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Systematic revision of the Family Micrococcidae (Homoptera: Coccoidea), with a discussion of its relationships, and a description of a gynandromorph

INTRODUCTION

The genus *Micrococcus* Leonardi has been an enigma since its was described in 1907. It has been placed in the Eriococcidae (Ferris, 1957), Coccidae (Balachowsky, 1942), Micrococcidae (Koteja, 1974), and Pseudococcidae (Silvestri, 1939) but its true relationships have never been studied in detail. The genus is of interest not only because of its unusual combination of characters, but also because of its potential economic importance. In Israel *Micrococcus bodenheimeri* Bytinski-Salz is commonly found on the roots and crowns of wheat and other graminaceous crop hosts and can be the cause of root damage and yellowing of the leaves. This agricultural concern is of particular importance in areas of the world where the genus does not occur since it could become a pest of several major crop systems without its natural enemies. Concern in the United States is especially heightened since specimens of *Micrococcus* have been intercepted at a U.S. port-of-entry.

In most instances it has been impossible to identify the species because the genus has never been studied in a comprehensive revision. Therefore the purpose of this paper is to revise the genus and its relative *Molluscococcus* Hall, to study the relationships of these genera with other groups of scale insects using objective and repeatable criteria, and to provide information on an unusual specimen of *Micrococcus similis* Leonardi that appears to be the first record of a gynandromorph within the Coccoidea.

Actually, it was this specimen that precipitated our study. We were interested in understanding if the unusual «male», which possessed mouthparts and a well-developed anal ring was typical of the genus or was an aberration.

METHODS AND TERMINOLOGY

Terminology follows that of Williams & Granara de Willink (1992) and McKenzie (1967) for adult females, Afifi (1968) and Giliomee (1967) for adult males, and Miller (1991) for first, second, and third instars. Specialized terminology for the Micrococcidae includes the anal plates, multilocular pores, intrastigmatic pores, parastigmatic pores, cicatrices, and apparent anal lobes. The **anal plates** develop from the anal lobes in the first instar. In the immatures and young adult females of *Micrococcus* they appear as two dorsally projecting structures that are heavily sclerotized and are located laterad of the anal ring. In old adult females, the anal plates become fused and completely surround the anal ring. **Multilocular pores** have many loculi that surround a central hub of loculi giving the appearance of a sieve. These pores are derived from pores in the earlier instars, that have a solid central hub and no central loculi. **Intrastigmatic pores** are multilocular pores that occur in the atrium of the spiracle or on the sclerotized plate surrounding the spiracle. **Parastigmatic pores** are multilocular pores that occur on the derm surrounding the spiracles and form a band near the body margin; this band may extend from the head, past the spiracles, to the abdomen, or may be more restricted. **Cicatrices** are two large circular structures on the dorsal abdomen of *Molluscococcus*. It is unclear if these structures are homologous with the anal plates found in *Micrococcus*; perhaps examination of second and third instars will clarify the derivation of these structures. The **apparent anal lobes** are slightly protruding structures located at the posterior apex of the abdomen that contain several long setae. They are part of abdominal segment 7, rather than segment 8, and are not homologus to the anal lobes of other scale insects. **Discoidal pores** in all species are usually wider than the setal collars, heavily sclerotized and cylindrical. According to Marotta *et al.* (1995) they have a sieve like structure when being studied with the scanning electron microscope.

Measurements and numbers are from 10 specimens when available and are given as a mean with ranges in parentheses. Phylogenetic analyses were performed using Hennig 86 (Farris, 1988). The functions mhennig «mh*», branch swapping «bb», and ultimately implicit enumeration «ie» were used to determine the structure of the trees. Successive weighting «xs w» also was used. Diagnostics involved «dos equis» and character coding «cc» functions. The data matrix consisted of 20 taxa and 39 characters. Outgroup comparison was used to determine the polarities of the character states and *Puto kosztarabi* Miller et Miller (Pseudococcidae) was chosen as the outgroup. Representative species of each of the hypothesized related higher categories were selected based primarily on the availability of descriptions in the literature or the presence of adequate specimens. Data were gathered from the following sources: For *Acanthococcus droserae* Miller, Liu, et Howell (Eriococcidae) – male, female, and first instar specimens were examined and were supplemented by information in Miller *et al.* (1992); *Aclerda arundinariae* McConnell (Aclerdidae) – male, female, and first instar specimens were examined and were supplemented by information in McConnell (1953); *Apiomorpha conica* (Froggatt) (Eriococcidae) – female and first instar specimens were examined along with adult males identified only as *Apiomorpha* sp., which were supplemented with information in Theron (1968) and Gullan (1984); *Asterolecanium proteae* Giliomee et Munting (Asterolecaniidae) – *Capulinia sallei* Signoret (Eriococcidae) – females, males, and first instar specimens were examined; *Carpochloroides viridis* Cockerell (Eriococcidae) – females, males, and first instar specimens were examined; *Cerococcus andinus* Leonardi (Cerococcidae) – female, male, and first instar specimens were examined and were supplemented with information in Lambdin & Kosztarab (1977) and Hamon & Kosztarab (1979); *Coccus hesperidum* Linnaeus (Coccidae) – female, male, and first instar specimens were examined and were supplemented with information in Giliomee (1967); *Cryptococcus fagisuga* Lindinger (Eriococcidae) – female and first instar specimens were examined and were supplemented with information in Miller & Miller (1993a); *Eriokermes gillettei* (Tinsley) (Kermesidae) – female, male, and first instar specimens were examined and were supplemented with information in Miller & Miller (1993c); *Grammococcus adentocorymbus* Miller et Lambdin (Asterolecaniidae) – male,

female, and first instar specimens were examined and were supplemented by information in MILLER & LAMBDIN (1978); *Lecanodiaspis acaciae* (Maskell) (Lecanodiaspididae) – female and first instar specimens were examined and were supplemented with information in HOWELL & KOSZTARAB (1972), AFIFI & KOSZTARAB (1969), and WILLIAMS & KOSZTARAB (1970); *Micrococcus bodenheimeri* Bytinski-Salz (Micrococcidae) – female, male, and first instar specimens were examined; *Molluscococcus fibrillae* Hall (Micrococcidae) – female and first instar specimens were examined; *Pollinia pollini* (Costa) (Asterolecaniidae) – female, male, and first instar specimens were examined; *Nanokermes pubescens* (Bogue) (Kermesidae) – female, male, and first instar specimens were examined and were supplemented with information in BULLINGTON & KOSZTARAB (1985) and BAER & KOSZTARAB (1985); *Pulvinaria acericola* (Walsh and Riley) (Coccidae) – female, male, and first instar specimens were examined and were supplemented with information in GILIOMEE (1967); *Puto kosztarabi* Miller et Miller (Pseudococcidae) – female, male, and first instar specimens were examined and were supplemented with information in MILLER & MILLER (1993b); *Sphaerolecanium prunastri* (Fonscolombe) (Coccidae) – female, male, and first instar specimens were examined and were supplemented with information in GILIOMEE (1967); *Tachardiella larreae* Chamberlin (Tachardiidae) – female and first instar specimens were examined along with adult males of *Tachardina aurantiaca* Cockerell, which were supplemented with information in CHAMBERLIN (1923).

Abbreviations of depositories are as follows: The Natural History Museum, London, United Kingdom (BMNH); The Coccoidea Collection, Department of Entomology, The Volcani Center, Bet Dagan, Israel (ICV); Muséum National d'Histoire Naturelle, Paris, France (MNHN); University of California, Bohart Collection, Davis, California (UCD); United States National Museum of Natural History, Beltsville, Maryland (USNM).

Family Micrococcidae Silvestri

Family Micrococcidae Silvestri.
Type genus *Micrococcus* LEONARDI, 1907: 135.
Micrococci SILVESTRI, 1939: 702.
Micrococcinae Silvestri; BALACHOWSKY, 1942: 43.
Micrococcini Silvestri; BALACHOWSKY, 1948: 255.
Micrococcidae Silvestri; KOTEJA, 1974: 56.

Description: Body of adult female elongate oval to broadly oval. Antennae with fewer than 4 segments, basal segment widest, third segment elongate, bluntly conical. Labium 1-segmented, rectangular in shape, with 5 pairs of setae on each side. Legs well developed, without translucent pores, with sensoria on trochanter arranged diagonally towards proximal end (Fig. 1); tarsus without basal sensillum; tarsal and claw digitules conspicuous and capitate. Anal ring dorsal with 10-28 setae and numerous pores. Apparent anal lobes each with marginal setae longer than other marginal setae. Vulva situated on segment VI. Spiracles well developed with numerous intraspiracular multilocular pores and with or without parastigmatic multilocular pores, these sometimes extending almost around entire margin or associated only with spiracles. Setae normally

filamentous. Discoidal pores unusually cylindrical and wider than setal collars, scattered over dorsum and venter. Macrotubular ducts present on venter, each with inner end invaginated. Bilocular pores of two sizes: Small type present on dorsum and venter; large type present only on venter.

Diagnosis: The unique characters of this family are the position of the vulva on abdominal segment VI, the presence of apparent anal lobes rather than true anal lobes, and discoidal pores that have an unusually thick margin.

KEY TO GENERA OF MICROCOCCIDAE (ADULT FEMALES)

1 Anal plates present on each side of anal ring; multilocular pores absent from medial area of venter of abdomen; macrotubular ducts of 2 sizes; legs with tibia and tarsus fused ..... *Micrococcus* Leonardi

– Anal plates absent from each side of anal ring; multilocular pores present in medial area of venter of abdomen; macrotubular ducts of one size; legs with tibia and tarsus separate ..... *Molluscococcus* Hall

Genus *Micrococcus* Leonardi

Micrococcus LEONARDI, 1907: 135. Type species *Micrococcus silvestrii* Leonardi, subsequent designation by SANDERS, 1909: 42.

Ixeidococcus KOTEJA, 1974: 56. (Unavailable name according to International Code of Zoological Nomenclature Article 13 (c) because Koteja did not mark the genus and species as «n.g., n.sp., or an equivalent expression»; it seems clear that he did not intend to describe the genus or species which are manuscript names of Green).

Diagnosis: Adult female with abdominal segment VIII modified into anal plates that surround anal ring; cicatrices absent; multilocular pores restricted to ventrosubmarginal areas, absent from medial areas; macrotubular ducts of 2 sizes, not forming submarginal band; multilocular pores present; tibia and tarsus fused. First instar antennae 5-segmented; dorsomarginal line of setae complete on abdomen; macrotubular ducts absent.

GENERAL DESCRIPTION OF ADULT FEMALE

Description: Body elongate oval in newly mature females, very rotund in older females. Abdominal segment VIII modified so that entire segment is dorsal leaving segment VII as posterior-most segment. Setae filamentous, scattered over both surfaces, longest ventral setae excluding those on body margin approximately 25 μ long. Multilocular pores each with 7 to more than 20 loculi,

with single central loculus or more than 1 central loculus. Parastigmatic pores, when present, comprising multilocular pores, occurring outside of stigmatic plate. Intrastigmatic pores comprising multilocular pores, restricted to sclerotized plates surrounding spiracular atria. Invaginated tubular ducts of 2 sizes: broader ducts present on medial and submarginal areas of abdomen and metathorax; narrower ducts on medial and submarginal areas of abdomen and head. Anal lobes modified into anal plates that surround anal ring. Anal lobe-like structures developed on segment VII with several long setae giving appearance of normal lobes. Legs with tibia and tarsus fused.

GENERAL DESCRIPTION OF THIRD INSTAR FEMALE

Description: Same as adult female except as follows. Body elongate oval. Longest ventral setae excluding those on body margin less than 25 μ long. Multilocular pores each with 5 to more than 15 loculi. Parastigmatic pores usually absent. Invaginated tubular ducts absent. Vulva absent. Anal ring with more than 4 setae on each side; anal-ring pores in 2 rows.

GENERAL DESCRIPTION OF SECOND INSTAR FEMALE

Description: Same as third instar female except as follows. Multilocular pores each with 5 to more than 15 loculi. Parastigmatic pores present. Anal ring with fewer than 5 setae on each side; anal-ring pores absent or in 1 row.

GENERAL DESCRIPTION OF FIRST INSTAR

Description: Body elongate. Abdominal segment VIII modified into sclerotized lobes which transform into plates in later instars; each lobe with a sclerotized bar and long apical seta. Antennae 5-segmented. Setae filamentous, with 2 pairs of longitudinal lines on each side of dorsum, with 3 pairs of lines on each side of venter. Bilocular pores absent. Multilocular pores with 5 to 9 loculi, without central loculus. Parastigmatic and intrastigmatic pores present. Discoidal pores present on both surfaces. Invaginated tubular ducts absent. Microtubular ducts present on submarginal area of venter, with conspicuous dermal orifice. Legs without sensillum on tarsus; tibia and tarsus separate; tibia divided by tarsus about 1.6; tarsal digitules staggered, not arranged side-by-side, apices acute or slightly enlarged; tarsal digitules on front legs each with 1 small filamentous seta and 1 enlarged seta; claw digitules each with 1 large seta, and 1 conspicuously smaller seta.

GENERAL DESCRIPTION OF ADULT MALE OF *MICROCOCCUS*

Description: Without wings and sclerotization on head and thorax. Head with 1 pair of eyes. Body elongate. Abdominal segment VIII with sclerotized lobes. Labium absent, clypeolabral shield present. Antennae 3-segmented. Setae filamentous, with 3 indefinite, longitudinal lines on each side of dorsum. Bilocular pores of 2 sizes, smaller size associated with setal clusters on dorsum, and on lateral areas of venter; larger size scattered over venter. Multilocular pores absent. Parastigmatic and intrastigmatic pores absent. Discoidal pores present on both surfaces. Invaginated tubular ducts absent. Microtubular ducts absent. Penial sheath forming complete capsule, partially divided dorsally. Aedeagus tubular, with blunt apex. Legs with tibia and tarsus fused; tarsus without basal sensillum; tarsal and claw digitules conspicuous and capitate; tarsal digitules with 1 digitule conspicuously smaller than other.

KEY TO INSTARS

1	Antennae 2- or 3-segmented; tibia and tarsus at least partially fused	2
–	Antennae 5- or 6-segmented; tibia and tarsus separate	first instar
2 (1)	Apex of abdomen without aedeagus and penial sheath	3
–	Apex of abdomen with aedeagus and penial sheath	adult male
3 (2)	Anal ring with more than 4 setae on each side	4
–	Anal ring with fewer than 5 setae on each side	second instar female
4 (3)	Vulva and tubular ducts present	adult female
–	Vulva and tubular ducts absent	third instar female

KEY TO ADULT FEMALES

1	Parastigmatic pores absent or restricted to thorax	2
–	Parastigmatic pores present on thorax and abdomen	5
2 (1)	Parastigmatic pores absent; with fewer than 10 setae on each anal plate	3
–	Parastigmatic pores near spiracular plates; with more than 10 setae on each anal plate	*similis* Leonardi
3 (2)	Some marginal discoidals oval, narrow area of oval sclerotized in shape of an eye (we have not seen adults of this species but assume that this statement will be true on adults as well as immatures)	*rungsi* Balachowsky
–	Marginal discoidals round, or if oval without sclerotization in shape of an eye	4
4 (3)	Antennae 3-segmented; longest seta on apparent anal lobes 237 (172-306) μ long	*bodenheimeri* Bytinski-Salz
–	Antennae 2-segmented (segments 3 and 2 partially or completely fused); longest seta on apparent anal lobes 90 (83-96) μ	*dumonti* Balachowsky
5 (1)	Longest dorsal seta on metathorax longer than 100 μ; more than 8 setae on each hind femur	*longispinus* Miller et Williams
–	Longest dorsal seta on metathorax shorter than 100 μ; 8 setae or fewer on each hind femur	6
6 (5)	Tibia + tarsus more than 300 μ long; with more than 5 parastigmatic pores near each lateral	

margin of abdominal segment IV; longest seta on anal plates longer than 50 μ..... .....*silvestrii* Leonardi

– Tibia+tarsus less than 300 μ long; with fewer than 5 sieve pores near each lateral margin of abdominal segment IV; longest seta on anal plates less than 50 μ..... .....*confusus* Miller et Williams

KEY TO SECOND INSTAR FEMALES

1 With pores in anal ring.....2
– Without pores in anal ring.....*silvestrii* Leonardi
2 (1) Parastigmatic pores present near anterior spiracles.....*rungsi* Balachowsky
– Parastigmatic pores absent near anterior spiracles.....*longispinus* Miller et Williams

KEY TO THIRD INSTAR FEMALES

1 Longest dorsal setae less than 100 μ; dorsomedial setae about same length as remaining setae.....2
– Longest dorsal setae more than 100 μ; dorsomedial setae noticeably longer than remaining setae.....*longispinus* Miller et Williams
2 (1) Antenna more than 120 μ long.....*silvestrii* Leonardi and *similis* Leonardi
– Antenna less than 120 μ long.....*bodenheimeri* Bytinski-Salz

KEY TO FIRST INSTARS

1 Fewer than 15 parastigmatic pores on each side of body; usually without a pore or cluster of pores near body margin between clusters associated with anterior and posterior spiracles.....*bodenheimeri* Bytinski-Salz
– 15 or more parastigmatic pores on each side of body; with 1 or more pores near body margin between clusters associated with anterior and posterior spiracles..... .....*dumonti* Balachowsky, *silvestrii* Leonardi, and *rungsi* Balachowsky

TREATMENT OF SPECIES

Micrococcus bodenheimeri Bytinski-Salz

Micrococcus bodenheimeri Bytinski-Salz, 1961: 90-96.

