + 4 hs; VII: 48 fs + 3 hs. Chaetotaxy of other segments difficult to resolve, because of specimen condition, but segment X clearly with 2 apical hs which are capitate, similar in length to fs.

Thorax. Prothorax. – pronotal ridge (prnr) well developed, with narrow, striated, lateral pronotal sclerites (prn); without lateral pronotal setae. Post-tergite (pt) sclerotised with polygonal reticulations, without post-tergital setae. Medial pronotal setae absent. Proepisternum + cervical sclerite (pepcv) unusually broad posteriorly. Sternum (stn_1) with a strong, bow-shaped, transverse ridge; median ridge absent but with a broad striated area in this position; prosternal setae, anteprosternal and antemesospiracular setae absent.

Mesothorax. – (probably rather convex in life; scutal area rather deformed during mounting); prescutum (prsc) about half as long as broad (144 μm long and 215 μm wide); heavily sclerotised but not reticulated. Scutum (set); median membranous area (sma) probably quite a lot larger than is apparent on slide, about 3 times as wide as long, perhaps 62+ μm long and 207+ μm wide; scutal setae (scts) absent; lateral margins rather damaged but sclerotised, with polygonal reticulations near scutellum. Scutellum (scl) 103 μm long and 269 μm wide; probably with a large foramen. Mesepisternum (eps_2) sclerotised but not reticulated. Basisternum (stn_2) large, about 236 μm long and 385 μm wide; with a complete, strong median ridge (mdr), which broadens posteriorly just before reaching posterior margin; bounded by strong marginal (mr) and precoxal ridges (pcr_2); without setae; lateropleurite (lpl) without an extension from

marginal ridge; furca (f) well developed and extending anteriorly to about level with point where marginal ridge and precoxal ridges meet laterally. Mesothoracic spiracle (sp_2); width of peritreme 46 μm ; postmesospiracular setae absent. Postalare (pa) reticulated at anterior end; without postalare setae. Tegula (teg); possibly quite large, without tegular setae. Subepisternal ridge (ser) present. Antemesospiracular setae absent. Anterior part of mesopostnotum (pn_2) with large polygonal reticulations.

Metathorax. – metatergal setae absent. Ventral part of metapleural ridge (plr_3) well developed; episternum (eps_3) sclerotised with 17 fs postmetaspiracular setae ($pmss_3$); metepimeron (epm_3) well developed and sclerotised, with about 7 fs. Metathoracic spiracle (sp_3); width of peritreme 40 μm . Dorsospiracular setae absent. Metasternum (stn_3) slightly sclerotised but not reticulated. Anterior metasternal and posterior metasternal setae absent.

Wings. – hyaline; of moderate length and width, 1.562 mm long and 0.750-0.763 mm wide (ratio of length to width 1:0.48). Hamulohalteres absent (and therefore associated structures also absent).

Legs. – long and very hairy, subequal in length. Coxae (cx); length (μm): I: 132, II: 132, III: 162; coxal setae mainly fs and abundant; without coxal bristles. Trochanter + femur (tfm) fused, with no intersegmental membrane; length (μm): I: 434; II: 397, III: 414; each trochanter (tr) with 6 small campaniform sensilla; with no or only a short hs trochanter seta; other setae mainly fs and frequent; each femur with numerous fs and a few hs. Tibia (ti) long; length (μm): I: 414; II: 414; III: 438; each with a large number of setae, mainly fs but with some hs and with increasing numbers of spur-like setae on distal third; apical spur (tibs) barely differentiated from other spur-like setae, quite short, about 30 μm long. Tarsi (ta); lengths (μm): I: 202; II: 207; III: 232; each with numerous setae, mainly fs, but with many spur-like setae and some hs; tarsal campaniform pore absent; distal tarsal spur (tars) 25 μm long; tarsal digitules (tdt) longer than claw. Claws (c) moderately long, subequal to width of tarsi, with a distinct denticle (cd); length 33-35 μm ; claw digitules (cdt) slightly longer than claw.

Abdomen. – Segments I-VII: tergites (at) represented by heavily sclerotised plates on segments II-VII, each polygonally reticulated, each reticulation with parallel inner striations on posterior segments; sternites (as) similarly sclerotised on segments VI and VII; segment V more lightly sclerotised without reticulations; sternites of segments II-IV possibly membranous or only lightly sclerotised. Caudal extension of segment VII small or absent, rounded and unsclerotised. Dorsal setae (ads) almost absent, only represented by 1 pair of hs on segment VII. Pleural setae: difficult to separate into dorsopleural setae and ventropleural setae and so combined (pls): I-IV absent; V-VII: 1-2 hs. Ventral setae absent.

Segments VIII: tergite and sternites heavily sclerotised as on segment VII; tergite with 2 large ante-anal setae (aas);

sternite without setae; caudal extension very small or absent, with 2 hs. Glandular pouches (gp) present, each with 2 setae (gls), 180-195 μm long. Tergite of segment XI probably present and fairly clearly separated from that of segment VIII.

Genital segment. – Penial sheath (ps) apparently atypical of male Coccidae; rather stout and strong, narrowing abruptly near tip into a short finger-like process; basal part embedded between sternite VIII and tergite IX; about 0.2 of total body length (ratio of total body length to penial sheath length 1:0.19); length to overlap of sternite IX 368 μm , total length 397 μm ; 101 μm wide at base; possibly unsclerotised on dorsal surface, but with strongly sclerotised margins. Basal rod (bra) about two-thirds length of aedeagus, length 104 μm , anterior to aedeagus; anterior end of basal rod not nearly reaching basal membranous area (bma) anteriorly; aedeagus (aed) short, 162 μm long, of uniform width. Lying within aedeagus is an odd structure, probably sperm bundles (but perhaps also including an eversible endophallus). Apex of penial sheath without a membranous extension; with 16-18 small setae (gts) along each posterior margin and on dorsal surface of penial sheath and with a cluster of small sensillae (gtp) present near apex.

Comment. – the males of *C. tailungensis* have a number of unique characters for a member of the Coccidae: (i) the presence of distinct sclerotised tergal plates on segments II to VIII (IX?) (as recorded on some Margarodidae, Theron, 1958); (ii) the presence of distinct sternal plates on segments VI, VII and VIII; (iii) the almost complete absence of setae (both hs and fs) on the body (this character also known to a lesser degree from some other Coccidae, e.g., some *Eulecanium* species (Giliomee, 1967; Miller, 1991)); (iv) the heavy sclerotisation at the posterior end of the medial ridge, similar to a postoccipital ridge (character known from one other male soft scale from New Zealand, personal observation by Hodgson); and (v) the broadness of the propisternum + cervical sclerite. Other features which appear to be characteristic of this species are (i) the shortness of the fleshy setae (equal to or shorter than width of antennae) and (ii) the type of extra ridges within the polygonal reticulations on the head.

Whilst the adult female characters more strongly suggest that this genus is a member of the tribe Pulvinariini, almost none of the above male characters are known from species currently placed in this tribe (see Giliomee, 1967; Miller, 1991) and, as it shares a number of primitive characters with such genera as *Eulecanium* (tribe Eulecaniini) (Giliomee, 1967; Miller, 1991), it is here considered to represent a taxon near the base of the Pulvinariini.

PUPA (Fig. 6)

Described from 2 specimens in good condition.

Mounted material, – elongate oval, rather pointed at each end. Division into head, thorax and abdomen clear; segmentation obscure except on abdomen. Derm

membranous, with small dermal spinules. Ducts and pores absent and setae few. Quite large; length 1.8-1.9 mm; head width 330-394 μm .

