# A Revision of the Genus *Heterococcus* Ferris With a Diagnosis of *Brevennia* Goux
## (Homoptera: Coccoidea: Pseudococcidae)

By Douglass R. Miller

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## CONTENTS

Page

Genus *Heterococcus* Ferris ---- 2
- Key to instars ---- 2
- Key to adult females ---- 3
- General description of adult females ---- 3
- Species descriptions ---- 4
- Key to third-instar females ---- 19
- General description of third-instar females ---- 19
- Species descriptions ---- 19
- Key to second-instar females ---- 24
- General description of second-instar females ---- 24
- Species descriptions ---- 26
- Key to first instars ---- 29
- General description of first instars ---- 31
- Species descriptions ---- 31
- Key to adult males ---- 35
- General description of adult males ---- 35
- Species descriptions ---- 37
- Fourth-instar males (pupae) ---- 39
- Species description ---- 41
- Third-instar males (prepupae) ---- 41
- Species description ---- 43
- Key to second-instar males ---- 43
- General description of second-instar males ---- 43
- Species descriptions ---- 44

Genus *Brevennia* Goux ---- 47
Discussion ---- 56
Summary ---- 56
Literature cited ---- 58
Index to species ---- 61

# A Revision of the Genus *Heterococcus* Ferris With a Diagnosis of *Brevennia* Goux (Homoptera: Coccoidea: Pseudococcidae)

By DOUGLASS R. MILLER, *Systematic Entomology Laboratory, Northeastern Region, Agricultural Research Service*

In 1970 Howard McKenzie and I published a review of the genus *Heterococcus*, in which we presented a generic diagnosis, briefly discussed each species based on the literature or available specimens, and described a new species. We pointed out that a more detailed treatment of the genus would be necessary to clarify the position of some of the less well known species.

Our work was based almost entirely on the adult female, although we partially illustrated the males of *Heterococcus tuttlei* Miller and McKenzie (= *Brevennia rehi* (Lindinger)) and *H. nudus* (Green). Unfortunately at that time we were unable to interpret the significance of the differences in the external morphology of these males. It is now apparent that these two species should have been included in two genera. If our present understanding of pseudococcid tribes is reasonably correct, the two species should be placed not only in separate genera but also in different tribes.

The two known adult males of *Heterococcus* s. str. possess the following characters typical of the tribe Phenacoccini: (1) Two pairs of tail-forming pore clusters, (2) inner margin of proepisternum heavily sclerotized and ridge-like, and (3) separate postocular and preocular ridges. In fact, these males are remarkably similar to the adult male of *Phenacoccus dearnessi* King, differing only in relatively minor characteristics.

The male of *B. rehi* is most closely associated with the "Saccharicoccus group" of Afifi (*1968*).[1] Of the distinguishing characters given by Afifi, *B. rehi* has (1) preocular ridge reduced, (2) postocular ridge absent dorsally, (3) prosternal ridge absent, and (4) marginal ridge of basisternum absent medially. The "Saccharicoccus group" is in a different tribe from the Phenacoccini, but no name is presently in use.

In reviewing the genus *Heterococcus* we were concerned about the unusual amount of variation in our generic diagnosis. When using the adult females, we were unable to find any combination of characters that would divide the group into two genera. Since *H. tuttlei* (= *B. rehi*) lacked some of the primary characteristics of the tribe Phenacoccini, we decided to examine the Old World species of the genus. Since they presented a morphological mosaic encompassing all the characters that had previously concerned us, we decided to describe *tuttlei* in *Heterococcus*.

Because of the striking differences among the adult males, I have reexamined and reassessed the adult females and found that they can be divided into two genera. Unfortunately no single character is diagnostic for every species, but by using a combination of characters, there should be no problem in placing the species in either *Brevennia*, including the *rehi* type of species, or *Heterococcus* s. str.

Measurements given in the species descriptions are based on 10 specimens selected from as many localities as possible. The numbers in parentheses are not true averages but are the averages rounded off to the nearest whole numbers.

The term "swirled trilocular pore" is used here for pores typical of most pseudococcids. When focusing up and down with a microscope, such pores appear to spin or swirl. This type of pore differs from trilocular pores, which are

[1]The year in italic after the authors' names refers to Literature Cited, p. 58.

merely aberrant quinqueloculars because they do not present the swirling illusion. The latter pore is often found on specimens of *Heterococcus*, whereas the swirled type is entirely absent.