Ixeidococcus graminis Koteja 1974: 56. (Unavailable name according to the International Code of Zoological Nomenclature Article 13 (c) because Koteja did not mark the genus and species as «n.g., n.sp., or an equivalent expression». It seems clear that he did not intend to describe the genus or species which are manuscript names of Green).

Adult female (Fig. I)

Recognition characters: Mounted, 1.7 (1.5-2.1) mm long, 0.9 (0.5-1.2) mm wide.

Dorsum with filamentous setae scattered over surface; longest seta on dorsomedial area of metathorax 19 (15-26) μ long, all setae in area about same length. Marginal setae usually slightly longer than setae on rest of dorsum, some specimens with long marginal setae on any of abdominal segments, one specimen with long marginal setae around entire body. Small bilocular pores abundant over surface except on posterior one or two segments where rare or absent. Discoidal pores oval to circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 5 (4-6) setae; longest seta 38 (29-44) μ long. Anal ring with 6 (5-6) setae and 36 (29-43) pores on each half. Apparent anal lobes each with 7 (3-12) setae; longest seta 237 (172-306) μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 23 (20-26) μ long. Macrotubular ducts of two sizes: Broader size on abdomen and metathorax, absent from marginal areas; narrower size on head and pro- and mesothorax, absent from marginal areas. Small bilocular pores scattered over marginal and submedial areas. Large bilocular pores usually on head, thorax, and anterior abdominal segments, some specimens with these pores on head and thorax only. Discoidal pores oval to circular, scattered over surface. Intrastigmatic pores with 7-28 loculi, 71 (62-79) pores associated with each anterior spiracle. Parastigmatic pores absent.

Legs with hind femora each with 6 (5-6) setae; tibia+tarsus with 6 (5-7) setae; tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 181 (170-189) μ long; tibia+tarsus 230 (210-250) μ long; femur length divided by tibia+tarsus length 0.8 (0.7-0.8). Antennae 3-segmented, 153 (143-160) μ long; segment III 75 (64-90) μ long, with 11 (10-11) setae; segment II 31 (26-35) μ long, 67 (58-79) μ wide.

Notes - The description is based on 180 specimens from 21 localities.

The adult female of this species differs from most other species of *Micrococcus* by lacking parastigmatic pores and by having short appendages. *Micrococcus dumonti* also lacks parastigmatic pores and has appendages that are slightly longer than on *M. bodenheimeri*, but is distinguished by having 2-segmented antennae, apparent anal-lobe setae that are about 90 μ long, and the longest anal plate setae that are about 15 μ long. *Micrococcus bodenheimeri* has 3-segmented antennae, apparent anal-lobe setae that are about 237 μ long, and the longest anal plate setae that are about 38 μ long.

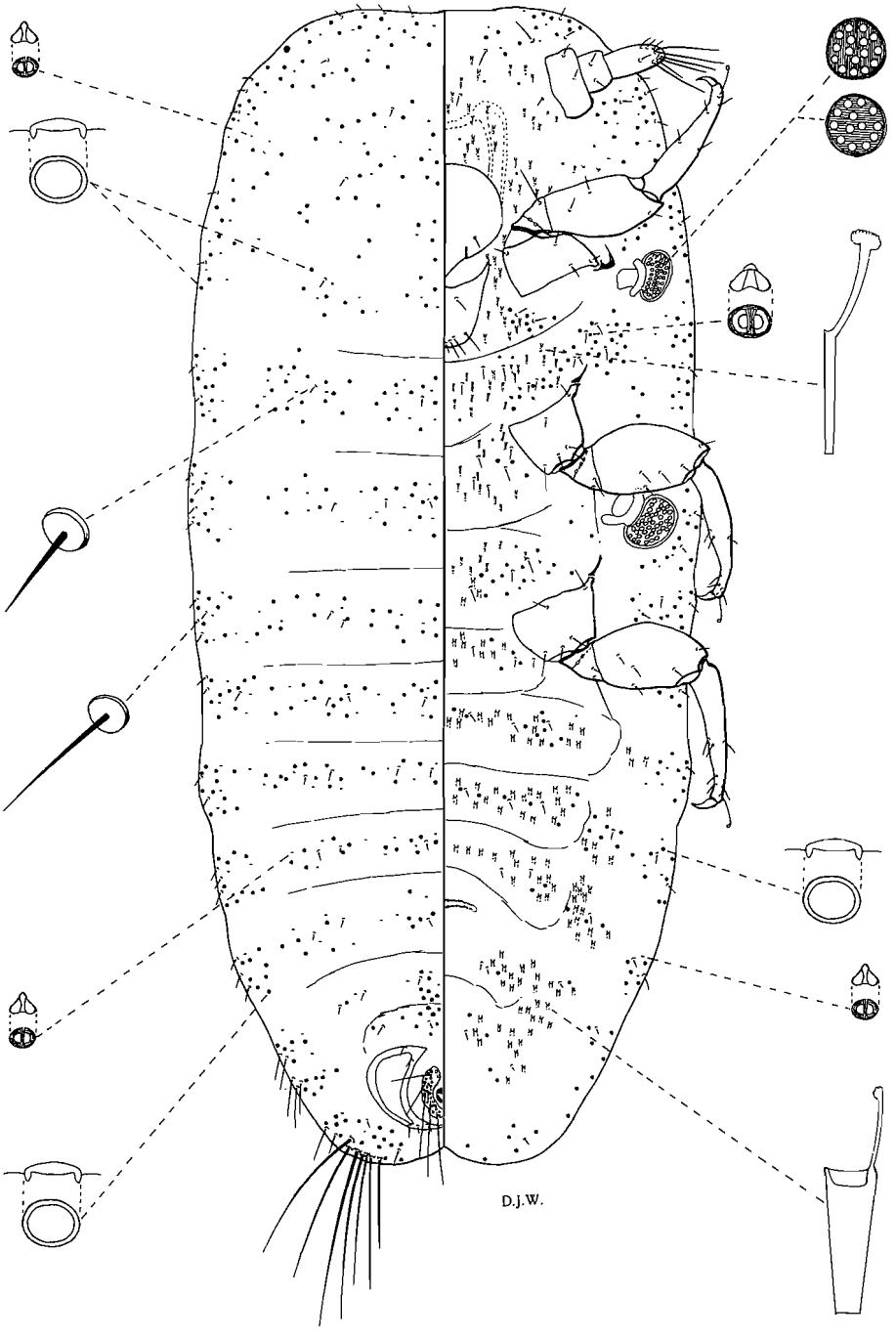

Fig. I - *Micrococcus bodenheimeri* Bytinski-Salz. - Adult female.

Third instar female (Fig. II)

Recognition characters: Mounted, 1.6 (1.5-1.8) mm long, 0.8 (0.7-0.9) mm wide.

Dorsum with filamentous setae arranged in 3 pairs of longitudinal lines on each side of abdomen, medial, mediolateral, and marginal; longest seta on dorsomedial area of metathorax 10 (9-11) μ long, all setae in area about same length. Marginal setae often slightly longer than setae on rest of dorsum. Small bilocular pores scattered over surface except on posterior one or two segments where rare or absent. Discoidal pores oval or circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 5 setae; longest seta 23 (14-32) μ long. Anal ring with 5 (5-6) setae and 9(6-10) pores on each half. Apparent anal lobes each with 7 (4-10) setae; longest seta 86 (81-91) μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 17 (15-20) μ long.

Small bilocular pores scattered over surface, absent from posterior 2 or 3 abdominal segments or scarce. Large bilocular pores usually on head, thorax, and anterior 1 to 3 abdominal segments, some specimens with these pores on head and thorax only. Discoidal pores oval to circular, scattered over surface, except absent from medial area of posterior 2 or 3 abdominal segments. Intrastigmatic pores each with 6-10 loculi, 7 (5-8) pores associated with each anterior spiracle. Parastigmatic pores absent.

Legs with hind femora each with 6 (5-7) setae; tibia+tarsus with 6 (4-7) setae; tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 113 (111-119) μ long; tibia+tarsus 146 (141-153) μ long; femur length divided by tibia+tarsus length 0.7 (0.7-0.8). Antennae 3-segmented, 91 (82-96) μ long; segment III 49 (47-52) μ long, with 9 (8-10) setae; segment II 16 (12-18) μ long, 56 (52-62) μ wide.

Notes - The description is based on 14 specimens from 2 localities.

First instar (Sex not determined) (Fig. III)

Recognition characters: Mounted, 0.7 (0.6-0.9) mm long, 0.2 (0.2-0.3) mm wide.

Dorsum with filamentous setae arranged in 2 longitudinal lines on each side of body, submedial line restricted to segment I, thorax, and head, marginal line present around perimeter of body; longest seta on dorsomedial area of metathorax 11 (10-14) μ long, all setae in area about same length. Marginal-

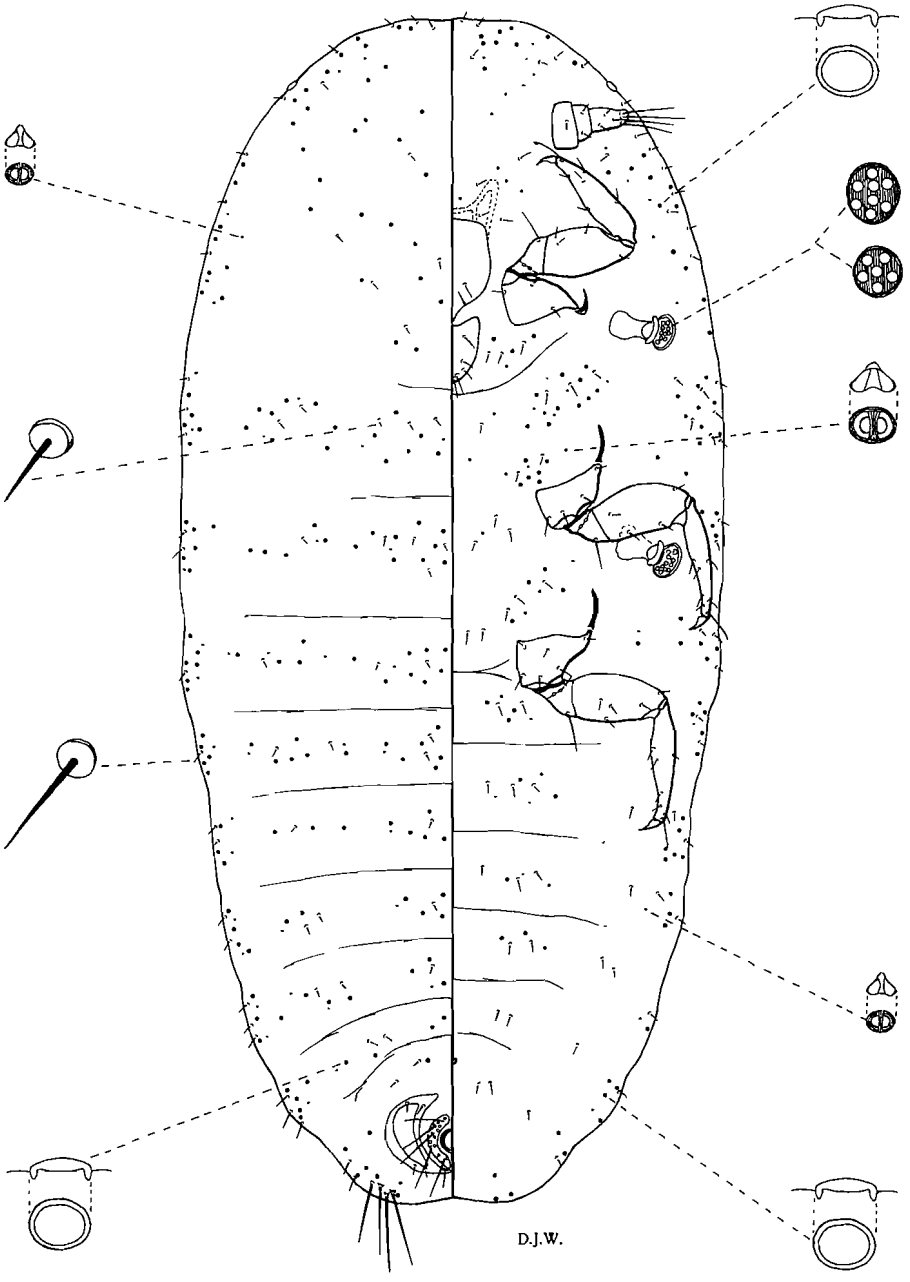

Fig. II - *Micrococcus bodenheimeri* Bytinski-Salz. - Third instar female.

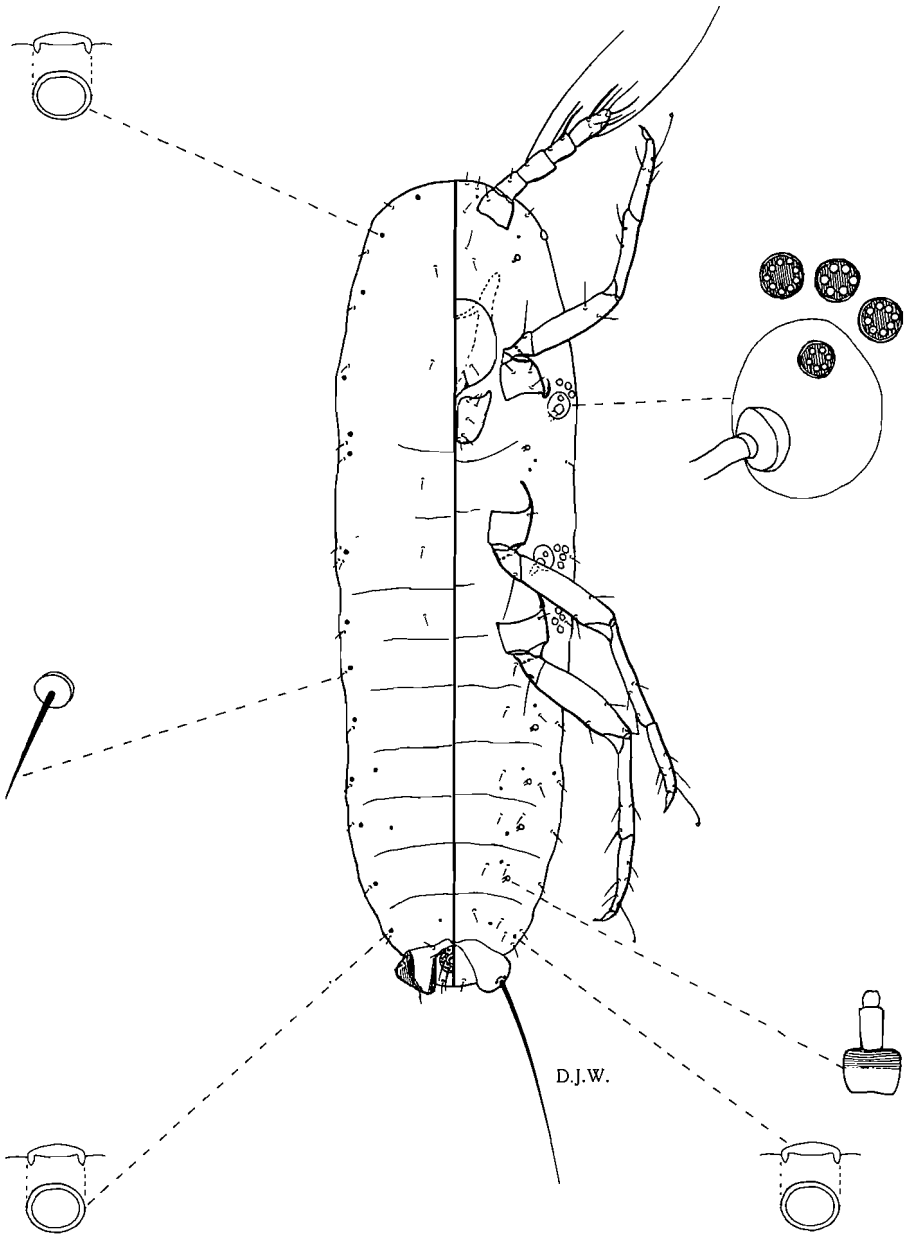

Fig. III - *Micrococcus bodenheimeri* Bytinski-Salz. - First instar.

setae usually about same length as rest of dorsum. Discoidal pores arranged in 2 pairs of longitudinal lines on each side of body, mediolateral line variable, comprising 1 to 4 pores on any of abdominal segments II to VII, marginal line present around perimeter of body.

Anal lobes (plates) each with 3 (3 or 4) setae; longest seta 352 (260-424) μ long. Anal ring with 3 (8-11) pores on each half.

Venter with small setae and 9 setae arranged in segmental lines, longest seta on abdomen, excluding marginal ones, 18 (14-23) μ long. Microtubular ducts present in 1 submarginal line on each side of body, with 2 ducts present on each segment. Discoidal pores in mediolateral and marginal areas of body, forming 2 pairs of indistinct longitudinal lines on each side of body.