Head. – lacking mouthparts and simple eyes. Antennae: moderately long, 10-segmented, pointing posteriorly and reaching mesocoxae, total length 793-870 μm (ratio of total body length to antennal length 1:0.45); with 2 short fleshy fingers on apex; basal segments slightly sclerotised. Setae: with 1 pair of minute setae medially on dorsal surface, a pair anteriorly and a seta ventrally, just posterior to each scape.

Thorax. – unsclerotised, segmentation unmarked. With 3 pairs of moderately well-developed legs; coxa and trochanter slightly sclerotised; prothoracic legs C-shaped, directed anteriorly and curving round in front of anterior margin of head; metathoracic legs extending posteriorly to about abdominal segment VII; coxae each with 1-2 minute seta; tarsal campaniform pores absent; each tarsus with a small triangular finger on apex, probably an incipient claw; length of metathoracic legs 717-745 μm . With a wing-bud (wb) on each side, extending to about abdominal segment II, mildly sclerotised, length 660-673 μm , width 215-222 μm (ratio length to width 1:0.32). With 2 pairs of spiracles, anterior pair (sp₂) just posterior to procoxa and posterior pair (sp₁) laterad of mesocoxae; neither with spiracular disc-pores; width of peritremes 36-39 μm . Setae: possibly absent.

Abdomen. – segmentation distinct, anterior-most segment considered to represent segment II, so that there are 7 visible segments (segments II to VIII) anterior to penial sheath. Setae: small dorsal abdominal setae absent; with 2 short ant-anal setae (aas); with single pairs of small ventral abdominal setae (avs) on segments IV-VII; with usually 1 dorsopleural seta (dps) on each side on segments V-VII; ventropleural setae (vps); with 1 minute ventropleural seta on each side of segments V-VII. Lobes of segment VII (pl_{VII}) inconspicuous and rounded, not even extending posteriorly to base of penial sheath. Lobes of segment VIII (pl_{VIII}) small, each with 2 minute setae. Penial sheath (ps) sclerotised, distinctly shorter than width (about 124-130 μm long and 141 μm wide at base; ratio length to width 1:1.1); with 1 pair of minute pores on dorsal surface; genital opening present medially on ventral surface.

Comment. – whilst the basic pattern of this pupa is similar to those of other Coccidae, it can be separated from all others by the following combination of characters: (i) very short and rounded lobes on abdominal segment VII (on other species, usually extremely well developed, extending posteriorly to at least half the length of the penial sheath), (ii) spiracular disc-pores absent (usually, though not quite always, present and associated at least with the anterior spiracles), and (iii) apparent absence of pairs of small dorsal setae on abdominal segments V, VI and VII (usually present, sometimes on all segments).

PREPUPA: not available.

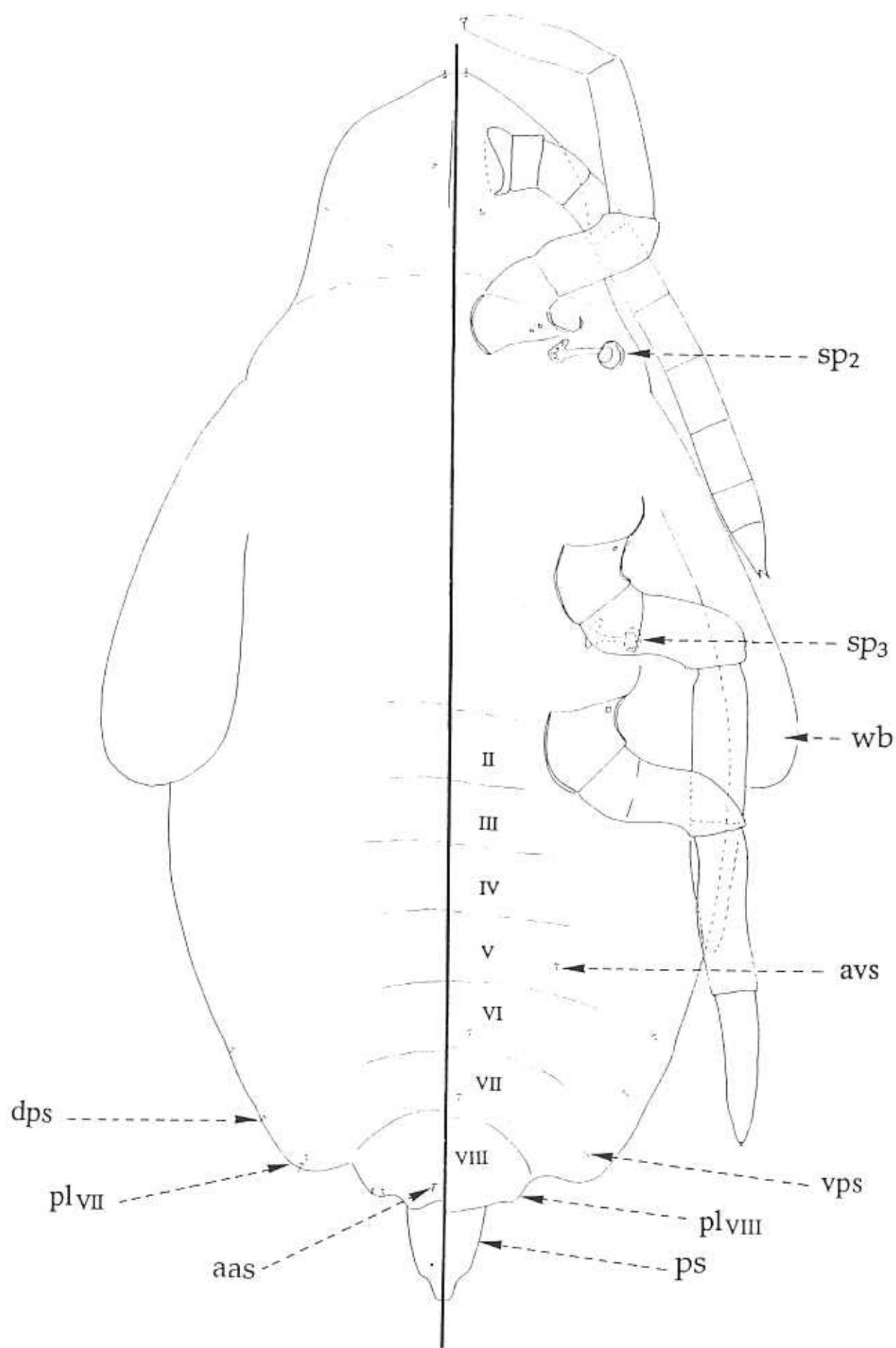


Fig. 6. *Cribropulvinaria tailungensis*, new species, Pupa. For lettering, see Fig. 5.

SECOND-INSTAR MALE (Fig. 7)

Described from 4 specimens in good condition.

Unmounted material. – approximately oval in shape, covered in a glassy test with small areas of white wax in 2 medial lines and with a line between these and margin. With a marked margin of white wax filaments, these quite long laterally. Test with an opening for anal plates posteriorly and, on test from which adult male had emerged, with a clear gap between test and marginal band of filaments, presumably used by adult male to emerge.

Mounted material. – oval in shape, but showing some clear signs of asymmetry; length 1.6-1.9 mm, width 1.0-1.1 mm; with a short anal cleft, about 0.09 of total length; stigmatic clefts very shallow or apparently absent.

Dorsum. – derm membranous, without signs of segmentation. Dorsal setae: with a single pair of minute setae just anterior to anal plates. Dorsal pores of perhaps 3 types: (i) a moderate-sized open pore - in 2 lines anterior to anal plates and also dotted fairly commonly over more lateral areas, but not laterad to band of cribriform plates; (ii) a much smaller dark-staining pore - throughout but most abundant in a submarginal band just mesad to marginal spines; and (iii) a minute pore - throughout but perhaps most common submarginally. Preopercular pores and dorsal tubercles absent. Dorsal tubular ducts of 1 type, with a short, broad outer ductule and a short, broad inner ductule with a large glandular end - in a band around margin of head, thorax and anterior third of abdomen but absent from margin of posterior two-thirds of abdomen. Cribriform plates often quite large, each comprising about 15-70 small pores - with 4-5 pairs on abdomen, 2 pairs on thorax and 2 pairs on head. Anal plates together probably quadrate, 61-65 μm long and 89-98 μm wide, each with 4 stout spines, 3 along inner margin and 1 rather longer spine apically, length of latter 33-35 μm . Anal fold without setae. Anal cleft short, with 6-10 stout marginal spines along each margin; anal ring with 6 setae. Eyespots absent.

Margin. – marginal setae spinose, sharply pointed, slightly waisted, each with a well-developed basal socket; each 18-25 μm long; in a single line around margin, with 22-24 laterally between stigmatic clefts. Stigmatic clefts present but very shallow and parallel sided; stigmatic spines not differentiated from marginal spines.

Venter. – derm membranous, segmentation clear on abdomen. Pre-anal disc-pores absent. Spiracular disc-pores with 3-6 outer loculi and with a round inner loculus; with 7-10 in each spiracular disc-pore band. Ventral microducts with a long fine inner ductule - rather sparse, each abdominal segment usually with a duct near each mediolateral fold, and in a line more marginally; also with a few on thorax and head. Preantennal pores absent. Ventral tubular ducts quite different in structure to those on dorsum, with a long, thinner outer ductule, a thin inner ductule and a large glandular end - in a marginal band around entire margin. Ventral setae

rather sparse - with a single seta near each mediolateral fold on each abdominal segment; a seta near each coxa; without interantennal setae; submarginal setae sparse, with 2 laterally between stigmatic clefts. Antennae reduced, but with about 6 ring-like segments, with a single seta on both basal segments, a fleshy seta on subterminal 2 segments, and with about 5 fleshy setae and 2 hair-like setae on apical segment; antennal length 53-65 μm . Mouthparts displaced slightly to one side, with labium twisted sideways through 90°. Spiracles small, width of each peritreme 23-27 μm . Legs reduced, mammiform, each with about 3 ring-like segments; length 31-42 μm ; with a single seta on base; claw much reduced, perhaps with very short digitules.

Comment. – the 2nd-instar male differs from most other known 2nd-instar coccid males in: (i) presence of cribriform plates, (ii) absence or non-differentiation of stigmatic spines, (iii) lack of setae on anal fold, (iv) setae medially on 3 preanal segments all small and similar to other ventral setae, (iv) absence of interantennal setae, and (v) great reduction of legs and antennae. In having legs and antennae reduced, this species resembles the 2nd-instar males of *Pseudophilippia quaintancei* Cockerell (Ray & Williams, 1980), but the latter species has dorsal bilocular pores and a different arrangement of dorsal tubular ducts, both of which are likely to be important generic characters.

Material examined. – HOLOTYPE – adult female: HONG KONG, New Territories, Tai Lung Farm, Sheung Shui, on *Aporosa dioica* (Euphorbiaceae), coll. J.H. Martin, 22 Nov. 1999 (# 7253) (BMNH).

PARATYPES – 15 adult females, 3 third-instar females, 1 second-instar female, 1 crawler, 1 adult male, 2 male pupae, 4 second-instar males, same data as for holotype (BMNH, HKDA, USNM); 8 adult females, 3 third-instar females, 3 second-instar females, 1 crawler, 1 adult male, 2 male pupae, 1 second-instar male, same host and locality, coll. Chan Ping Wing, 31 Mar. 2000 (BMNH, HKDA). The holotype and paratypes are distributed between 13 microscope slide mounts.

OTHER MATERIAL. – 3 adult females & several larval male tests, attached to leaf tissue, same data as holotype (BMNH).

Name derivation. – *tailung*, after Tai Lung Farm, the name of a field station of the Agriculture, Fisheries & Conservation Department, Hong Kong SAR, from where this species was collected, and *-ensis*, adjectival suffix indicating place of origin.

***Maeococcus* Tao, Wong & Chang**

Maeococcus Tao, Wong & Chang, 1983: 71; Tang, 1991: 110; Ben-Dov, 1993: 170; Hodgson, 1994: 324; Ben-Dov et al., 1997: 201. Type species: *Lecanium bicruciatum* Green, by original designation.

Sharanococcus Avasthi, 1993: 74. Type species: *Lecanium bicruciatum* Green, Synonymised by Ben-Dov et al., 1997: 201 on grounds of community of type species.

This genus was introduced by Tao, Wong & Chang (1983) to accommodate *Lecanium bicruciatum* Green (1904) as the type species, along with *Coccus scolopiae* Takahashi (1933). *M. bicruciatum* was redescribed by Hodgson (1994). In the