Intrastigmatic pores without central loculi, with 5-7 loculi, with 1 pore in each spiracle. Parastigmatic pores near each spiracle and near hind pair of legs, without central loculi, with 5-9 loculi, with 9 (7-11) pores on each side of body. Two specimens with 1 pore on 1 side of body between clusters near anterior and posterior spiracular clusters.

Legs with hind femora each with 3 setae; tibiae with 3; tarsi with 4; tarsal digitule on hind 2 pairs of legs with acute or slightly swollen apices, front pair with 1 digitule small and filamentous and 1 digitule larger and slightly enlarged; claw digitules unequal in size, 1 with conspicuously swollen base and clubbed apex, 1 filamentous with acute or slightly swollen apex; femur 96 (84-116) μ long; tibia 95 (79-126) μ long; tarsus 60 (52-69) μ long; femur length divided by tibia+tarsus length 0.6 (0.5-0.7). Antennae 130 (119-140) μ long; segments III and V each with 1 conspicuously long seta, longest seta on segment V 210 (195-227) μ long.

Notes - The description is based on 30 specimens from 3 localities.

This material includes 6 specimens that are conspicuously larger than the rest of the series. They have legs and antennae that are approximately the same size as those described above, and we suspect that they are the form that aestivates during the dry season. These specimens are approximately 2 mm long and 1 mm wide and differ from those described above by having the orifices of the microtubular ducts, the parastigmatic pores, and the anal lobes much more heavily sclerotized.

Adult male (Fig. IV)

Recognition characters: Mounted, 1.9 (1.6-2.3) mm long, 0.7 (0.6-0.7) mm wide.

Dorsum with filamentous setae arranged in 3 longitudinal lines on each side of abdomen, medial, mediolateral, and marginal; with 6 (6-8) setae on metathorax; longest seta on dorsomedial area of metathorax 17 (14-23) μ long, all setae in area about same length. Marginal setae usually about same length as rest of dorsum. Small bilocular pores uncommon, most prevalent near body

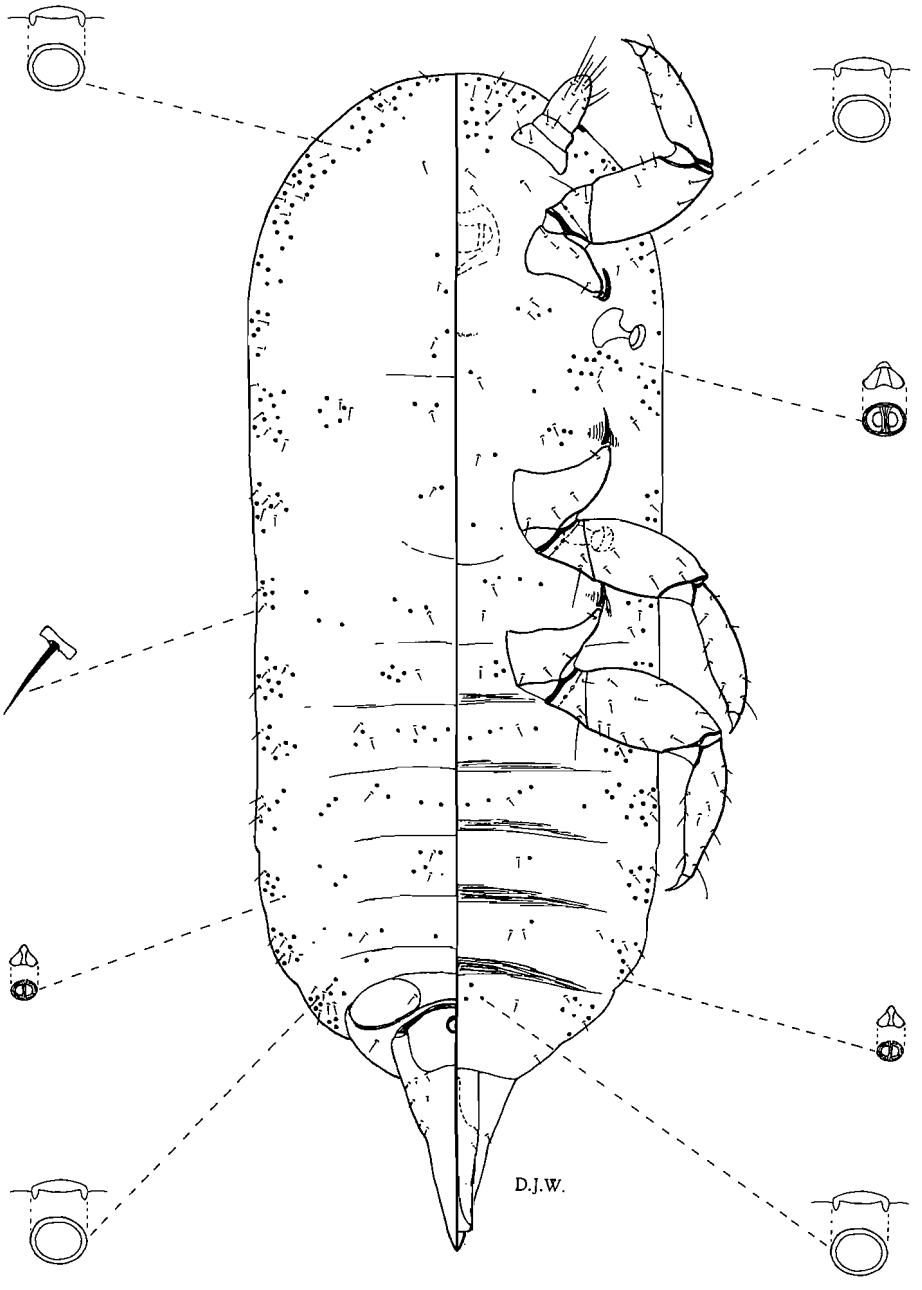

Fig. IV - *Micrococcus bodenheimeri* Bytinski-Salz. - Adult male.

marginodorsal setae. Discoidal pores oval to circular, scattered over surface, most abundant near body margin.

Anal lobes sclerotized, joined by sternite on segment VIII, developed into oval process, each with 2 (1-3) setae; longest seta about 22 (21-27) μ long. Anal ring without setae or pores. Penial sheath partially divided into 2 segments on ventral surface, 320 (193-398) μ long. Aedeagus apically blunt, tubular, 130 (92-161) μ long.

Venter with setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 22 (18-25) μ long. Small biloculars in small numbers near body marginal. Large bilocular pores on head, thorax, and abdomen, most abundant on thorax. Discoidal pores oval to circular, scattered over surface. Intrastigmatic and parastigmatic pores absent. Abdominal sternites noticeably sclerotized towards posterior edges.

Legs with hind femora each with 19 (18-20) setae; tibia+tarsus with 25 (17-28) setae; tarsal and claw digitules with clubbed apices, all about same size; femur 214 (175-262) μ long; tibia+tarsus 218 (184-265) μ long; femur length divided by tibia+tarsus length 1.0 (0.9-1.0). Antennae 3-segmented, 167 (131-200) μ long; segment III 94 (78-104) μ long, with 26 (21-32) setae; segment II 32 (28-39) μ long, 86 (81-94) μ wide.

Notes - The description is based on 4 specimens from 1 locality.

One specimen is quite different from the others by having unsually small appendages.

Type material: The holotype is the left specimen of two mounted on a slide that is labelled as follows: Left label «C:2807,/1, Micrococcus/bodenheimeri/ByS./holotypus ad left/Paratypus ad»; right label«on grass roots/ISRAEL,/Tivon 6.II.56/AgByS.» (ICV). There also is an allotype with the same data.

Specimens examined: Cyprus, Kyrenia, I-16-1932, II-4-1932, III-24-1932, IV-11-1932, IV-13-1932, IV-24-1932, on roots of grass, E.E. Green, 45 adult females, 7 third instars, and 6 first instars on 25 slides (BMNH, UCD); Famagusta, III-9-1932, IV-?-1932, on roots of grass, T. Shiakides, 6 adult females, 16 first instars on 5 slides (BMNH); Lefkonico Pass, II-22-1968, on roots of wheat, G.P. Georghiou, 8 adult females on 2 slides (BMNH); Nicosia, ?-?-1984, on wheat roots, 2 adult females on 2 slides (BMNH); Limasol, II-28-1932, on roots of grasses, E.E. Green, adult female (BMNH).

Israel, in quarantine at St. Louis, Missouri, USA, X-10-1992, on *Triticum* sp., G. Olson, 6 first instars on 2 slides (USNM); Bet-Alpha, on *Triticum* sp. roots, 3 adult females on 1 slide (ICV); Bet Dagan, III-3-1987, on *Cynodon dactylon*, S. Amitai, 7 adult females on 5 slides (ICV); Galon, II-12-1954, on *Phalaris* sp. roots, attended by *Tapinoma phoenicissus*, H. Bytinski-Salz, 4 first instars on 4 slides (ICV); Jerusalem, I-?-1929, II-?-1929, III-18-1932, on grass, F.S. Bodenheimer, 20 adult females on 16 slides (BMNH, ICV); Jerusalem, I-25-43, II-6-1943, on grass in *Tapinoma* sp. nest, F.S. Bodenheimer, 5 adult females on 2 slides (ICV); Migda, III-17-1980, on *Stipa* sp., M. Berlinger, 2 adult females on slide (ICV); Nebi Rubin, date ?, on roots of grasses in ants nest, 12 second instars and 36 adult females on 15 slides (ICV); Netanya, III-23-1962, on Gramineae roots,

10 adult females on 6 slides (ICV); Raanana, II-10-1941, H. Bytinski-Salz, 3 adult females on 3 slides (ICV); Rehovoth, III-28-1942, on *Avena sterilis*, 4 adult females on 1 slide (ICV); Rishon Lezziyon, IV-11-1952, 3 adult females on 1 slide (ICV); Shivta in Negev, III-20-1969, on grass roots, Y. Ben-Dov, 2 second instar females and 12 first instars on 5 slides (ICV); Tel Aviv, I-25-1982, on *Triticum vulgarae* (damaging roots of plant and causing yellowing), 7 adult female on 3 slides (ICV); Tivon, III-25-1954, V-6-1954, II-6-1956 on grass roots, in *Tapinoma* sp. nest, H. Bytinski-Salz, 3 adult females, 3 adult males 4 slides (ICV, BMNH); Tivon, III-?-1957, on grass roots, H. Bytinski-Salz, 1 adult female (ICV); Tivon, III-3-1958, on grass, M. Sternlicht, 5 adult females on 4 slides (BMNH, ICV).

Micrococcus confusus Miller et Williams, sp. nov.

Adult female (Fig. V)

Recognition characters: Holotype mounted, 2.0 mm long (paratypes 2.6 (2.0-5.1) mm), 0.9 mm wide (paratypes 1.9 (1.1-4.7) mm).

Dorsum with filamentous setae scattered over surface; longest seta on dorsomedial area of metathorax 19 μ long (paratypes 18 (15-22) μ), all setae in area about same length. Marginal setae about same length as rest of dorsum. Small bilocular pores abundant over surface. Discoidal pores circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 5 setae (paratypes 5 (4-7)); longest seta 27 μ long (paratypes 26 (17-35) μ). Anal ring with 7 setae (paratypes 6 (5-7)) and 54 pores (paratypes 43 (35-61)) on each half. Apparent anal lobes each with 3 setae (paratypes 3 (2-5)); longest seta 291 μ long (paratypes 361 (285-415) μ).

Venter with small setae arranged in segmental lines, longest seta on abdomen, excluding marginal ones, 23 μ long (paratypes 20 (16-25) μ). Macrotubular ducts of two sizes: Broader size on abdomen and sometimes on metathorax, absent from marginal areas; narrower size on head and thorax, absent from marginal areas. Small bilocular pores scattered over surface, least abundant on medial and submedial areas. Large bilocular pores abundant on head, thorax, and anterior segments of abdomen. Discoidal pores circular, numerous, scattered over surface. Intrastigmatic pores each with 14-18 loculi, with 96 pores (paratypes with 74 (44-117)) pores associated with each anterior spiracle. Parastigmatic pores with 5-16 loculi, with 151 pores (paratypes with 150 (113-207)) pores on each side of body, present from head to abdominal segment II (paratypes from head to abdominal segments II, III or IV, 1 specimen with pores on segments V and VI, but with only a single pore on each segment).

Legs with hind femora each with 6 or 8 setae (paratypes 6 (4-7)); tibia+tarsus with 6 setae (paratypes 6 (4-6)); tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 200 μ long (paratypes 209 (185-247) μ); tibia+tarsus 251 μ long (paratypes 269 (224-289) μ); femur length divided

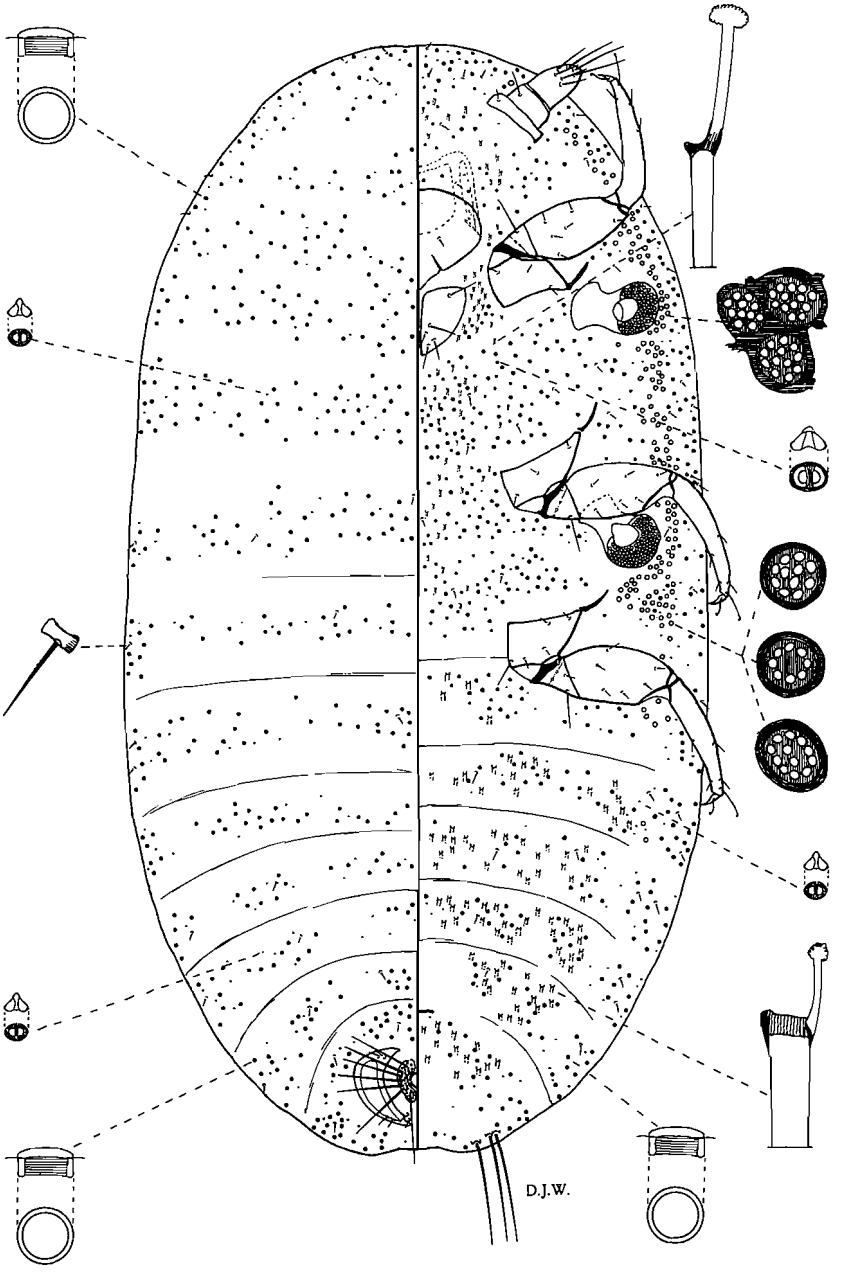

Fig. V - *Micrococcus confusus* Miller et Williams sp. nov. - Adult female.

by tibia+tarsus length 0.8 (paratypes 0.8 (0.7-0.8)). Antennae 3-segmented, 160 μ long (paratypes 187 (153-210) μ); segment III 84 μ long (paratypes 92 (84-103) μ) with 12 setae (paratypes 12 (10-15)); segment II 30 μ long (paratypes 38 (30-44) μ), 86 μ wide (paratypes 82 (72-89) μ).

Notes - The description is based on 21 adult females from 5 localitites.

This species is similar to *Micrococcus silvestrii* but differs by having: the hind tibia+tarsus about 265 μ long; the femur about 210 μ long; the antennae about 185 μ long; antennal segment III about 90 μ long; longest seta on anal plates about 25 μ; and multilocular pores generally limited to abdominal segments II and III, when present on IV, V, or VI with only 1 or 2 such pores on each segment. *Micrococcus silvestrii*, on the other hand, has: the hind tibia+tarsus about 330 μ long; the femur about 250 μ long; antennal segment III about 120 μ long; longest seta on anal plates about 85 μ; and multilocular pores abundant on abdominal segment IV, usually with more than 5 pores on each side of segment and usually with several pores on segment V.