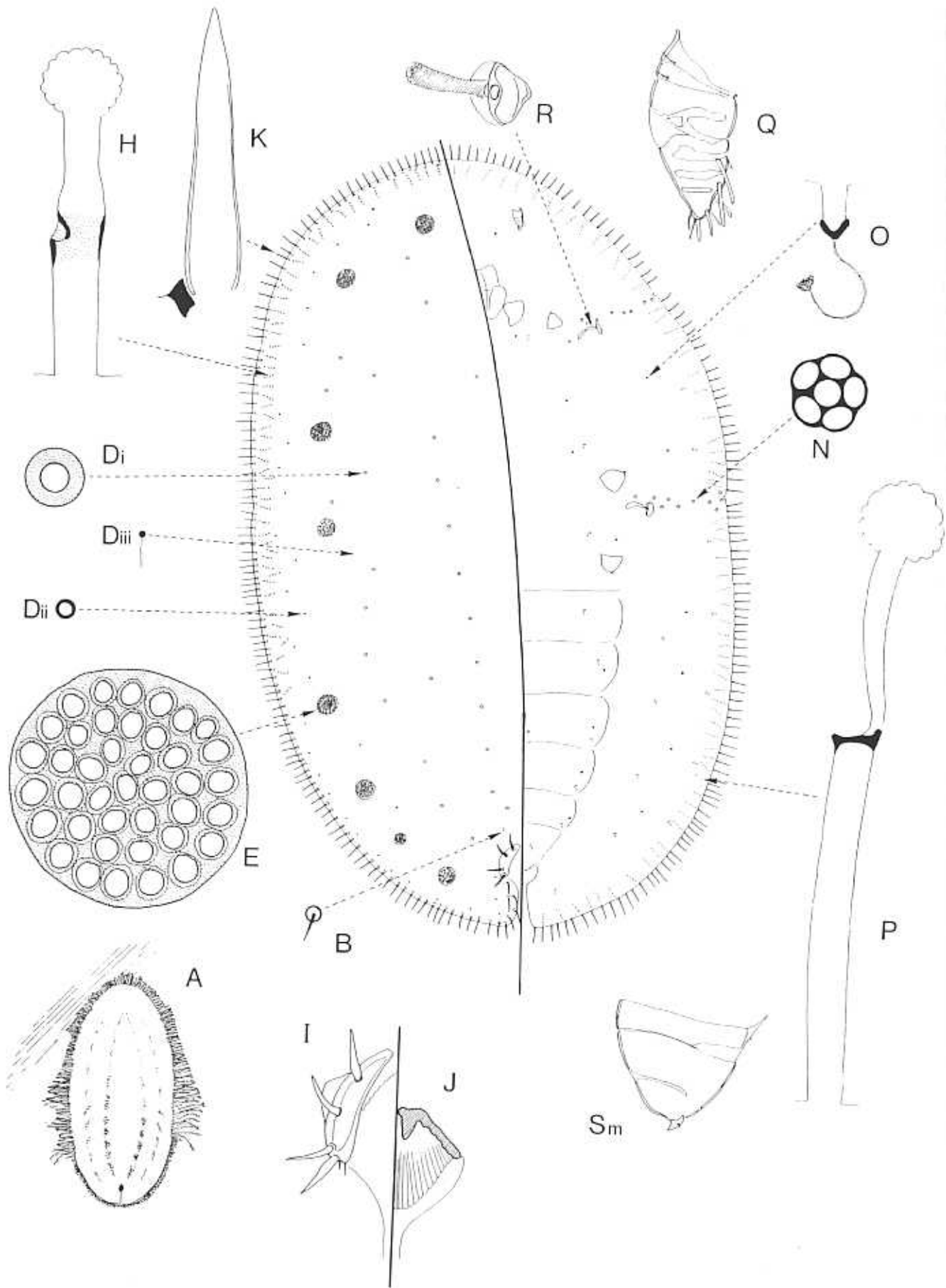


Fig. 7. *Cribropulvinaria tallungensis*, new species. Second-instar male nymph. For lettering, see Fig. 1.

literature, *Maacoccus* has twice been erroneously attributed to Tao & Wong (Kosztarab et al., 1986; Hodgson, 1994), resulting from a personal communication by Tao to Kosztarab. In that communication, Tao claimed that it had been intended that the authorship of all five new genera proposed in the 1983 paper should be restricted to Tao & Wong. However, Ben-Dov et al. (1997) refuted this by pointing out that authorship changes cannot be made retrospectively. According to Ben-Dov (1993), *Maacoccus* contains six species: *M. arundinariae* (Green) from Sri Lanka; *M. bicruciatatus* (Green) from India, Sri Lanka and Taiwan (and also Kenya and Zanzibar); *M. cinnamomicolus* (Takahashi) from Malaysia; *M. piperis* (Green) from Sri Lanka; *M. scolopiae* (Takahashi) from Taiwan, and *M. wattii* (Green) from India. Thus, apart from the two records of *M. bicruciatatus* from Africa, these species appear to be restricted to the Oriental and Austro-oriental regions.

Maacoccus belongs to the tribe Paralecaniini as defined by Hodgson (1994).

Maacoccus cinnamomicolus (Takahashi)

Coccus cinnamomicolus Takahashi, 1952: 13.

Maacoccus cinnamomicolus (Takahashi) – Tang, 1991: 113; Ben-Dov, 1993: 170.

ADULT FEMALE (Figs 8, 9)

Described from two type specimens, one in good condition, plus 26 new specimens in excellent condition (full measurements taken on 4).

Unmounted material. – in life, extremely flat, semi-cryptic, individuals scattered across upper surfaces of several leaves of its seedling host, their presence being indicated by the smoothly shining cuticle with a ring of ovoid patches of fine white mealy wax, each patch secreted by submarginal cribriform plates, from each of which issues a long, very fine, filamentous extrusion, probably secreted by the tubular duct within each plate. Dorsum with a shallow median carina and 2 lateral carinae, which are separate from the stigmatic furrows which are visible through the translucent body.

Mounted material. – body outline unevenly ovoid (although the original two Takahashi specimens distinctly asymmetrical, with a rather “banana”-shaped outline, Fig. 9); about equally rounded at both ends; quite large, mainly 2.75–3.85 mm long but a few specimens as small as 2.5 mm long; breadth 2.2–3.0 mm; anal cleft sides apparently fused, anal cleft about 0.14–0.16 of body length; with distinct, small stigmatic clefts.

Dorsum. – derm membranous when young, becoming sclerotised at maturity, with small, radially orientated, areolations near margin; with a distinct area of sclerotisation along anal cleft just posterior to anal plates, which extends around plates where it becomes less dense; in addition, each

stigmatic cleft with a U-shaped stigmatic sclerotisation along inner margin; also with 4–5 groups of 1–3 larger areolations more or less mesad of abdominal cribriform plates. Dorsal setae probably quite frequent, very short, with a large basal boss (but this only visible from above, Fig. 8B). Dorsal pores of 3 types: (i) a minute dorsal microductule - frequent throughout, generally in a small areolation; (ii) a larger, heavily sclerotised, slightly convex, closed pore - common in submarginal line all around margin and stigmatic clefts (with 18–20 laterally between clefts) but also frequent elsewhere on dorsum, where rather variable in size; (iii) preopercular pores; possibly flat to slightly convex, mainly oval to round (occasionally unevenly oval) closed pores - distributed in more or less segmentally arranged groups in 2 pairs of mediolateral lines extending anteriorly from anal plates to head, with 6–8 groups in inner bands and 4–7 in outer bands, each group with 1–15 pores; also with a few pores laterad to anal plates which appear similar in structure. Cribriform plates in a submedial line around entire insect, each plate usually with 35–60 pores (rarely only 1–2), each pore with a slightly dumb-bell-shaped inner sclerotisation and each cribriform plate with a single tubular duct more or less medially - with (on each side) 6 plates on abdomen, 2 (rarely 3) plates on thorax and 1 plate posterior to eye-spot and 2 anterior to eye-spot on head (total 11 plates but occasionally with 10 or 12). Dorsal tubercles and pocket-like sclerotisations absent. Dorsal tubular ducts almost entirely restricted to 1 per cribriform plate (one specimen had a single duct between 1 eye-spot and margin); each duct with a short sclerotised outer ductule, a well-developed cup-shaped invagination and a short inner ductule, probably lacking a glandular end. Anal plates together approximately pyriform, anterior margin clearly longer than posterior margin, inner margins parallel, posterior half of each inner margin slightly serrate; each plate 151–160 μm long, combined widths 101–110 μm ; anal plate setae - with a small to minute seta dorsally near middle of inner margin, another on margin nearer apex (often absent) and another on dorsal surface near posterior margin; also with a longer apical seta, each 13–15 μm long. With 2 (rarely 3) setae on each side of anterior margin of ano-genital fold; longest 25 μm long; and with 3 lateral margin setae at posterior end of heavily sclerotised lateral margins. Anal tube quite long, extending well anterior to anal plates; anal ring with 8 setae, length of setae 180–210 μm . With a distinct anterior extension of supporting-bar, from ano-genital fold into a plate-like structure. Eyespot oval, 18–25 x 15–18 μm wide, within a large unsclerotised area of dorsum almost dorsad to each scape within line of cribriform plates.

Margin. – marginal setae each flattened, strongly digitate on both margins, with a more or less pointed apex; each with a strongly sclerotised basal socket; with 35–54 laterally between stigmatic clefts; each 23–35 μm long; marginal setae not extending up anal cleft margin and those on either side of anal cleft not differentiated from marginal setae. Stigmatic clefts small, each with an inner U-shaped stigmatic sclerotisation at base; each with 3 stigmatic spines, median spine much the longest, each parallel-sided with a blunt apex and with a well-developed basal socket; length 17–50 μm .