Type material: The holotype is one of three adult females on a slide that is labelled as follows: «Nom: Micrococcus similis/ Leon./ Hôte: *Poa* (racines)/ Localité: [Morocco] Daïet Ifrah/ Date: 20.III.1949/ Collect.: Rungs/ Déterm.: Rungs/ No 1917/5335-1» A second label is attached to the back of the slide «Micrococcus/ confusus/ Miller and/ Williams/ HOLOTYPE &/ Paratypes» and a map is given of the position of the holotype. In addition there are nine other paratypes; the type series is deposited in Muséum national d'Histoire naturelle, Paris, France. Other specimens considered to be conspecific with this species are listed in the specimens examined section but are not considered to be paratypes because of their poor condition.

Specimens examined: Morocco, Dayet Ifrah (33 34 N 4 55W), III-20-49, on *Poa* sp., Rungs, 12 adult females on 3 slides (MNHN); Ifrane, IV-12-52, on ?, Theodorides, 3 adult females on 1 slide (MNHN); Sidi Ahmed el Berroussi (?), X-11-41, on grass, 1 adult female (MNHN); specific locality unknown, II-20-38, on ?, Bouhelier, 1 adult female (MNHN).

Algeria, Eulma (?) Constantine, V-?-32, on barley, Delassus, 4 adult females on 4 slides (MNHN).

Micrococcus dumonti Balachowsky

Synonymy: *Micrococcus dumonti* Balachowsky, 1936: 164.

Adult female (Fig. VI)

Recognition characters: Mounted, 3.9 (2.6-6.6) mm long, 3.2 (1.8-6.0) mm wide.

Dorsum with filamentous setae scattered over surface; longest seta on dorsomedial area of metathorax 13 (11-15) μ long, all setae in area about same length. Marginal setae about same length as rest of dorsum. Small bilocular pores in small numbers over surface except on head where rare or absent. Discoidal pores round, evenly distributed over surface.

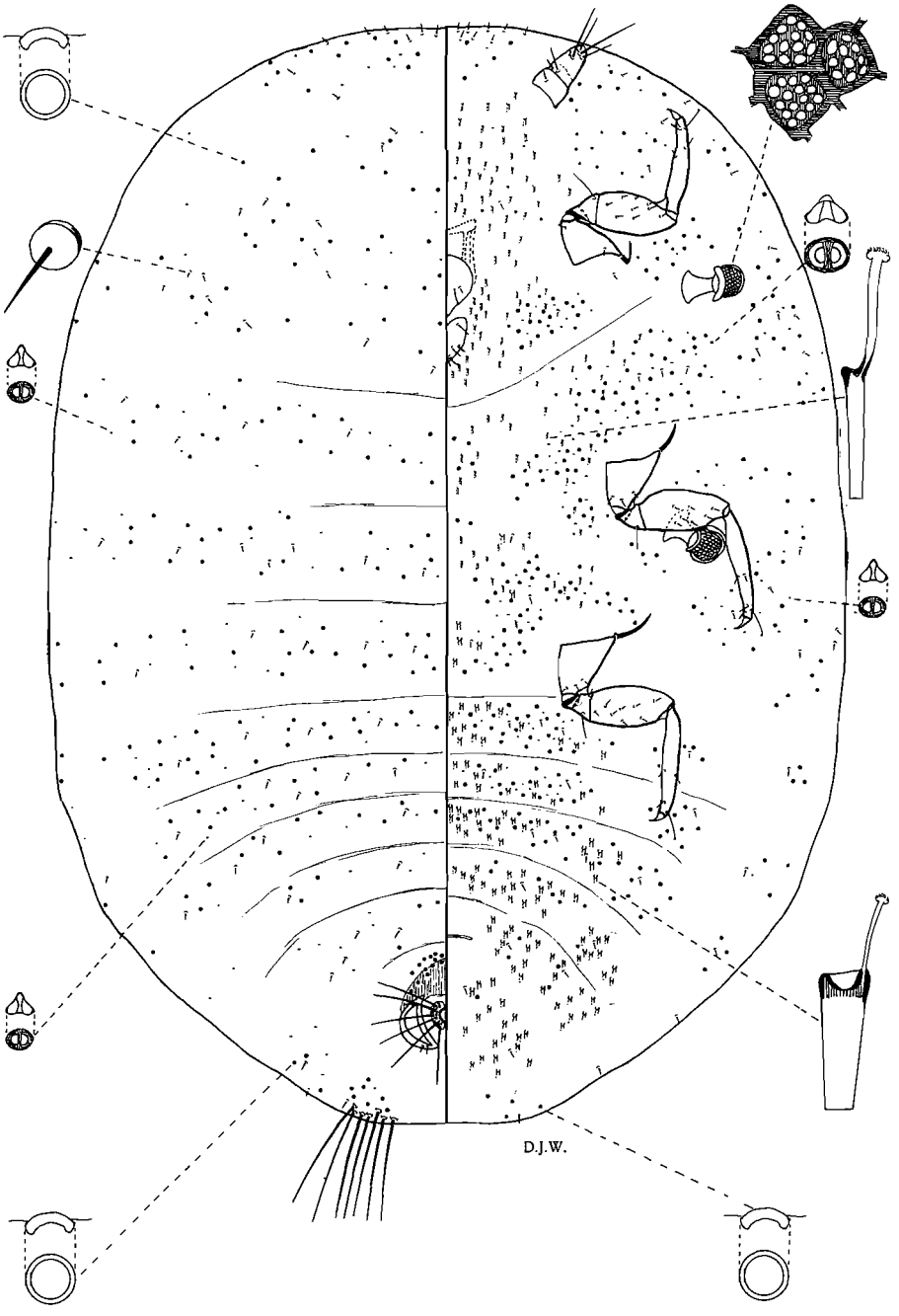

Fig. VI - *Micrococcus dumonti* Balachowsky. - Adult female.

Anal plates each with 5 (4-5) setae; longest seta 15 (8-21) μ long. Anal ring with 8 (6-10) setae and 39 (35-43) pores on each half. Apparent anal lobes each with 8 (6-11) setae; longest seta 90 (83-96) μ long.

Venter with setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, about 14 (13-14) μ long. Macrotubular ducts of two sizes: Broader size on abdomen and sometimes metathorax, absent from marginal areas; narrower size on head and pro- and mesothorax, absent from marginal areas. Small bilocular pores scattered, most abundant near legs, rare or absent on head. Large bilocular pores on head and thorax. Discoidal pores round, most abundant near legs and on anterior abdominal segments. Intrastigmatic pores with 8-18 loculi, 94 (70-115) pores associated with each anterior spiracle. Parastigmatic pores absent.

Legs with hind femora each with 7 setae; tibia+tarsus with 5 setae; tarsal and claw digitules broken on available specimens; femur 210 (202-218) μ long; tibia+tarsus about 260 μ long; femur length divided by tibia+tarsus length 0.8. Antennae 2-segmented (sometimes with signs of division on second segment), 161 (143-177) μ long; apical segment from campaniform sensilla to apex 71 (58-83) μ long, with 11 (10-12) setae; segment II (from base of segment to campaniform sensilla) 32 (32-34) μ long, 67 (62-71) μ wide.

Notes - The description is based on 8 specimens from 1 locality. For a comparison of this species with *Micrococcus bodenheimeri* see the notes section of the latter species.

Type material: We have studied the syntype material of this species and here designate as lectotype a specimen on a single slide labelled «Dumonti/Balachowsky/Racines d'*Aristida pungens* / Tunisie / Bordj-bou-Hedma / (Tunisie) / Dumont coll. xii.1928 / MNHN 5386-3». In addition there are seven other paralectotype slides each with single adult specimens with the same data (Muséum National d'Histoire naturelle, Paris).

Specimens examined: Tunisia, Bordj-bou-Hedma (?), XII-?-1928, on *Aristida pungens* (roots), Dumont, 8 adult females on 8 slides (MNHN).

Micrococcus longispinus Miller et Williams, sp. nov.

Adult female (Fig. VII)

Recognition characters: Holotype mounted, 1.9 mm long (paratypes 1.8 (1.6-2.1) mm), 1.2 mm wide (paratypes 1.1 (1.0-1.2) mm).

Dorsum with filamentous setae scattered over surface; longest seta on dor-

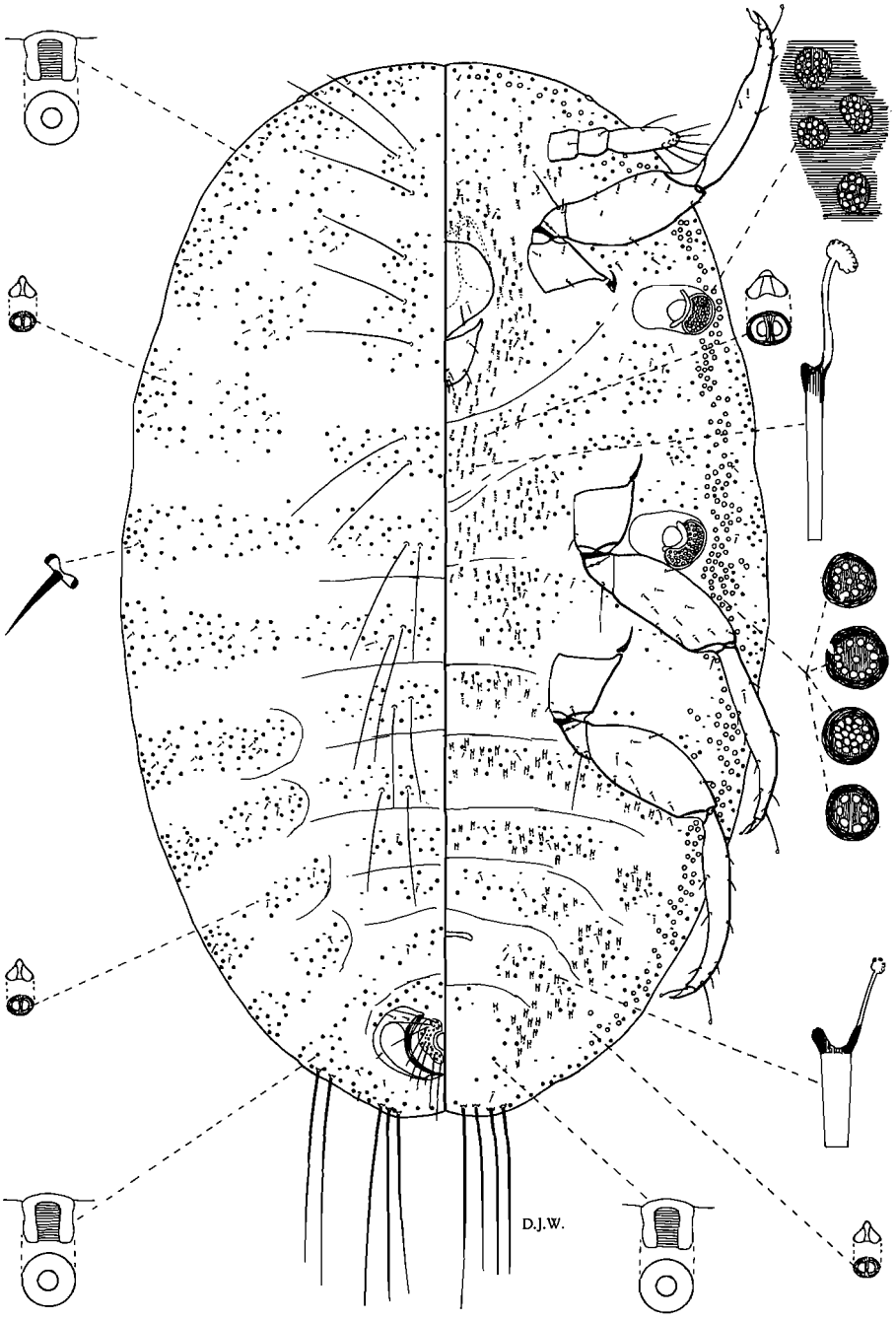

Fig. VII - *Micrococcus longispinus* Miller et Williams sp. nov. - Adult female.

somedial area of metathorax 234 μ long (paratypes 191 (160-222) μ), dorsal setae vary from short to long. Marginal setae short (one paratype with long marginal setae on segment VI). Small bilocular pores abundant over surface. Discoidal pores circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 4 setae (paratypes 5 (4-6)); longest seta 20 μ long (paratypes 30 (27-32) μ). Anal ring with 8 setae (paratypes 13 (9-18)) and 38 pores (paratypes 37 (30-45)) on each half. Apparent anal lobes each with 7 setae (paratypes 7 (4-12)); longest seta 518 μ long (paratypes 444 (420-469) μ).

Venter with small setae arranged in segmental lines, longest seta on abdomen, excluding marginal ones, 25 μ long (paratypes 20 (15-22) μ). Macrotubular ducts of two sizes: Broader size on abdomen and metathorax, absent from marginal areas; narrower size on head and thorax, absent from marginal areas. Small bilocular pores scattered over surface, least abundant on medial and submedial areas. Large bilocular pores on head, thorax, and anterior abdominal segments. Discoidal pores circular, scattered over surface. Intrastigmatic pores cannot be counted on available specimens because of orientation of spiracle. Parastigmatic pores with single central loculus (some paratypes with sieve pores), with 9-14 loculi, 277 pores on each side of body (paratypes 299 (279-312)) from head to abdominal segment VIII.

Legs with hind femora each with 12 setae (paratypes 11 (9-11)); tibia+tarsus with 8 setae (paratypes 8 (7-8)); tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 264 μ long (paratypes 331 (321-338) μ); tibia+tarsus 333 μ long (paratypes 352 (345-365) μ); femur length divided by tibia+tarsus length 0.8 (paratypes 0.9 (0.9-1.0)). Antennae 3-segmented, 256 μ long (paratypes 284 (259-296) μ); segment III 141 μ long (paratypes 136 (131-146) μ) with 12 setae; segment II 54 μ long (paratypes 63 (62-66) μ), 71 μ wide (paratypes 71 (71-72) μ).

Notes - The description is based on 3 specimens from 1 locality.

Micrococcus longispinus can be separated from all other species of *Micrococcus* by the dorsomedial setae that are conspicuously longer than all other dorsal setae and by the large number of parastigmatic pores (about 300 on each side of body).

Third instar female (Fig. VIII)

Recognition characters: Mounted, 1.6 mm long, 0.4 mm wide.

Dorsum with filamentous setae arranged in 3 pairs of longitudinal lines on each side of abdomen, medial, mediolateral, and marginal; not abundant, with about 20 setae on metathorax; longest seta on dorsomedial area of metathorax

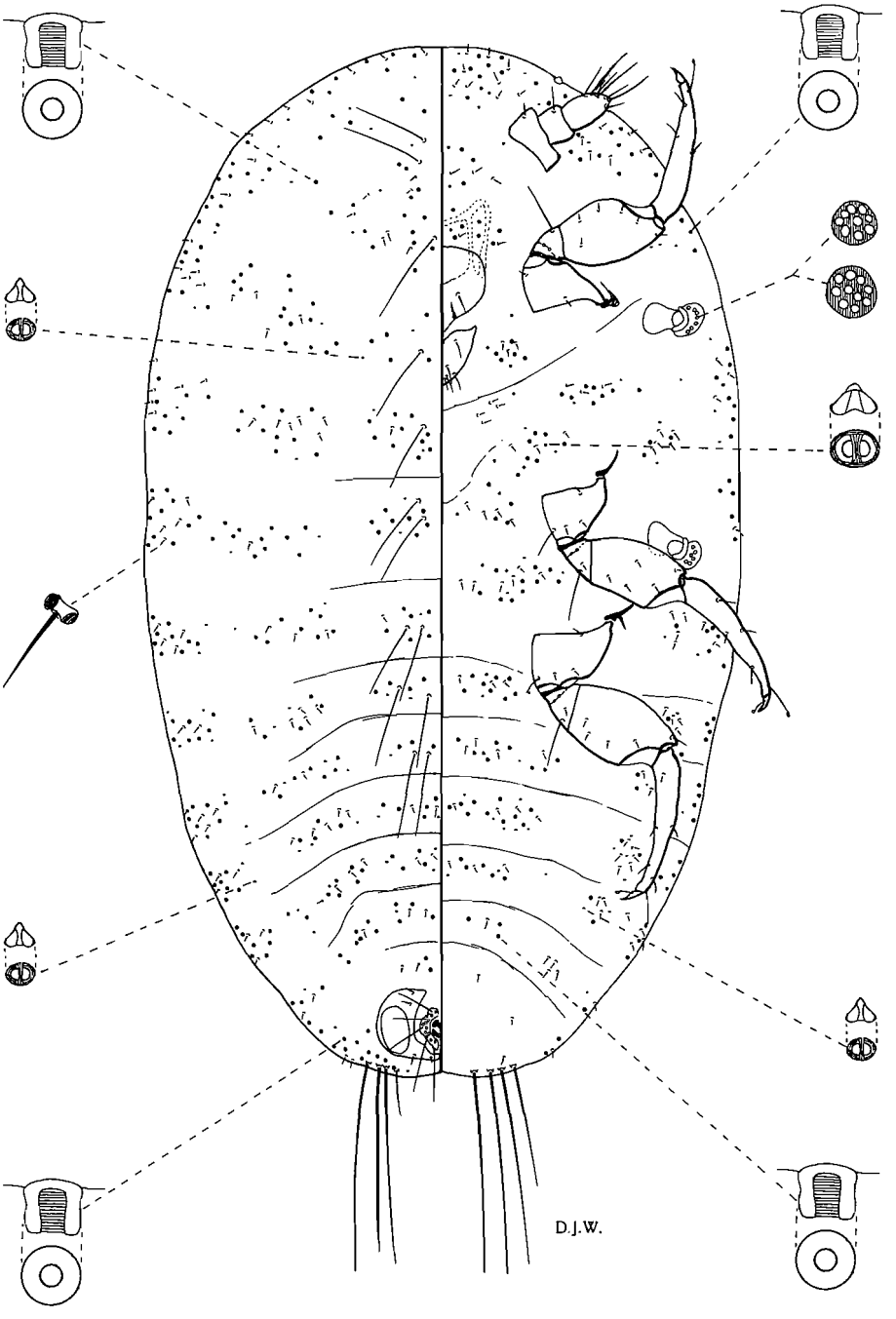

Fig. VIII - *Micrococcus longispinus* Miller et Williams sp. nov. - Third instar female.

197 μ long, medial setae conspicuously longer than other setae on segment. Marginal setae usually about same length as on rest of dorsum. Small bilocular pores scattered over surface. Discoidal pores circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 4 or 5 setae; longest seta 27 μ long. Anal ring with 5 or 6 setae and 13 and 14 pores on each half. Apparent anal lobes each with 8 and 9 setae; longest seta 347 μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 17 μ long. Small bilocular pores scattered over surface. Large bilocular pores usually on head, thorax, and anterior abdominal segements. Discoidal pores circular, scattered over surface. Intrastigmatic pores with 12-16 loculi, with 6 and 8 pores associated with each anterior spiracle. Parastigmatic pores absent.

Legs with hind femora each with 6 and 8 setae; tibia+tarsus with 6 and 8 setae; tarsal and claw digitules with clubbed apices all about same size; femur 174 μ long; tibia+tarsus 234 and 240 μ long; femur length divided by tibia+tarsus length 0.7. Antennae 3-segmented, 165 and 156 μ long; segment III 75 μ long, with 11 and 13 setae; segment II 37 and 40 μ long, 67 and 64 μ wide.

Notes - The description is based on 1 specimen from 1 locality.

Second instar female (Fig. IX)

Recognition characters: Mounted, 1.2 mm long, 0.6 mm wide.

Dorsum with filamentous setae arranged in 3 pairs of longitudinal lines on each side of abdomen, medial, mediolateral, and marginal; unusually abundant, with 78 setae on metathorax; longest seta on dorsomedial area of metathorax 32 μ long, all setae in area about same length. Marginal setae usually about same length as on rest of dorsum. Small bilocular pores sparsely scattered over surface. Discoidal pores circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 4 or 5 setae; longest seta 8 μ long. Anal ring with 5 setae and 9 and 6 pores on each half. Apparent anal lobes each with 4 or 5 setae, broken, but at least 60 μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 16 μ long. Small bilocular pores scattered over surface, except absent or rare on posterior portion of abdomen. Large bilocular pores on head and thorax. Discoidal pores circular, scattered over surface, except absent or rare on posterior portion of abdomen. Intrastigmatic pores so distorted that unable to determine number of loculi in spiracular

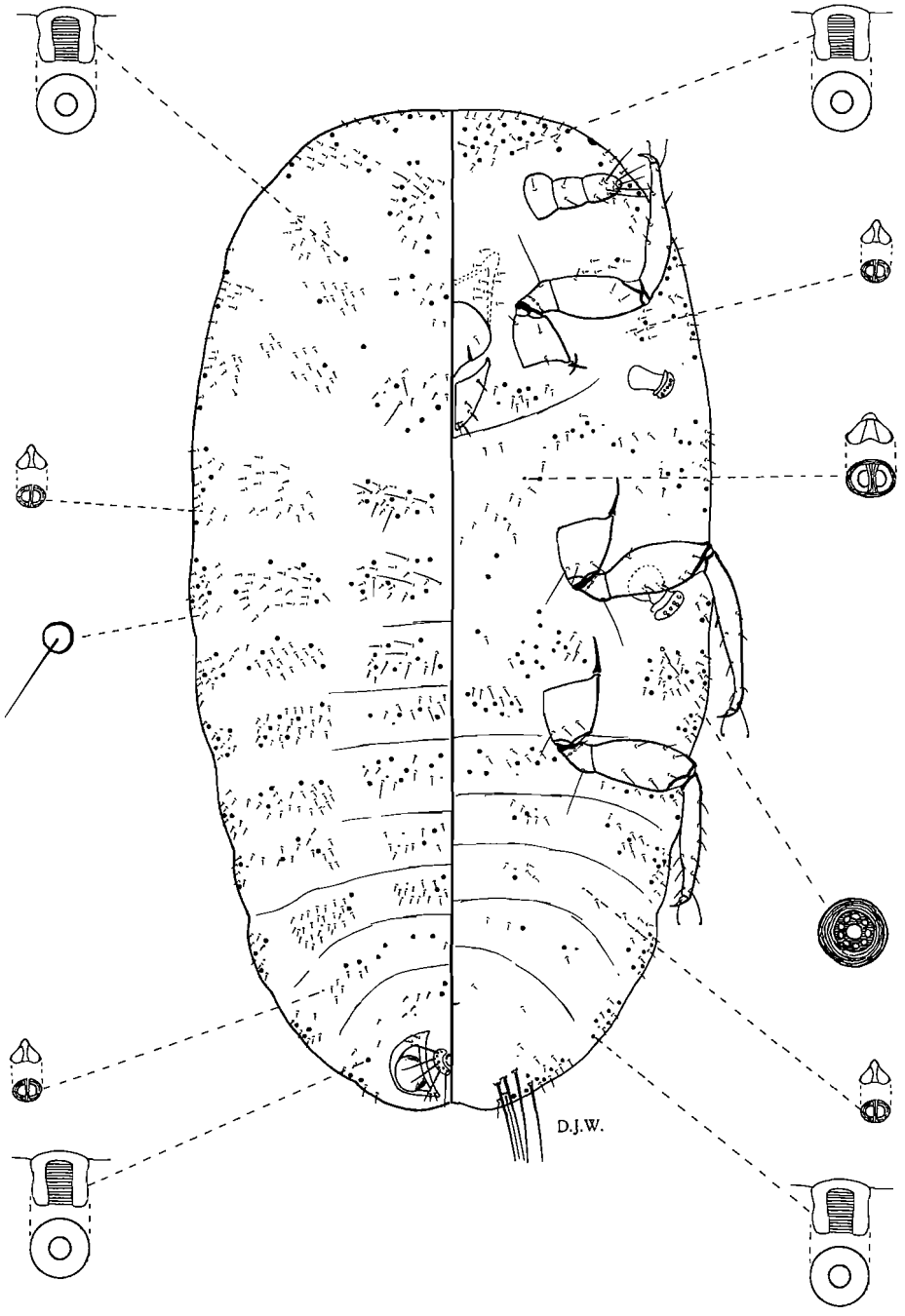

Fig. IX - *Micrococcus longispinus* Miller et Williams sp. nov. - Second instar female.

atrium; also unable to locate pores in anterior spiracles, present in posterior spiracles. Parastigmatic pores represented by 1 pore on 1 side of available specimen.

Legs with hind femora each with 7 and 11 setae; tibia+tarsus with 8 and 10 setae; tarsal and claw digitules with clubbed apices all about same size; femur 128 μ long; tibia+tasus 143 and 148 μ long; femur length divided by tibia+tarsus length 0.9. Antennae 3-segmented, 110 μ long; segment III bluntly conical, 47 μ long, with 9 setae; segment II 31 μ long, 42 μ wide.

Notes - The description is based on 1 specimen from 1 locality.

Type material: The holotype adult female is labelled as follows: «Tunisia, ii-1944, W. Pickles» on same slide as second instar female deposited in The Natural History Museum, London. In additional there are two paratypes deposited in The Natural History Museum, London and one paratype deposited in the U.S. National Collection in Beltsville, Maryland.

Specimens examined: Tunisia, specific locality unknown, II-1944, W. Pickles, 3 adult females, 1 third instar female, 1 second instar female (?) on 3 slides (BMNH, USNM).

Micrococcus rungsi Balachowsky

Synonymy: *Micrococcus rungsi* Balachowsky, 1936: 160.
Micrococcus bernardi Rungs, 1943: 103 New Synonymy.

Adult female

Unknown. The original description was based on second instars.

Second instar female (Fig. X)

Recognition characters: Mounted, 2.0 (1.8-2.2) mm long, 0.9 (0.9-1.0) mm wide.

Dorsum with filamentous setae arranged in 3 longitudinal lines on each side of abdomen, medial, mediolateral, and marginal; with 10 (7-13) setae on metathorax; longest seta on dorsomedial area of metathorax 15 (11-19) μ long, all setae in area about same length. Marginal setae same length as on rest of dorsum. Small bilocular pores sparse, scattered over surface, most abundant near body margin. Discoidal pores circular and oval, scattered over surface, most abundant in marginal and submarginal areas. Oval pores with sclerotization near long portion of oval giving appearance of an eye, situated mostly on thorax and anterior segments of abdomen.

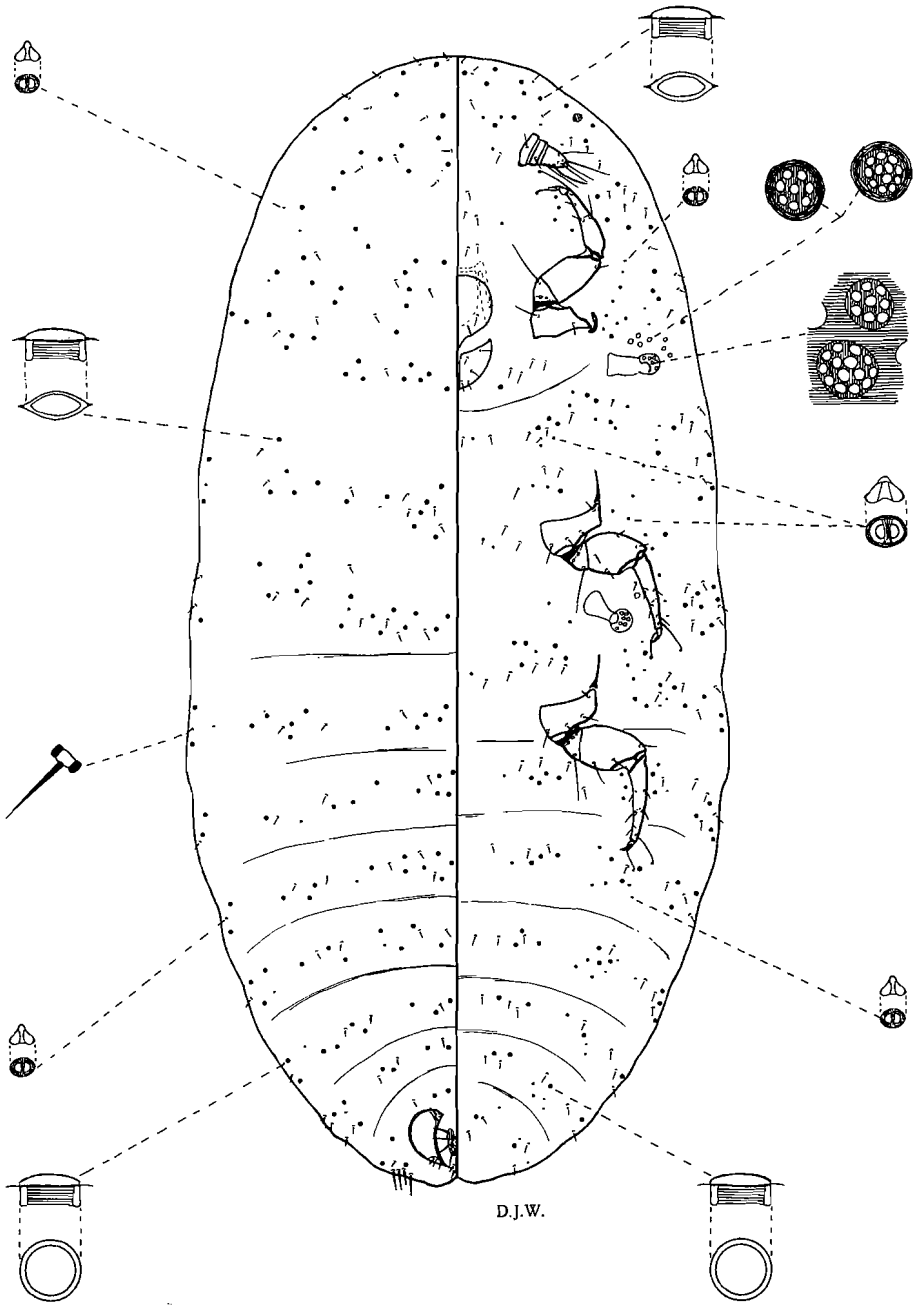

Fig. X - *Micrococcus rungsi* Balachowsky. - Second instar female.

Anal plates each with 5 (4-5) setae; longest seta 23 (20-25) μ long. Anal ring with 4 setae and 2 (0-8) pores. Apparent anal lobes each with 4 (2-5) setae; longest seta 34 (20-49) μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 17 (12-20) μ long. Small bilocular pores present in marginal areas. Large bilocular pores usually present in submarginal areas of head, thorax, and abdomen, some specimens with large clusters of pores on marginal areas of each abdominal segment, other specimens with only 1 or 2 pores in these areas. Discoidal pores circular and oval, oval pores usually present near legs, scattered over surface. Intrastigmatic pores with central loculus or with several loculi in center, with 5-10 loculi, 8 (4-14) pores associated with each anterior spiracle. Parastigmatic pores with central loculus or with several loculi in center, with 7-10 loculi, 4 (0-12) pores near each anterior spiracle, 1 (0-2) pores near each posterior spiracle.

Legs with hind femora each with 3 (2-3) setae; tibia+tarsus with 6 (5-7) setae; tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 103 (79-119) μ long; tibia+tarsus 130 (111-153) μ long; femur length divided by tibia+tarsus length 0.8 (0.7-0.9). Antennae 3-segmented, 83 (72-99) μ long; segment III 39 (32-49) μ long, with 11 (9-13) setae; segment II 19 (14-24) μ long, 52 (40-62) μ wide.

Notes - The description is based on 31 specimens from 2 localities.

First instar (Sex not determined)

Recognition characters: Mounted, 1.7 (1.5-1.9) mm long, 1.0 (0.9-1.1) mm wide.

Dorsum with filamentous setae arranged in 1 longitudinal line on each side of body, submedial line not observed because of poor condition of specimens, marginal line present around perimeter of body; longest seta on dorsomedial area of metathorax 11 μ long, all setae in area about same length. Discoidal pores arranged in 1 pair of longitudinal lines on each side of body, present around perimeter of body.

Anal lobes (plates) with setae broken; longest seta 103 μ long. Anal ring with 3 setae and 10 (9-11) pores on each half.

Venter with small setae arranged in segmental lines, longest seta on abdomen, excluding marginal ones, 20 μ long. Microtubular ducts present in 1 submarginal line on each side of body, with 2 ducts present on each segment, surrounded by area of sclerotization. Discoidal pores present on surface, but exact position not determined. Intrastigmatic pores without central loculi, with 5-7 loculi, with 1 pore in each spiracle (1 specimen with 2 pores in 1 spiracle).

Parastigmatic pores near each spiracle, near hind pair of legs, and with 1 pore in lateral area between spiracular clusters, without central loculi, with 5-9 loculi, with 14 (12-16) pores on each side of body.

Legs with hind femora each with 3 setae; tibiae with 3; tarsi with 4; tarsal and claw digitules broken; femur 100 (99-101) μ long; tibia 90 (89-91) μ long; tarsus 62 (59-64) μ long; femur length divided by tibia+tarsus length 0.6 (0.6-0.7). Antennae 119 (114-124) μ long; setae broken except 1 long seta on segment V 143 μ long.

Notes - The description is based on 2 large (aestivating) specimens from 1 locality.

Type material: We have studied the syntype series of this species and here designate as lectotype 1 of 3 second instar females on a slide that is labelled as follows: «Nom: Micrococcus Rungsi / Balachowsky / Hôte: Lygaeum spartum / Localité: Goulmina / Date: 9-VI-34 / Collect.: Rungs / Déterm.: / TYPE 849» A second label is attached to the back of the slide «Micrococcus / rungsi / Balachowsky / LECTOTYPE & / Paralectotypes» and a map is given of the position of the lectotype. In addition there are twelve other paralectotypes; the type series is deposited in Muséum National d'Histoire naturelle, Paris, France.

We also have studied the syntype series of *Micrococcus bernardi* and here designate as lectotype 1 of 2 second instar females on a slide that is labelled as follows: «Nom: Micrococcus / Bernardi / Rgs / Hote: Nids de Tapinoma / Simrothi Kr. / Localité: Ifrane / Date: 8-X-42 / Collect.: F Bernard / Déterm.: Ch. Rungs / types No 1476» A second label is attached to the back of the slide «Micrococcus / bernardi / Rungs / LECTOTYPE & / Paralectotypes» and a map is given of the position of the lectotype; the slide also contains a pupa. A third label reads «MNHN / type 53253». In addition there are sixteen other paralectotypes; the type series is deposited in Muséum National d'Histoire Naturelle, Paris, France.