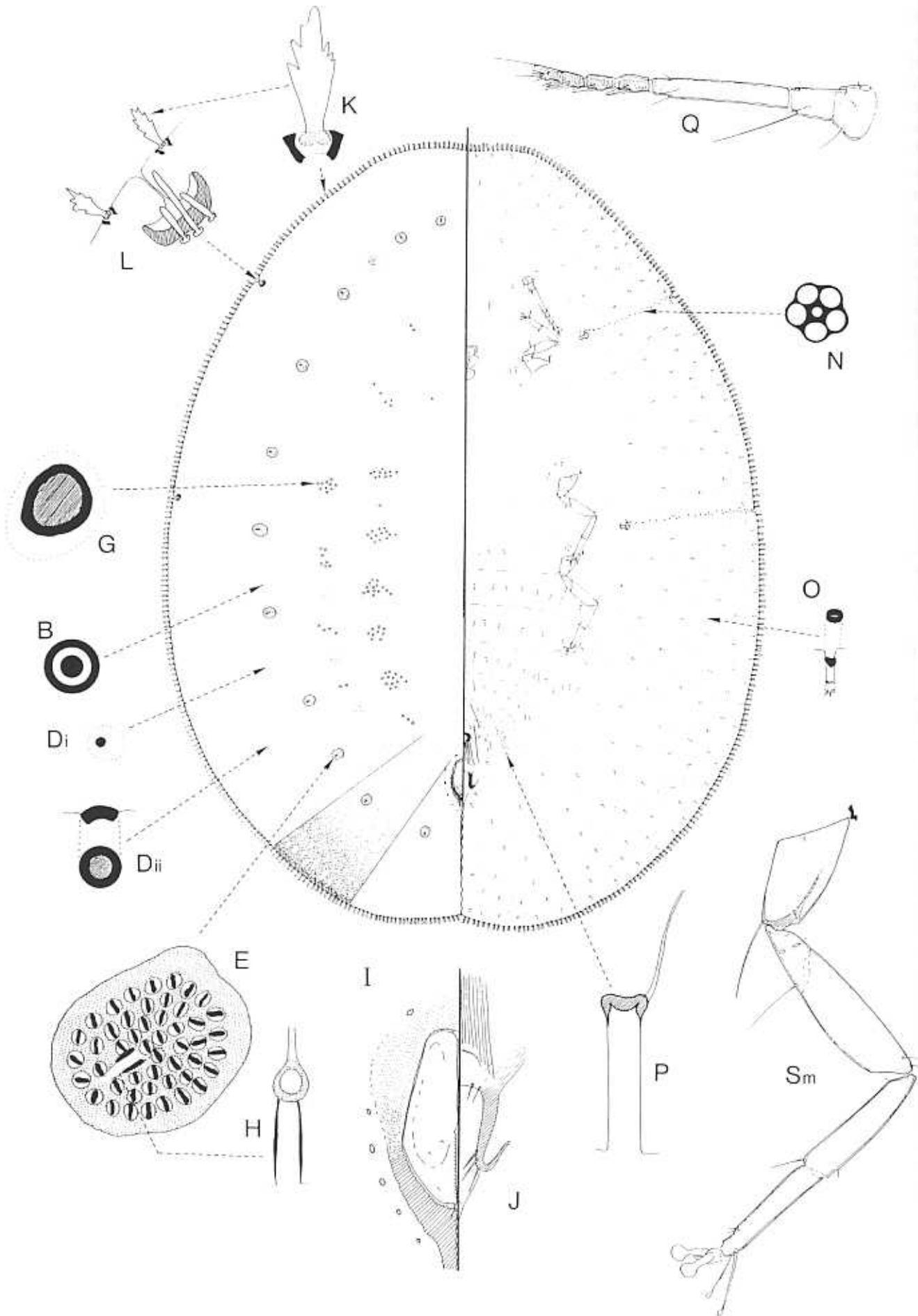


Fig. 8. *Maucoccus cinnamomicolus* (Takahashi). Adult female. For lettering, see Fig. 1.

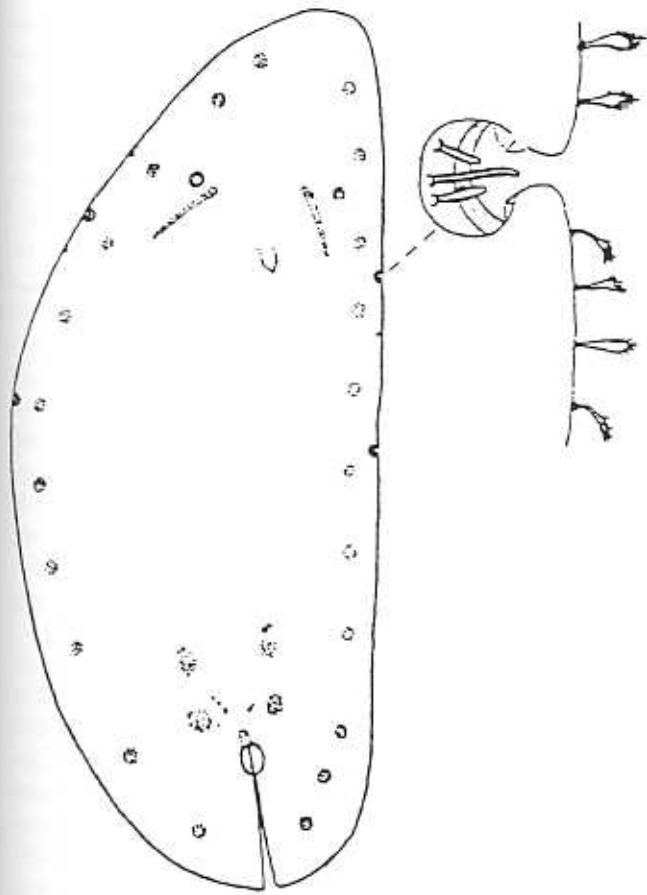


Fig. 9. *Maococcus cinnamomicolus* (Takahashi). Original drawing of adult female from Takahashi (1952), demonstrating pronounced asymmetry of the lectotype specimen, and the paucity of detail in coccoid illustrations of the time.

Venter. – membranous throughout, with microspinules around ano-genital area and medially throughout body. Preanal disc-pores absent. Spiracular disc-pores each with mainly 5 loculi in bands 1-2 pores wide between each spiracle and margin, each band widening slightly near margin; with 24-31 in each anterior band and 28-36 in each posterior band; each band of disc-pores not extending medially past peritreme. Ventral microducts minute, with a small inner ductule; throughout but scarce medially on thorax. Preantennal pores: only a single pore present near 1 antenna on 1 examined specimen. Ventral tubular ducts: restricted to mediolaterally on abdomen, each duct with a short outer ductule a shallow cup-shaped invagination and a thin inner ductule lacking a glandular end - with (on each side of segment) VII: 0; VI: 4-7; V: 0-2; IV: 0-4; III: 0-3 and II: 0-2. Ventral setae: posterior lobe setae not differentiated from submarginal setae; with 2 anterior anal cleft setae on either side of anterior end of anal cleft; longest pregenital setae present medially on segment VII, length 90-112 μm ; other setae medially on abdomen (totals): VII: 2 long setae + 6-11 short setae; VI: 2 medium length setae (48-72 μm long) + 8-10 short setae; V: 2 slightly long setae + 10-13 short setae; IV: 14-17 setae (2 medially slightly longer than others); III: 13-20 setae (2 medially slightly longer than others) and II: 13-16 setae (2 medially slightly longer than others); 4-5 setae medially on metathoracic segment + 2-3 just anterior to each metacoxa; 3 setae just anterior to each mesocoxa,