Specimens examined: Morocco, Goulmima, VI-9-34, on *Lygaeum spartum*, C. Rungs, 13 second instar females and 2 first instars on 6 slides (MNHN); Ifrane, Moyen Atlás, X-8-42, associated with *Tapinoma simrothi*, M.F. Bernard, 18 second instar females and 1 fourth instar male on 7 slides (MNHN).

Micrococcus silvestrii Leonardi

Because this species was described in detail in the previous paper (Marotta *et al.*, 1995) we are providing a diagnosis only. For more detailed information see Marotta *et al* (l.c.).

Adult female

Diagnosis: Dorsum with longest seta on dorsomedial area of metathorax 22 (17-25) μ long. Anal plates each with 4 (3-6) setae; longest seta 85 (52-118) μ long. Anal ring with 7 (7-9) setae and 48 (44-56) pores on each half. Apparent

anal lobes each with 4 (3-5) setae; longest seta 260 (222-285) μ long. Venter with broadest size tubular ducts on abdomen and metathorax. With 192 (149-236) parastigmatic pores on each side of body from prothorax or mesothorax to abdominal segments IV or V. Legs with hind femora each with 6 (5-6) setae; hind femur 250 (248-253) μ long; tibia+tarsus 333 (328-338) μ long. Antennae 236 (210-260) μ long; segment III 121 (93-146) μ long.

Notes - This species is most similar to *Micrococcus confusus*. For a comparison of these species see the «Notes» section of *M. confusus*.

Micrococcus similis Leonardi

Synonymy: *Micrococcus similis* Leonardi, 1907: 143.

Adult female (Fig. XI)

Recognition characters: Mounted, 3.3 (1.4-5.2) mm long, 2.1 (0.6-3.5) mm wide.

Dorsum with filamentous setae scattered over surface; longest seta on dorsomedial area of metathorax 23 (20-24) μ long, most setae strongly curved and about same length. Marginal setae about same length as rest of dorsum. Small bilocular pores abundant over surface. Discoidal pores circular, scattered over surface.

Anal plates each with 13 (11-14) setae; longest seta 21 (17-25) μ long. Anal ring with 5 (4-5) setae and 34 (26-44) pores on each half. Apparent anal lobes each with 4 (3-7) setae; longest seta 349 (284-384) μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 31 (25-37) μ long. Macrotubular ducts of two sizes: Broader size restricted to sublateral and medial areas of abdominal segments V or VI and VII, absent from marginal areas; narrower size on head, prothorax, mesothorax, and sometimes metathorax, absent from marginal areas. Small bilocular pores scattered over surface, least abundant on medial and submedial areas of abdomen. Large bilocular pores on head, thorax, and anterior abdominal segments to segment IV or V. Discoidal pores circular, scattered over surface. Intrastigmatic pores each with 14-18 loculi, 74 (55-95) pores associated with each anterior spiracle. Parastigmatic pores usually with single central loculus and about 12 loculi, 50 (29-72) pores on each side of body, restricted to areas around spiracular plates.

Legs with hind femora each with 10 (9-12) setae; tibia+tarsus with 6 (5-8) setae; tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 213 (198-227) μ long; tibia+tarsus 234 (202-259) μ long;

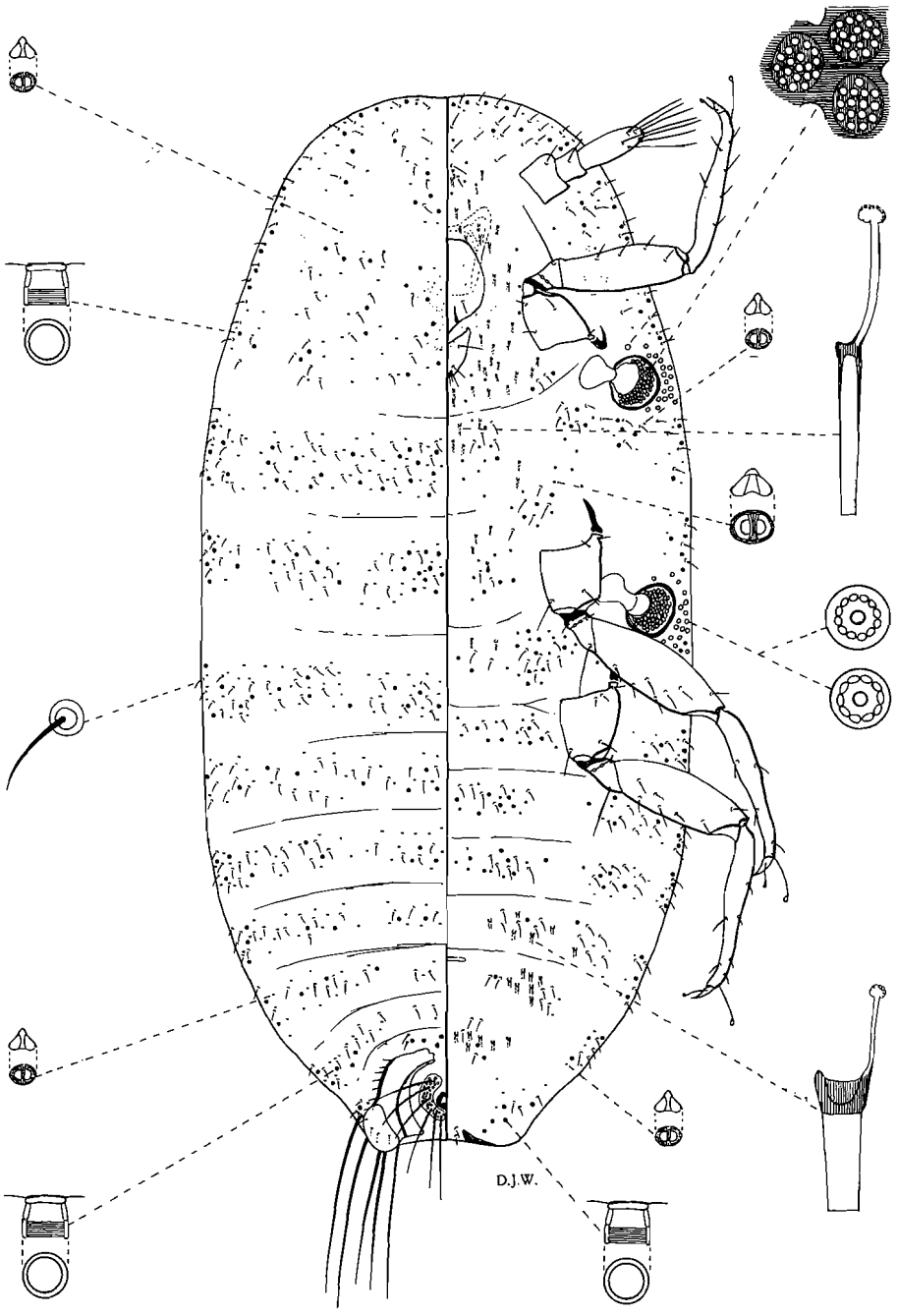

Fig. XI - *Micrococcus similis* Leonardi. - Adult female.

femur length divided by tibia+tarsus length 0.9 (0.9-1.0). Antennae 3-segmented, 169 (148-192) μ long; segment III 81 (71-91) μ long, with 11 (10-13) setae; segment II 34 (30-44) μ long, 58 (42-52) μ wide.

Notes - This description is based on 8 specimens from 2 localities.

Micrococcus similis is unique within *Micrococcus* by having the parastigmatic pores restricted to the areas surrounding the spiracles, by having the tubular ducts on the abdomen restricted to the posterior segments, and by having more than 10 setae on each anal plate.

The original description of this species includes an illustration that has 11 setae on each side of the anal ring. Although this is outside of the range of variation that we have recorded, in other species similar variation has been observed. For example, in *Micrococcus dumonti* most specimens have 6 setae on each side of the anal ring, but 1 specimen has 10 on 1 side and 9 on the other. Based on this evidence, we conclude that the specimens described here are within the expected range of variation for *Micrococcus similis*.

Third instar female (Fig. XII)

Recognition characters: Mounted, 1.6 (1.4-1.9) mm long, 0.8 (0.6-0.8) mm wide.

Dorsum with filamentous setae arranged in 3 pairs of longitudinal lines on each side of abdomen, medial, mediolateral, and marginal; longest seta on dorsomedial area of metathorax 19 (18-20) μ long, all setae in area about same length. Marginal setae usually about same length as rest of dorsum. Small bilocular pores scattered over surface. Discoidal pores circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 5 (4-6) setae; longest seta 24 (17-32) μ long. Anal ring with 6 (5-6) setae and 13 (11-16) pores on each half. Apparent anal lobes each with 7 (4-11) setae; longest seta 274 (252-301) μ long.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 17 (15-20) μ long. Small bilocular pores scattered over surface. Large bilocular pores usually on head, thorax, and anterior abdominal segments. Discoidal pores circular, scattered over surface. Intrastigmatic pores with 8-16 loculi, 10 (6-18) pores associated with each anterior spiracle. Parastigmatic pores absent.

Legs with hind femora each with 9 (7-10) setae; tibia+tarsus with 6 (5-7) setae; tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 169 (163-183) μ long; tibia+tarsus 217 (200-225) μ long; femur length divided by tibia+tarsus length 0.8 (0.7-0.8). Antennae 3-segmented, 165 (150-177) μ long; segment III bluntly conical, 80 (74-89) μ long, with 10 (8-12) setae; segment II 38 (35-42) μ long, 65 (59-74) μ wide.

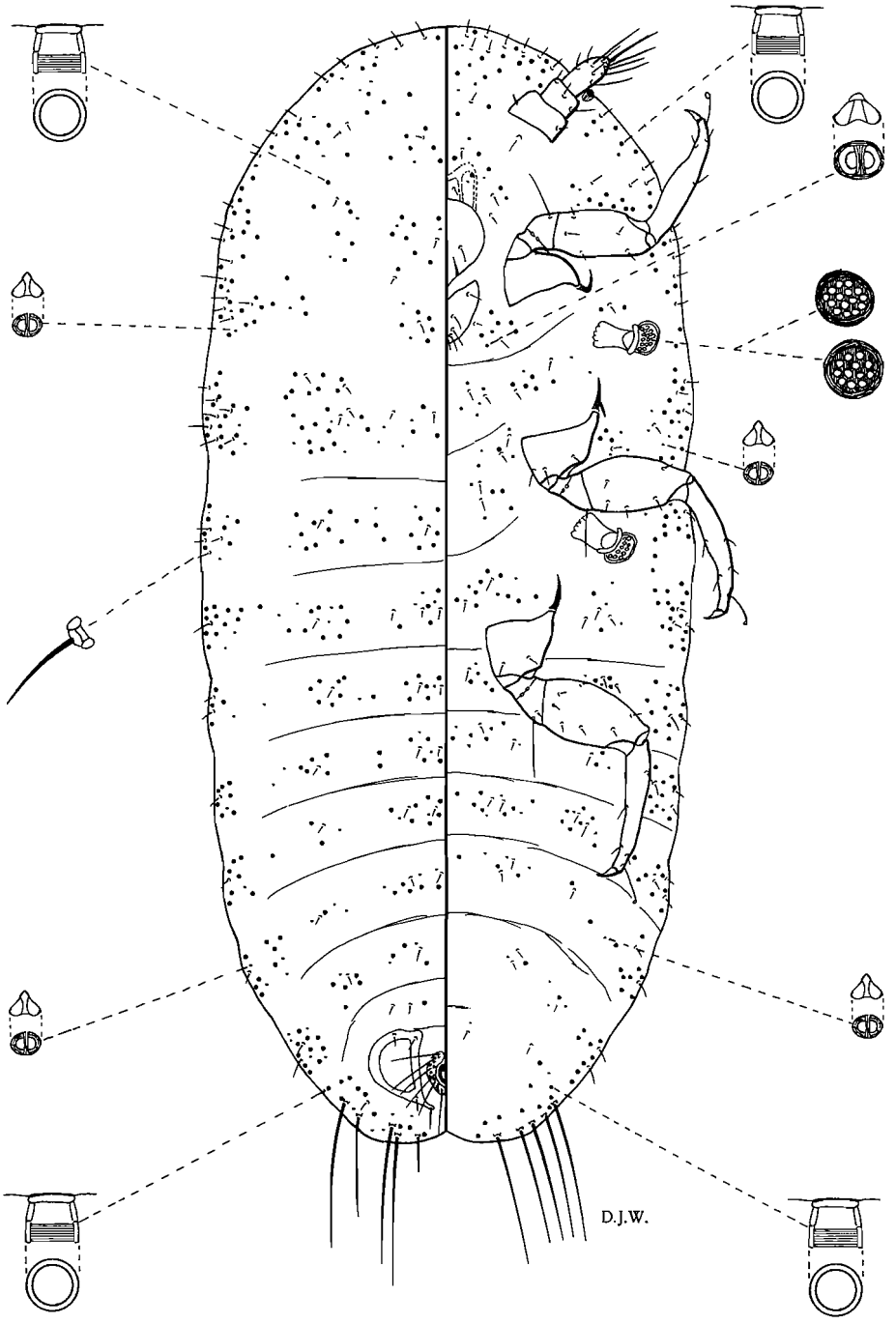

Fig. XII - *Micrococcus similis* Leonardi. - Third instar female.

Notes - The description is based on 7 specimens from 1 locality.

Gynandromorph (Fig. XIII)

Recognition characters: Mounted, 1.5 mm long, 0.7 mm wide.

Dorsum with filamentous setae scattered over surface; longest seta on dorsomedial area of metathorax 32 μ long, all setae in area about same length. Marginal setae about same length as rest of dorsum. Small bilocular pores abundant over surface. Discoidal pores circular, scattered over surface, most abundant in marginal and submarginal areas.

Anal plates each with 9 and 12 setae; longest seta 37 μ long. Anal ring with 4 or 5 setae and 12 and 18 pores on each half. Apparent anal lobes each with 4 setae; longest seta 291 μ long. Penial sheath undivided, 126 μ long. Aedeagus apically blunt, heavily sclerotized, 49 μ long.

Venter with small setae arranged in segmental lines, longest seta on abdomen, excluding marginal ones, 42 μ long. One size of macrotubular duct similar in size to small type of adult female, present between front pair of legs. Small bilocular pores scattered over surface, least abundant on medial and submedial areas of abdomen. Large bilocular pores on head, thorax, and anterior abdominal segments. Discoidal pores circular, scattered over surface. Intrastigmatic pores each with about 17 loculi, 21 pores associated with each anterior spiracle. Parastigmatic pores usually with single central loculus, with 5 or 7 loculi, 11 pores on each side of body, restricted to separate areas of spiracular plates.

Legs with hind femora each with 11 and 13 setae; tibia+tarsus with 6 or 7 setae; tarsal and claw digitules with conspicuous, clubbed apices, all about same size; femur 175 and 182 μ long; tibia+tarsus 198 and 203 μ long; femur length divided by tibia+tarsus length 0.9. Antennae 3-segmented, 128 and 141 μ long; segment III 64 and 72 μ long, with 13 setae; segment II 20 and 30 μ long, 44 and 47 μ wide.

Notes - The description is based on a single specimen.

Type material: Type material of this species has not been examined. Syntypes should be located in Tempio Pausania, Sardinia, Italy, where Leonardi did his research, but Salvatore Marotta indicates that he was unable to locate any scale material when he visited there in 1989. The types were collected in Sardinia, in the Province of Sassari, Italy on roots of a grain.

Specimens examined: Tunisia, II-1944, W. Pickles, 7 adult females, 7 third instar females, 1 gynandromorph, on 14 slides (BMNH). Algeria, III-?-1943, associated with *Tapinoma* sp., 1 adult female on 1 slide (BMNH).

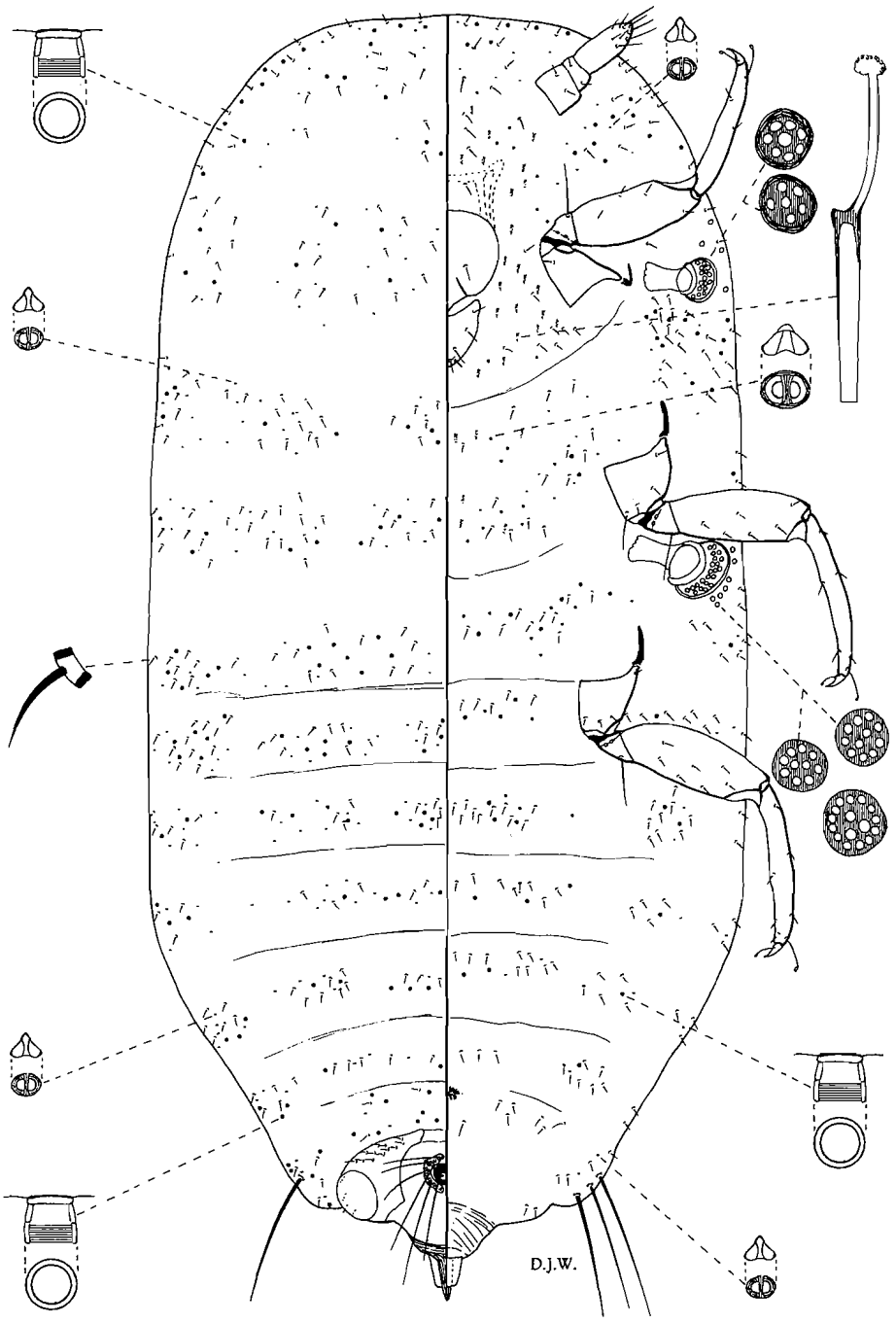

Fig. XIII - *Micrococcus similis* Leonardi. - Gynandromorph.

Molluscococcus Hall

Molluscococcus Hall, 1941: 236. Type species *Molluscococcus fibrillae* Hall, by original designation and monotypy.

Diagnosis: Adult female without anal plates that surround anal ring; cicatrices present; multilocular pores present in medial and mediolateral areas of ventral abdomen; macrotubular ducts of 1 size, forming submarginal band; multilocular pores absent; tibia and tarsus separate. First instar with antennae 6-segmented; dorsomarginal setae absent from segments IV to VII; macrotubular ducts present.

Molluscococcus fibrillae Hall

Synonymy: *Molluscococcus fibrillae* Hall, 1941: 236.

Adult female (Fig. XIV)

Recognition characters: Mounted, 2.9 (2.4-3.2) mm long, 2.9 (2.3-3.4) mm wide.

Dorsum with filamentous setae scattered over surface; longest seta on dorsomedial area of thorax variable from specimen to specimen, some specimens from South Marendellas with conspicuously long setae, 839 (812-928) μ long, also with a few short setae on dorsum, other specimens from South Marendellas and all specimens from Inkomo with short setae, 51 (44-61) μ long, all dorsal setae about same length. Smooth margin bilocular pores abundant over surface. Discoidal pores circular, evenly distributed over surface. Each side of abdomen with conspicuous large cicatrix.

Anal plates absent. Anal ring surrounded by heavily sclerotized crescentic area. Anal ring with 9 (6-14) setae and 28 (18-35) pores on each half. Margins of apparent anal lobes with a few setae about 70 μ long. Anal cleft present from body margin to anal ring, with multilocular pores present in cleft.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 65 (44-128) μ long. Macrotubular ducts arranged in broad band on mediolateral area of venter, absent elsewhere; ducts about same size as small ducts in *Micrococcus*. Smooth margin bilocular pores present in areas laterad of macrotubular duct band, absent elsewhere. Irregular margin bilocular pores on head, thorax, and abdominal segment II. Discoidal pores circular, scattered over surface, except rare or absent on thorax near irregular margin bilocular pores, uncommon near multilocular pores. Multilocular pores in medial areas of segments II-VII. Intrastigmatic pores of multilocular type, with 5-10 loculi, with or without central loculus, 24 (18-33)

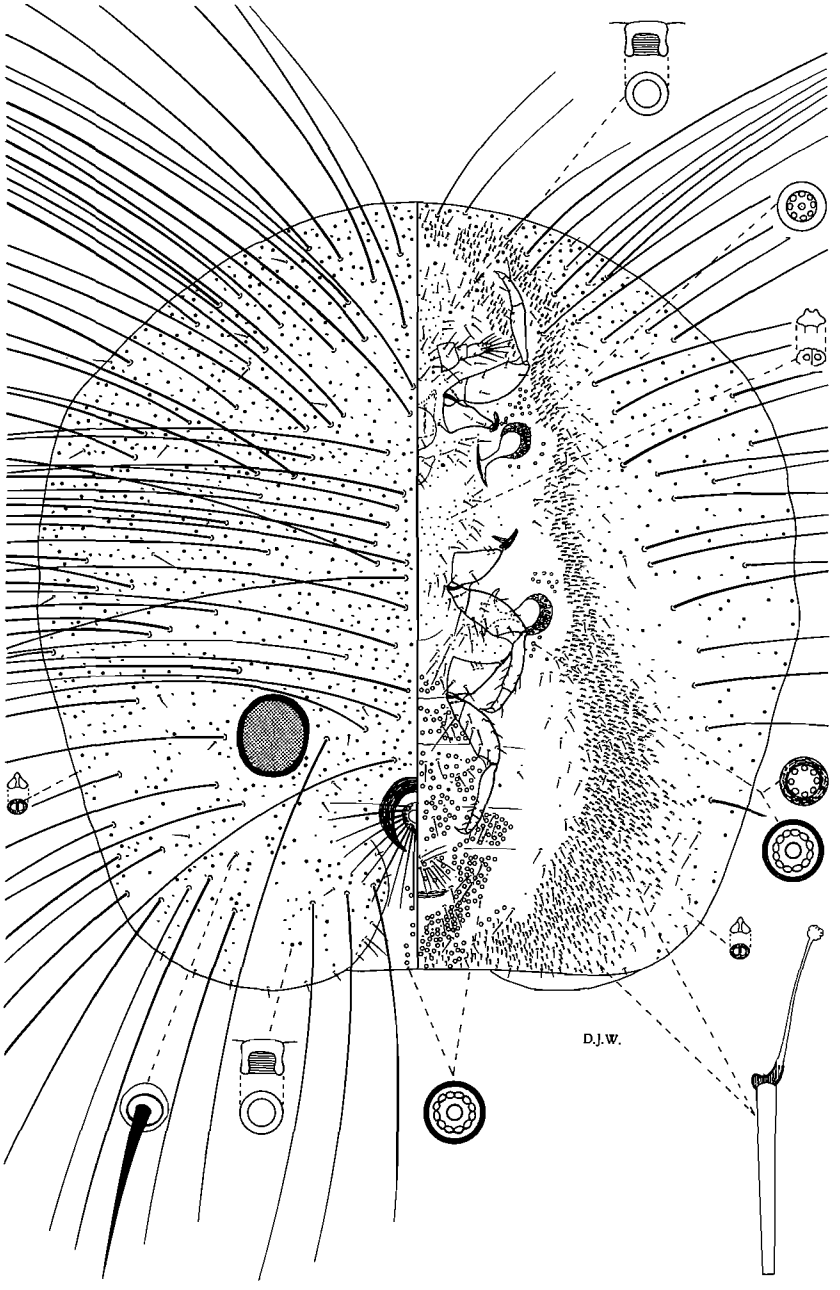

Fig. XIV - *Molluscococcus fibrillae* Hall. - Adult female.

pores associated with anterior spiracle. Parastigmatic pores of multilocular type, with 6-15 loculi, with or without central loculus, 40 (24-59) pores on each side of body, restricted to areas around spiracular plates, occasionally near base of antennae.

Legs with hind femora each with 10 (8-11) setae; tibia with 5 (3-7) setae; tarsus with 4 (2-6) setae; tarsus without modified digitules; claw digitules with inconspicuous, clubbed apices, not reaching apex of claw; femur 221 (207-237) μ long; tibia 194 (178-210) μ long; tarsus 89 (71-101) μ long; femur length divided by tibia+tarsus length 0.8. Antennae 3-segmented, 174 (153-183) μ long; segment III 83 (77-96) μ long, with 12 (10-13) setae; segment II 40 (30-49) μ long, 53 (49-59) μ wide.

Notes - This description is based on 21 specimens from 2 localities.

This species is quite unusual since it folds itself around the rootlets of the host and appears like a bivalve mollusc. A deep groove is formed inside of the macrotubular duct band. It also is interesting that there are 2 distinct types of females, 1 with very long dorsal setae (all collected in Marendellas), and the other with short dorsal setae occurring both in Marendellas and Inkomo. We could find no other evidence to suggest that these differences characterize two different species.

First instar (Sex not determined) (Fig. XV)

Recognition characters: Mounted, 0.7 (0.7-0.8) mm long, 0.3 (0.3-0.4) mm wide.

Dorsum with filamentous setae arranged in 2 longitudinal rows on each side of body, submedial line restricted to segment I, thorax, and head, marginal line present around perimeter of body, except on segments IV-VIII; longest seta on dorsomedial area of metathorax 11 (10-12) μ long, all setae in area about same length. Marginal setae usually about same length as rest of dorsum. Discoidal pores arranged in 1 longitudinal line on each side of body.

Anal lobes (plates) each with 3 (3 or 4) setae; longest seta 224 (190-247) μ long. Anal ring with 3 setae and 7 (6-9) pores on each half.

Venter with small setae arranged in segmental rows, longest seta on abdomen, excluding marginal ones, 32 (23-40) μ long. Microtubular ducts present in 1 submarginal line on each side of body, with 1 duct present on each segment. Macrotubular ducts present around perimeter of body, with 3 ducts on each lateral margin of each abdominal segment. Discoidal pores absent. Intrastigmatic pores absent. With 1 parastigmatic pore near each spiracle, absent elsewhere, without central loculi, with 5 loculi.

Legs with hind femora each with 3 setae; tibiae with 3; tarsi with 4; tarsal

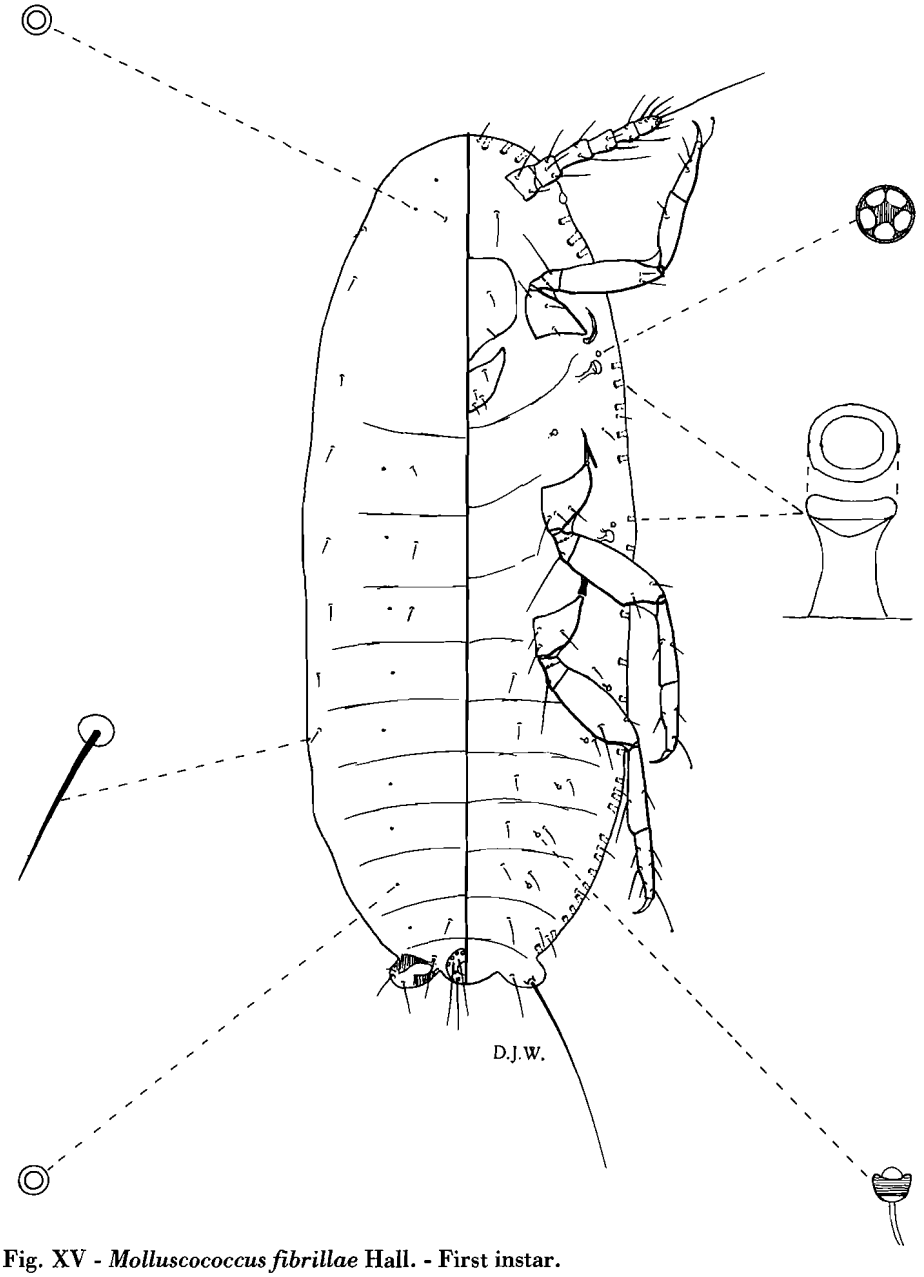

Fig. XV - *Molluscococcus fibrillae* Hall. - First instar.

digitules on hind 2 pairs of legs with swollen apices, front pair with 1 digitule small and filamentous and 1 digitule larger and clubbed; claw digitules equal in size, with clubbed apices; femur 90 (89-91) μ long; tibia 79 (74-81) μ long; tarsus 56 (54-59) μ long; femur length divided by tibia+tarsus length 0.7 (0.6-0.7).

Antennae 6-segmented, 142 (133-148) μ long; segments III and V without conspicuously long seta, longest seta on segment VI 76 (59-94) μ long.

Notes - The description is based on 9 specimens from 1 locality.

Type material: We have examined the holotype of this species which has the following engraved on the left side of the slide «Molluscococcus/ fibrillae Hall/ Hyparrhenia/ filipendula/ (rootlets)/ South/ Marendellas» right side with label «BM 1943-53/ 834/ *GENOTYPE/ TYPE*/ W.J. HALL/ 15.III.40». We also have examined 21 paratypes deposited in the Natural History Museum, London and 11 in the U. S. National Collection at Beltsville, Maryland.

Specimens examined: Zimbabwe [Southern Rhodesia], South Marendellas, II-23-36, on *Hyparrhenia filipendula*, 12 adult females on 6 slides (BMNH); Marendellas, III-9-28, on *H. filipendula*, 4 adult females on 2 slides (BMNH); Inkomo, III-26-28, on *H. filipendula*, 8 adult females and 9 first instars on 6 slides (BMNH, USNM).

PHYLOGENETIC ANALYSIS

The relationship of *Micrococcus* and *Molluscococcus* with other scale taxa has been controversial since the first species was discovered. Ferris (1921, 1957) suggested that *Micrococcus* belonged in what is now called the family Eriococcidae; Silvestri (1939) suggested that it should be associated with the mealybugs; and Koteja (1974) indicated that it should be a separate family related to the Coccidae.

To test these hypotheses, a phylogentic analysis was implemented including representatives of each of the groups suggested as close relatives. Using characteristics of adult females, adult males, and first instars, we anticipated that we would be able to provide definitive evidence about the placement of this peculiar group of scale insects.

Characters. Character distributions for 20 taxa and 39 characters are presented in the matrix in table 1. Unknown characters were coded as missing data.