and 0-3 near each procoxa; length of setae associated with each procoxa about 25-32 μm ; with 2-3 pairs of inter-antennal setae, longest about 29-46 μm long; with 8-13 submarginal setae laterally between stigmatic clefts; other setae small, common, distributed rather randomly in a broad submarginal band. Antennae well developed and 6 segmented, third segment much the longest; total length 269-307 μm ; scape with 3 setae, pedicel with 2 setae + a campaniform pore; segment III with 3 setae; segments IV & V with 1 fleshy seta + 1 hair-like seta, and segment VI elongate, with 3 fleshy setae, 5 spinose setae + 2 setose setae; each apical seta short, about 13-14 μm ; length of outer long seta on apical segment about 41-50 μm ; distal part of segment III and segments IV, V & VI with light transverse ridges. Clypeolabral shield small, sometimes strongly displaced to one side, length 105-116 μm long; labium sometimes twisted, with probably 4 pairs of setae. Width of each spiracular peritreme: anterior 26-35 μm , posterior 30-37 μm . Legs well developed though appearing proportionately rather small; prothoracic legs shorter than other legs; lengths for metathoracic leg: coxa 124-137 μm , trochanter + femur 170-195 μm , tibia 103-121 μm , tarsus 104-116 μm , claw 18 μm ; length of long seta on inner margin of metacoxa 35-50 μm ; with 4-6 setae on each coxa; each trochanter with 1 long seta, about 78-93 μm long, and 1 seta on dorsal margin; each femur with 2 setae; each tibia with 2 setae; without a tibio-tarsal articular sclerite (tibia + tarsus fused on 1 leg); tarsus with 2-3 setae; tarsal campaniform pore absent; tarsal digitules possibly slightly dissimilar, with 1 slightly thicker and longer than other; claw digitules both broad and about 2x length of claw; claw without a denticle.

Comment. – The adult female of this species of *Maococcus* is easily distinguished from those of other species by the presence of cribriform plates, otherwise unknown in this genus.

THIRD-INSTAR NYMPH (Fig. 10)

Described from 3 specimens in excellent condition.

Unmounted material. – unknown.

Mounted material. – oval, broadest across abdomen, showing no signs of asymmetry; length 1.4-2.1 mm, width 0.8-1.4 mm, with a short anal cleft, about 0.11-1.14 of total length; stigmatic clefts distinct.

Dorsum. – derm membranous, without signs of segmentation. Dorsal setae absent. Dorsal pores of 1 type: minute round pores - mainly in a submarginal band (with about 8 on each side laterally between stigmatic clefts) but perhaps occasionally elsewhere. Dorsal tubular ducts, preopercular pores, dorsal tubercles and cribriform plates absent. Anal plates together rather pyriform, anterior margins longer than posterior margins; length 101-108 μm , narrow, combined width about 68 μm ; each with 4 small setae: a minute seta on dorsal surface near inner margin, another on inner margin near apex and another on dorsal surface near posterior

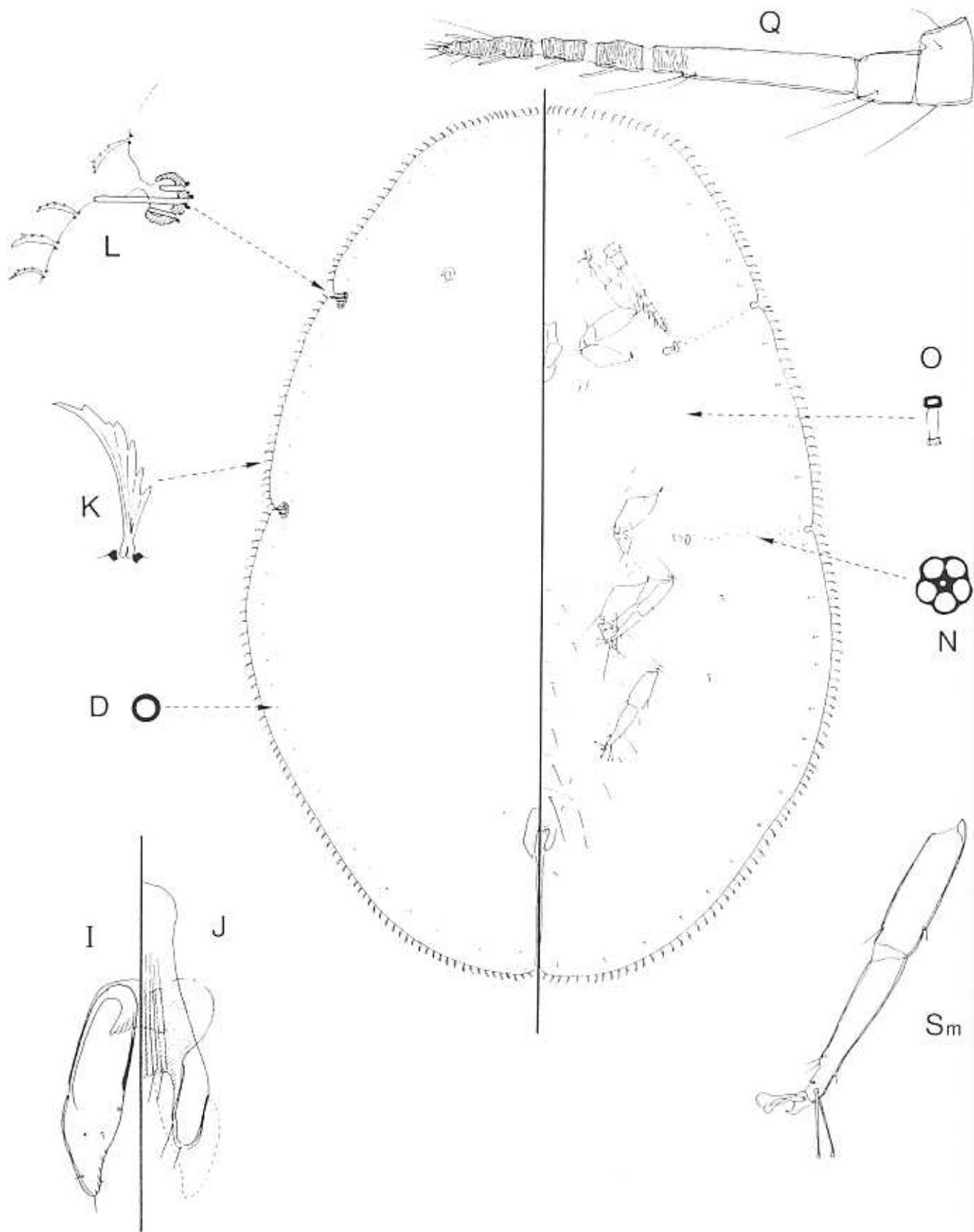


Fig. 10. *Maucoccus cinnamomicolus* (Takahashi). Third-instar female nymph. For lettering, see Fig. 1.

margin, plus a short apical seta 10-14 μm long. Anal fold with 2 pairs of setae along anterior margin and 2 on each lateral margin; with a distinct sclerotised plate or inner apodeme anterior to anogenital fold. Anal ring with 6 setae, each about 150 μm long; anal tube long. Eyespots present on dorsum just posterolaterally to a point dorsad to each scape, oval, 13-17x18-20 μm wide, each in a slightly paler area of dorsum.

Margin. – each marginal seta flattened, curved posteriorly, anterior margin dentate, with about 6-8 teeth and with a few slight ridges; each 17-20 μm long; with a well-developed basal socket; in a single line around margin, with 22-26 laterally between stigmatic clefts. Stigmatic clefts distinct, each narrow, broadening away from margin, with a distinct U-shaped stigmatic sclerotisation around inner margin; each cleft with 3 spines, each blunt and parallel-sided, median spine longest (33-45 μm long), lateral spines only 15-17 μm long. Anal cleft margins adpressed.

Venter. – derm membranous; segmentation distinct on abdomen. Preanal disc-pores absent. Spiracular disc-pores with mainly 5 outer loculi and with a round inner loculus; with 12-15 disc-pores in each disc-pore band. Ventral microducts minute - probably present throughout but sparse medially on thorax and abdomen. Preantennal pores absent. Ventral tubular ducts absent. Ventral setae - with 1 pair of anal cleft setae; with 1 pair of setae present medially on each abdominal segment, preanal pair 75 μm long; with 2 setae near each coxa; with 2 pairs of interantennal setae, longest about 42 μm ; with 5 setae in submarginal band laterally between stigmatic clefts. Antennae well developed, each with 6 segments; length 215-228 μm ; each scape with 3 setae; each pedicel with 1 long seta, 1 short seta and a campaniform sensilla; segment III longest, with 1 long seta plus 2 shorter setae; segments IV and V both with a fleshy seta + 1 hair-like seta; segment VI elongate, with 3 fleshy setae, 5 stout setae and 1 long flagellate seta (41-50 μm long); apical seta short, 15-16 μm long; distal part of segment III and apical 3 segments with narrow transverse ridges. Mouthparts normal; labium with 4 pairs of setae and not twisted. Spiracles small, width of each peritreme 18-23 μm . Legs well developed; measurements and data for metathoracic leg: coxa 85-88 μm long, with 1 long seta (36-42 μm long) on inner margin + 4 other setae; trochanter + femur 117-123 μm long, each trochanter with 1 long seta (about 56 μm) on inner margin and 2 short setae on outer margin; each femur with 2 setae; tibia + tarsus without an articulatory sclerite; tibia 59-62 μm long, with 2 setae; tarsus 73-77 μm long, with 3 setae; without a tarsal campaniform pore; tarsal digitules rather long, extending past tips of claw, 1 slightly thicker than other; claws short and curved, 10 μm long, without a denticle; 1 claw digitule distinctly broader than other.

Comment. – This stage is considered to be the 3rd instar because the dimensions of the legs, antennae and anal plates compared with those of the 1st-instar nymph is considered to be too great an increase in size for these specimens to represent 2nd-instar. This instar is very similar to the adult

female but lacks the cribriform plates, dorsal pores, dorsal setae and ventral tubular ducts. In addition, the marginal setae are subtly different, appearing to be digitate on one side only.

FIRST-INSTAR NYMPH (Fig. 11)

Described from a single specimen in excellent condition.

Unmounted material. – unknown.

Mounted material. – small, 490 μm long and 273 μm wide; stigmatic clefts distinct, with stigmatic sclerotisations; anal cleft shallow; showing no signs of asymmetry.

Dorsum. – derm membranous. Dorsal setae absent. Dorsal pores small and dark - few, in a submarginal band (about 7 on each side of abdomen plus 1 just mesad of each stigmatic cleft, 1 on each side of thorax and 2 pairs on head; and with 3 pairs submedially on abdomen and another pair on head. Trilocular pore near anterior margin absent. Anal plates each narrow, about 53 μm long; each plate with a few longitudinal ridges on dorsal surface and with 4 setae; a minute seta on inner margin and 2 more on apex, plus a very long (about 150 μm) apical seta. Anogenital fold with 1 seta anteriorly and another on lateral margin. Eyespots on margin, small and inconspicuous, about 8 μm wide.

Margin. – marginal setae each 10-14 μm long, finely spinose, curved posteriorly; with well-developed basal sockets; with 1 on each side laterally between stigmatic clefts. Stigmatic clefts quite deep, outer margins almost touching; with a strong U-shaped inner stigmatic sclerotisation; each with 3 stigmatic spines, each blunt and parallel-sided, median spine long, 17-20 μm , lateral spines each about 5-6 μm long.

Venter. – derm membranous; segmentation just visible on abdomen. Pregenital disc-pores absent. Spiracular disc-pores apparently with 3 outer loculi and no central loculus; with 2-3 in each band. Ventral microducts - few but with 1 pair between scape and anterior legs, 1 pair just posterior to procoxae and with 3 pairs on abdomen (1 near each mediolateral seta between abdominal segments II/III, IV/V and VI/VII). Ventral setae - in 4 longitudinal lines on abdomen, setae in median 2 rows quite long (pregenital setae each 22 μm long), mediolateral row all short; with a single long seta anterior to meta- and mesocoxae and 2 setae posterior to procoxae; without interantennal setae; with 1 submarginal seta laterally between stigmatic clefts. Antennae well developed, 6-segmented, 154 μm long; each scape with 3 setae; each pedicel with 1 long seta, a short seta and a campaniform sensilla; segment III longest, with 1 moderately long seta and 2 shorter setae; segments IV and V each with a fleshy seta + a hairlike seta; segment VI elongate, with 3 fleshy setae, 6 stout setae, 1 short fine seta and a long outer flagellate seta about 85 μm long; apical seta short, 17 μm long; terminal 4 segments with fine annulations. Mouthparts normally developed; labium not twisted to one side, possibly with only 3 pairs of setae. Spiracles small, width of each peritreme 7 μm . Legs well developed, measurements and