Adult female

1. *Asterolecanium* type 8-shaped pores 0 = absent, 1 = present
2. Small dark-rimmed 8-shaped pores 0 = absent, 1 = present
3. Translucent pores on hind legs 0 = present, 1 = absent
4. Tubular ducts 0 = not invaginated, a = invaginated, b = eriococcid microtubulars
5. Arch plate 0 = absent, 1 = present
6. Trilocular pores 0 = present, 1 = absent
7. Quinquelocular pores 0 = absent, 1 = present
8. Cribriform pores 0 = absent, 1 = present
9. Spiracular setae 0 = absent, 1 = present

10. Spiracular furrow 0 = without defined pore row, 1 = with defined pore row
11. Pores in spiracular plate surrounding atrium, 0 = absent, 1 = present
11a. Vulva position 0 = between segments 7 and 8, 1 = on segment 6

First instar

12. Ostioles 0 = present, 1 = absent
13. Outer distal tibial seta 0 = present, 1 = absent
14. Outer medial tibial seta 0 = present, 1 = absent
15. Tibial seta 0 = more than 5, 1 = 4 or 5, 2 = 3, 3 = 2 to 0
16. Campaniform sensilla on tarsus 0 = present, 1 = absent
17. Tarsal digitules on hind leg 0 = acute, 1 = clubbed
18. Tarsal digitules 0 = side by side, 1 = noticeably staggered
19. Antennal segments 0 = 7-segmented, 1 = 6-segmented, 2 = fewer than 6
20. Front tarsal digitules 0 = equal in size, 1 = 1 smaller with acute apices
21. Trochanter sensoria 0 = closest to femur, 1 = transverse or closest to coxa
22. Labium 0 = 3-segmented, 1 = 1- or 2-segmented
23. Number of setae on labium 0 = 9 or more, 1 = 6, 7, or 8, 2 = 4 or 5, 3 = 3 or fewer
24. Lines of setae on each side of dorsum 0 = more than 2, 1 = 2, 2 = 1
25. Anal lobes 0 = unmodified, 1 = modified and sclerotized
26. Sclerotized area outside of anal ring 0 = absent, 1 = present

Adult male

27. Aedeagus 0 = acute or rounded, 1 = blunt
28. Ungual digitules 0 = simple, 1 = clubbed
29. Scutum 0 = solid or partially clear, 1 = clear
30. Penial sheath 0 = simple, 1 = at least partially divided
31. Lateral pore clusters, 0 = with pores and setae, 1 = with setae only
32. Postoccipital ridge, 0 = simple laterally, 1 = divided
33. Sclerotized lobe on segment 8, 0 = absent, 1 = present
34. Medial ridge of mesosternite, 0 = absent, 1 = present

Life history data

35. Number of female instars, 0 = 4, 1 = 3

Characters in any instar

36. Enlarged setae, 0 = absent, 1 = present
37. Cruciform (bilocular) pores, 0 = absent, 1 = present
38. Aclerdid type microtubular ducts, 0 = absent, 1 = present

RESULTS AND DISCUSSION

Two equally parsimonious trees were found (length=88, CI=53, RI=73). The difference in the two trees stemmed around the position of *Coccus hesperidum* relative to the other two soft scale species, i.e., either *C. hesperidum* is the sister of the group comprising *Pulvinaria acericola* and *Sphaerolecanium prunastri* or all three species form a trichotomy. We have chosen the former (Fig. XVI) since it is the tree that is produced using successive weighting and is the only tree produced when using the mh* function in combination with branch swapping. Differences in the two trees do not effect the conclusions of this paper.

CHARACTERS THAT JUSTIFY THE MONOPHYLY OF THE CLADES ARE AS FOLLOWS.

Stem 1. Adult female with microtubular ducts (4.b); trilocular pores absent (6.1); quinquelocular pores present (7.1). First instar with ostioles absent (12.1); tibiae with four or five setae (15.1); tarsal digitules clubbed (17.1); antennae 6-segmented (19.1); trochanter sensoria transverse or nearest coxa (21.1); with eight or fewer setae on labium (23.1); with 2 or fewer lines of setae on each side of dorsum (24.1). Adult male with ungual digitules clubbed (28.1);

TABLE 1. - The character matrix used in the phylogentic analysis. A «–» is given when a character state is unknown.

	Character Number			
	000000000111	111111112222222	22233333	3 333
	123456789011	234567890123456	78901234	5 678
	a			
kosztarabi	000000000000	000000000000000	00000000	0 000
bodenheimeri	011101100011	110211121112210	11-1--1-	0 011
sallei	001201100000	111301010112201	01000100	1 100
droserae	000211100000	101101010101100	01000100	1 110
viridis	00120110000-	100101010112100	01000100	1 100
conica	000-01100000	101201110101100	01000100	1 100
fagisuga	000201100010	111301020101101	--------	1 100
arundinariae	001101100010	110211111112210	11211001	0 101
larreae	00110110001-	111301111112210	01200100	1 000
adentocorymbus	111101100100	111301011113200	01201001	1 000
proteae	111111100100	111301011113200	01201101	1 000
acaciae	111111111100	101301010112210	01201100	1 010
andinus	101111110100	111301011101200	01201100	1 010
pollini	101-11100000	111301011111200	01201100	1 000
gilletti	001101100000	101101010101200	01200100	1 110
pubescens	00110110000-	101101011101200	01200100	0 110
hesperidum	011101101100	110311111112210	01200011	0 000
acericola	011101101100	110211111112210	01200011	0 000
prunastri	011-01101100	110211111112210	01200011	0 000
fibrillae	011101100011	110211111112210	--------	0 011

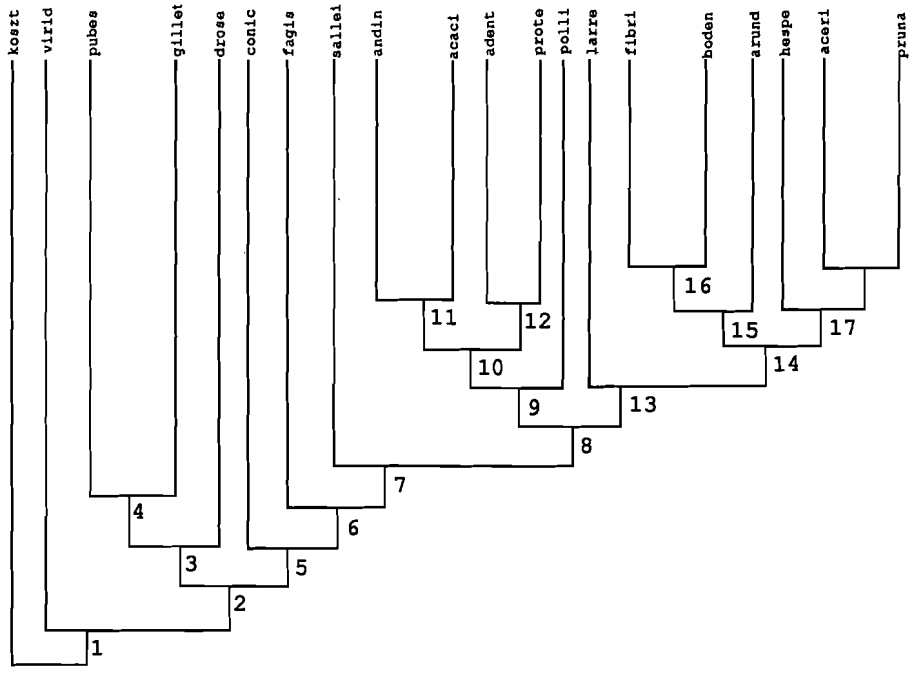

Fig. XVI - Phylogenetic tree showing relationship of the Micrococcidae. Character changes for clades. Stem 1: 4.b; 6.1; 7.1; 12.1; 15.1; 17.1; 19.1; 21.1; 23.1; 24.1; 28.1; 32.1; 35.1; 36.1 – Stem 2: 14.1 – Stem 3: 37.1 – Stem 4: 3.1; 4.b; 24.2; 29.1 – Stem 5: 15.2 – Stem 6: 13.1; 15.3 – Stem 7: 3.1; 22.1; 23.2; 24.2; 25.1 – Stem 8: 4.b; 20.1; 29.1; 36.0 – Stem 9: 1.1; 5.1; 31.1 – Stem 10: 2.1; 10.1 – Stem 11: 8.1; 37.1 – Stem 12: 23.3; 34.1 – Stem 13: 11.1; 18.1; 25.1 – Stem 14: 2.1; 14.0; 15.2; 16.1; 32.0; 33.1; 34.1; 35.0 – Stem 15: 27.1; 30.1; 38.1 – Stem 16: 11a.1; 37.1 – Stem 17: 9.1; 10.1; 11.0.

postoccipital ridge at least partially divided (32.1). Life history with three female instars (reversal at stem 14) (35.1). Any instar with enlarged setae present (convergent with *Aclerda arundinariae*, reversal at stem 8) (36.1).

Stem 2. First instar with outer medial tibial seta absent (there is a reversal to seta present in stem 14) (14.1).

Stem 3. Any instar with cruciform (bilocular) pores (convergent with stem 25 and 20) (37.1).

Stem 4. Adult female without translucent pores on hind legs (convergent with *Carphochloroides viridis* and stem 7) (3.1); with invaginated tubular ducts and without eriococcid-type microtubular ducts present (4.b). First instar with one line of setae on each side of dorsum (convergent with stem 7) (24.2). Adult male with scutum clear (convergent with stem 8) (29.1).

Stem 5. First instar with 3 setae on hind tibia (15.2).

Stem 6. First instar with outer distal tibial seta absent (reversal in

Lecanodiaspis acaciae) (13.1); two or fewer setae on hind tibia (convergent with *Coccus hesperidum*, reversal at stem 14) (15.3).

Stem 7. Adult female with translucent pores on hind legs absent (convergent with *Carphochloroides viridis* and stem 4) (3.1). First instar with labium 1- or 2-segmented (convergent with *C. viridis*, reversal in *Cerococcus andinus*) (22.1); four or five setae on labium (reversal in *Pollinia pollini* and *Cerococcus andinus*) (23.2); one line of setae on each side of dorsum (convergent with stem 4) (24.2); anal lobes modified and sclerotized (convergent with *Lecanodiaspis acaciae*) (25.1).

Stem 8. Adult female with invaginated tubular ducts and without eriococcid-type microtubular ducts (convergent with stem 4) (4.b). First instar with tarsal digitules on front legs with one digitule that is smaller and with acute apex (convergent with *Pollinia pollini*, reversal in *Lecanodiaspis acaciae*) (20.1). Adult male with scutum clear (convergent with stem 4) (29.1). Any instar without enlarged setae (reversal) (36.0).

Stem 9. Adult female with *Asterolecanium*-type 8-shaped pores (1.1); arch plate present (convergent with *Acanthococcus droserae*, reversal in *Grammococcus adentocorymbus*) (5.1). Adult male with lateral pore clusters with setae only (convergent with *Aclerda arundinariae*) (31.1).

Stem 10. Adult female with small, dark-rimmed pores present (convergent with stem 14, reversal in *Aclerda arundinariae* and *Lecanodiaspis andinus*) (2.1); spiracular furrow with well defined row of pores (convergent with stem 17) (10.1).

Stem 11. Adult female with cribriform pores (8.1). Any instar with cruciform (bilocular) pores present (convergent with stem 3 and 16) (37.1).

Stem 12. First instar with three or fewer setae on labium (23.3). Adult male with medial ridge of mesosternite present (convergent with stem 14) (34.1).

Stem 13. Adult female with pores in spiracular plate surrounding atrium present (convergent with *Cryptococcus fagisuga;* reversal at stem 17) (11.1). First instar with tarsal digitules noticeably staggered (convergent with *Apiomorpha conica*) (18.1); anal lobes modified and sclerotized (convergent with *Lecanodiaspis acaciae*) (25.1).

Stem 14. Adult female with small, dark-rimmed pores present (convergent with stem 10, reversal in *Aclerda arundinariae* and *Cerococcus andinus*) (2.1). First instar with outer medial tibial seta absent (reversal) (14.0); three tibial setae (reversal) (15.2); campaniform sensilla on tarsus absent (16.1). Adult male with postoccipital ridge undivided laterally (reversal) (32.0); sclerotized lobe present on segment eight (reversal in *Aclerda arundinariae*) (33.1); medial ridge of mesosternite present (convergent with stem 12) (34.1). Life history with four female instars (reversal) (35.0).

Stem 15. Adult male with aedeagus blunt (27.1); penial sheath at least partially divided (30.1). Any instar with aclerdid type microtubular ducts (38.1).

Stem 16. Adult female with vulva on segment 6 (11a.1). Any instar with cruciform (bilocular) pores present (convergent with stems 3 and 11) (37.1).

Stem 17. Adult female with spiracular setae present (convergent with *Lecanodiaspis acaciae*) (9.1); spiracular furrow with well defined row of pores (convergent with stem 10) (10.1); pores in spiracular plate surrounding atrium absent (reversal) (11.0).

CONCLUSIONS

The primary thrust of the analysis was to revise this unusual group of scale insects so that specimens collected in quarantine and elsewhere could be identified. We recognize two genera and eight species within the family Micrococcidae. Illustrations, descriptions and keys are presented for each species except for *Micrococcus silvestrii* which is described in detail in the paper preceeding this one (Marotta *et al.* 1995).

Another thrust of this paper is to determine the relationships of *Micrococcus* and *Molluscococcus* with other scale taxa. Our results place the genera in a well-defined group of families that includes the Coccidae (*Coccus hesperidum, Pulvinaria acericola, Sphaerolecanium prunastri*), Aclerdidae (*Aclerda arundinariae*), and Tachardiidae (*Tachardiella larreae*). Numerous synapomophies associate *Micrococcus* and *Molluscococcus* with this group rather than with the Eriococcidae or Pseudococcidae. The precise position of *Micrococcus* and *Molluscococcus* with the Aclerdidae and Coccidae is not as clear.

Our analysis suggests that the genera are most closely related to the Aclerdidae based on the structure of the penial sheath, aedeagus, and the unusual microtubular ducts found on the first instar. Unfortunately, the genital characters appear to be relatively simple, and the similarity of the microtubular ducts may be artificial. Based on the fact that both the Aclerdidae and the group comprising *Micrococcus* and *Molluscococcus* feed on monocotyledonous hosts, it seems logical that these groups could be sister taxa. However, to provide more definitive information on the subject it is important to undertake a critical analysis of details of the various wax glands and pores. This analysis will require use of the scanning and transmission electron microscopes. It currently is difficult or impossible to make informed homology decisions about these important glandular structures using a light microscope. The Scanning Electron Microscope observations presented by Marotta *et al.* (1995) are helpful in this regard, but more needs to be done with the ultrastructure of the wax glands.

It is our current position to consider *Micrococcus* and *Molluscococcus* to be a separate family, the Micrococcidae, rather than to incorporate them in the Aclerdidae. The latter approach would significantly modify the definition of the Aclerdidae and would not take into account the possible superficial nature of

the characteristics used to define the group including *Micrococcus*, *Molluscococcus*, and the Aclerdidae.

Although the focus of this analysis is on the relationships of *Micrococcus* and *Molluscococcus* with other higher scale taxa, some other results merit mention. The asterolecanoid taxa form a well-defined group of families including the Cerococcidae (*Cerococcus andinus*), Lecanodiaspididae (*Lecanodiaspis acaciae*), Asterolecaniidae (*Grammococcus adentocorymbus* and *Asterolecanium proteae*), and *Pollinia pollini*. The placement of *Pollinia pollini* is problematic since it is the sister group to all of the rest of the asterolecanoid taxa. It currently is placed in the Asterolecaniidae, but should be studied in more detail to ascertain its correct position. The arrangement of the remaining taxa is problematic. Only *Nanokermes pubescens* and *Eriokermes gilletti*, which currently are placed in the family Kermesidae, form a group that conforms to the current classification. The other taxa, which currently are placed in the Eriococcidae, are paraphyletic. Unlike previous analyses where typical eriococcid taxa were chosen for evaluation (MILLER & MILLER 1993a, 1993b), we purposefully chose unusual eriococcid taxa for this analysis in case *Micrococcus* and *Molluscococcus* would demonstrate affinities with them. Our results suggest that the definition of the family Eriococcidae requires more careful scrutiny and analysis and that some of the more unusual genera may need to be assigned to other families.

Several items require further study. The number of female instars is not absolutely certain at this time. Based on the specimens that we have examined it appears that there are four female and five male instars, but this should be clarified with a detailed life history study. It also seems likely that we have described only a small portion of the total Micrococcidae fauna. We are aware of one additional species from North Africa, but the specimens are in such poor condition that we decided not to include it in this publication. We suspect that many of the larger Mediterranean islands will have endemic species and that many Mediterranean countries such as Egypt, France, Greece, Lebanon, Libya, Syria and Turkey also will have micrococcid components to their scale fauna. More intensive collecting on grasses in Africa may also lead to the discovery of additional species of *Molluscococcus* or related new genera. The unusual cicatrices that occur on *Molluscococcus* deserve special analysis in second and third instars as a possible mechanism to understand their homology with structures in *Micrococcus*.

SUMMARY

The family Micrococcidae is revised comprising eight species and two genera. Keys, illustrations, and descriptions are included for all species; first instars, second instar females, third instar females, and adult males are treated when specimens are available. A phylogenetic analysis is presented that demonstrates that the Micrococcidae is most closely related to the Aclerdidae. A

gynandromorph of *Micrococcus similis* is described and illustrated; this is the first record of a gynandromorph within the Coccoidea.

RIASSUNTO

Revisione sistematica della famiglia Micrococcidae (Homoptera: Coccoidea), con discussione delle interrelazioni filogenetiche e descrizione di un ginandromorfo.

È stata fatta la revisione della famiglia Micrococcidae includendo otto specie e due generi. Sono fornite chiavi, illustrazioni e descrizioni per tutte le specie; vengono descritti, quando disponibili, le neanidi di prima, seconda e terza età femminili e gli adulti dei maschi. È fornita una analisi filogenetica che dimostra come i Micrococcidae siano strettamente correlati con gli Aelerdidae. È descritto ed illustrato un ginandromorfo di *Micrococcus similis* che risulta essere la prima segnalazione di un ginandromorfo all'interno dei Coccoidea.

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