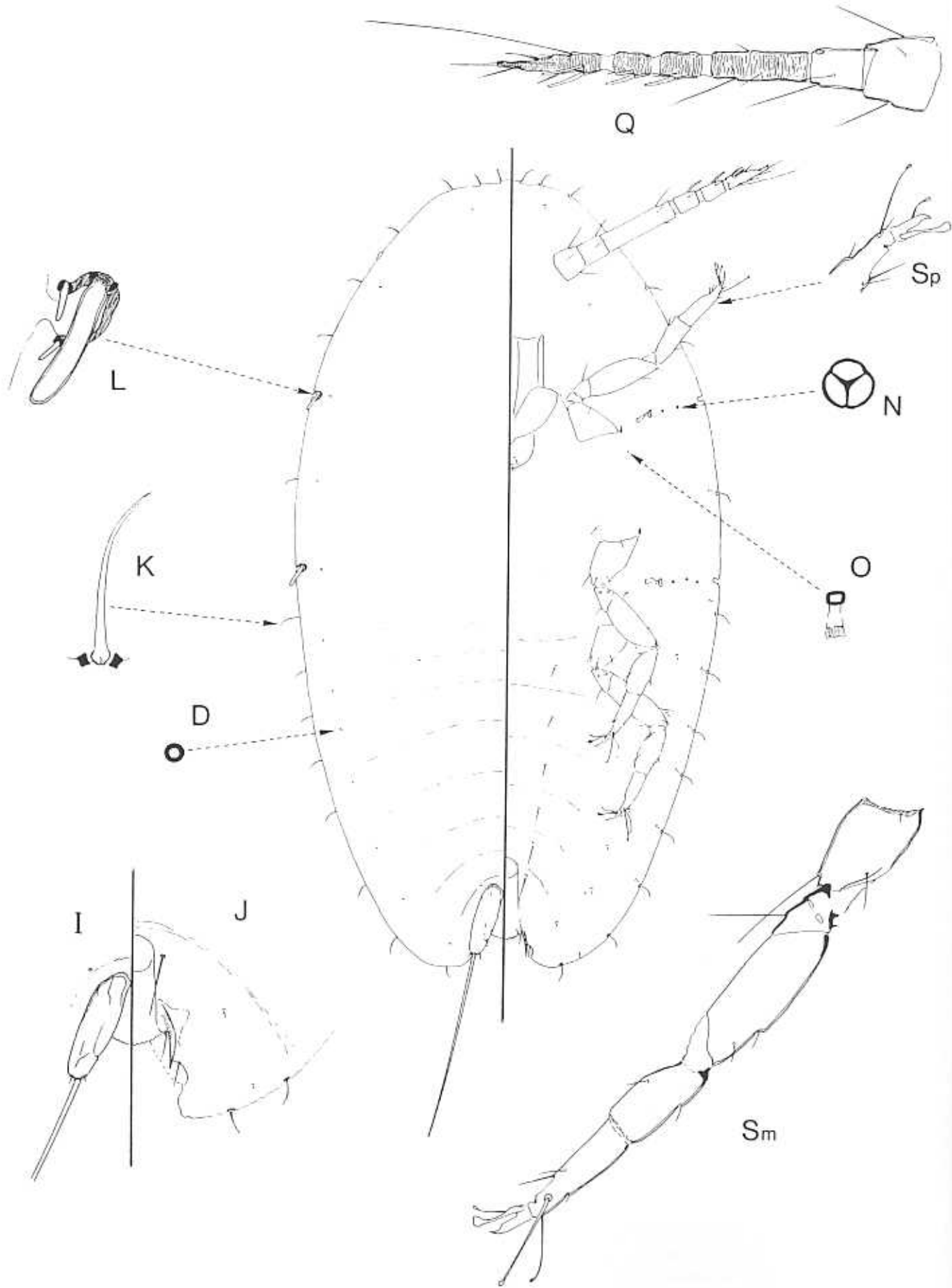


Fig. 11. *Maucoccus cinnamomicolus* (Takahashi), First-instar nymph. For lettering, see Fig. 1.

other data for metathoracic leg: coxa 43 μm long, with 1 long seta medially, 25 μm long, plus 3 other setae; trochanter + femur 68 μm long; each trochanter with 1 long seta 23-25 μm long and 1 short seta on outer margin; each femur with 2 setae; tibia and tarsus without an articulatory sclerotisation but distal margin of tibia with minutely dentate edge; tibia 34-37 μm long, with 2 setae (protibia with similar number of setae); tarsus 35-38 μm long with 2 inner setae and a fine seta on outer margin; without tarsal campaniform pores; tarsal digitules offset, 1 markedly stouter and longer than other (thicker replaced by a small setose seta on protarsus); claws long and fine (10 μm long), rather unusually shaped, with a broad denticle and 1 digitule distinctly thicker than other. Anal ring with 6 setae; anal tube quite long.

Comment. – this is a fairly typical 1st-instar soft scale, but is characterised by: (i) presence of stigmatic clefts, each with a stigmatic sclerotisation and 3 spines, (ii) absence of a trilobular pore on the head, (iii) absence of dorsal setae, (iv) ventral microducts present on head and abdomen as well as on thorax, (v) claw digitules dissimilar, (vi) anal plates slightly withdrawn onto dorsum, (vii) apical setae on anal plates long, (viii) claw with a rather broad denticle. No other crawler of species belonging to the tribe Paralecaniini has been described in detail previously.

Type material examined. – LECTOTYPE – adult female (here designated): WEST MALAYSIA, Selangor, Kuala Lumpur, on *Cinnamomum* sp. (Lauraceae), coll. R. Takahashi, 26 Apr. 1944 (BMNH, B.M.1955-812).

PARALECTOTYPE – 1, adult female, same data and on same slide as lectotype [a third specimen, an adult female of *Platylecanium asymmetricum* Morrison, is also on the same slide] (BMNH). The lectotype and paralectotype are clearly marked, as is the specimen of *P. asymmetricum*.

Other material examined. – 26 adult females, 3 third-instar females, 1 crawler (+ some embryos), SINGAPORE, Bukit Timah Forest Reserve, on upper leaf surface of seedling of *Prunus polystachya* (Rosaceae), coll. J.H. Martin, 13 May 2000 (#7461) (BMNH, SBG).

Note. – Takahashi (1952) described this interesting species from only two specimens. These two syntype specimens are present on a single slide in the BMNH, together with a solitary female of *Platylecanium asymmetricum* Morrison. Although the slide is typical of Takahashi's own preparations, in this case bearing two coverslips which are partially covered by the labels, partially obscured by extruded balsam and with the balsam mountant having shrunk back from the edges of the coverslips during the drying process, the individual here selected as the lectotype is in remarkably good condition. It was therefore decided not to risk remounting and separating the specimens, even though this leaves the individual of *P. asymmetricum* on the same slide. The opportunity has, however, been taken to clean the slide surface. Fresh balsam clearly has been infused under the coverslips at some time in the past, very likely when the slide first arrived at BMNH, in 1955.

Although Takahashi (1952) made comparisons between *M. cinnamomicolus* and *P. asymmetricum*, the latter species was not actually listed in the paper, although the paper did list 25 other non-diaspidine scales. The reason appears to have been that the paper was a vehicle for new records for the Malay Peninsula, whereas *P. asymmetricum* had been described from Singapore, regarded as being part of the Malay Peninsula, and therefore was not a new record.

Comment. – the species within the genus *Maacoccus* are not well known. The type species, *M. bicruciatatus* was redescribed by Hodgson (1994) and the above description of the adult female of *M. cinnamomicolus* agrees with it in having: *dorsum* – (i) preopercular pores in segmental bands, (ii) dorsal setae very short, (iii) anal plates together rather pyriform, anterior margin longer than posterior margin and with a rounded outer angle, (iv) eye-spots displaced onto dorsum, almost dorsal to each scape, (v) dorsal tubercles and pocket-like sclerotisations absent, and (vi) anal plates with only very small setae; *margin* – (vii) marginal setae which are flattened and broad, with fimbriate or divided margins, (viii) anal cleft fused along its length, (ix) each stigmatic cleft with only 3 stigmatic spines, (x) stigmatic clefts with a U-shaped stigmatic sclerotisation, and (xi) anal ring with 4 pairs of setae; *venter* – (xii) pregenital disc-pores absent, (xiii) ventral tubular ducts restricted to medio-laterally on abdominal segments, (xvi) antennae with setose setae as well as fleshy setae on subterminal 2 antennal segments, and (xiii) ventral microducts minute. It differs from *M. bicruciatatus* in (i) having a submedial band of cribriform plates, (ii) the shape of the marginal setae, and (iii) in not having the mouthparts displaced to one side.

The genus *Sacharolecanium* Williams (which currently contains just two species, *S. fujianensis* Tang, from China and *S. krugeri* (Zehntner), from Java) is closely similar (and is also restricted to the Oriental region) but differs in having (i) reduced legs and antennae, (ii) the clypeolabral shield is enlarged anteriorly, and (iii) the anal plates are quadrate and about as long as their combined widths.

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