Depositories mentioned in the species descriptions are abbreviated as follows: British Museum (Natural History), London (BM); California State Department of Agriculture, Sacramento (CDA); Muséum National d'Histoire Naturelle, Paris (FNM); Florida State Collection of Arthropods, Gainesville (FSCA); Museo de Historia Natural de la Ciudad de Mexico, Mexico City (MNC); South African National Collection of Insects, Pretoria (SA); University of California, Davis (UCD); University of Hawaii, Honolulu (UH); U.S. National Museum of Natural History, Washington, D.C. (USNM); Virginia Polytechnic Institute and State University, Blacksburg (VPI); and Zoological Academy of Sciences of U.S.S.R., Leningrad (ZAS).

## Genus HETEROCOCCUS Ferris

*Heterococcus* Ferris 1918: 65.

Type-species: *Heterococcus arenae* Ferris 1918. Orig. design. and monotypy.

**Diagnosis.**—*Fourth-instar female (adult).*—Dorsal and ventral quinquelocular pores more numerous than other pores; swirled trilocular pores absent; claw with denticle; ostioles on abdomen and thorax (apparently absent on one species); antennae eight- or nine-segmented (six- or seven-segmented on one species); elongate body; at least one pair of cerarii; oral-collar tubular ducts at least two times longer than wide; circulus normally absent, never with more than one; tarsal digitules with acute apices; multilocular disk pores larger than quinqueloculars.

*Third-instar female, second-instar female, first instar, and second-instar male.*—Quinquelocular pores on both body surfaces; swirled trilocular pores absent; claw with or without denticle; anterior ostioles present; without multilocular disk pores.

*Fifth-instar male (adult).*—Two pairs of tail-forming pore clusters; preocular and postocular ridges separate; prosternal ridge present; marginal ridge of basisternum present; basal rod attachment of aedeagus absent.

*Fourth-instar male (pupa).*—With two lateral sclerotized plates.

*Third-instar male (prepupa).*—Without oral-collar tubular ducts.

**Notes.**—The adult female of this genus is most closely related to *Brevennia*, but it may be separated as follows: Without swirled trilocular pores, normally with two pairs of ostioles, claw with denticle, and antennae normally eight- or nine-segmented. *Brevennia* differs as follows: Normally with swirled triloculars, with one pair of ostioles, claw normally without denticle, and antennae normally six- or seven-segmented.

Adult females of *Heterococcus* are also similar to adult females of *Annulococcus* James, *Laingiococcus* Morrison, *Lacombia* Goux, *Boreococcus* Danzig, *Coleococcus* Borchsenius, *Heterococcopsis* Borchsenius, *Pseudorhodania* Borchsenius, and *Stachycoccus* Borchsenius. For comparisons of these genera with *Heterococcus*, see Miller and McKenzie (*1970*).

### Key to Instars

1. Wings or wing buds present ..... 2
   Wings or wing buds absent ..... 4

2 (1). Tail-forming pore clusters present on margins of abdominal segments IX and VIII, wings fully developed; aedeagus present; thorax and head heavily sclerotized ..... fifth-instar male (adult)
   Tail-forming pore clusters absent; wings in form of wing buds, not well developed; aedeagus absent; thorax and head with little or no sclerotization ..... 3

3 (2). Margins of posterior abdominal segments with lateral sclerotized plates; postocular ridges present; hamulohaltera wing shaped, protruding from body margin; front wing buds greater than 280 μ long ..... fourth-instar male (pupa)

Margins of posterior abdominal segments without lateral sclerotized plates; postocular ridges absent; hamulohaltera represented by small wrinkled area on derm, not protruding or wing shaped; front wing buds less than 200 μ long ..... third-instar male (prepupa)

4 (1). Vulva present; multilocular disk pores on all but one species; hind legs with translucent pores ..... fourth-instar female (adult)

Vulva absent; multilocular disk pores absent; hind legs without translucent pores ..... 5

5 (4). Dorsum of abdominal segment V with more than 14 setae (normally with 21-29) ..... third-instar female

Dorsum of abdominal segment V with less than 15 setae ..... 6

6 (5). With oral-collar tubular ducts ..... second-instar male

Without oral-collar tubular ducts ..... 7

7 (6). Dorsum of abdominal segment V with 12, 13, or 14 setae (normally 13) ..... second-instar female

Dorsum of abdominal segment V with seven or eight setae (normally eight) ..... first instar

## Key to Adult Females

1 Multilocular disk pores present on dorsum ..... 2

Multilocular disk pores absent from dorsum ..... 3

2 (1). Antennae six-segmented; multilocular disk pores restricted to abdomen ..... *abludens* Borchsenius

Antennae seven-, eight-, or nine-segmented; multilocular disk pores present on thorax and head ..... *nudus* (Green)

3 (1). Multilocular disk pores absent ..... *biporous* (Goux)

Multilocular disk pores present ..... 4

4 (3). Hind coxae without translucent pores; anal ring with single row of pores ..... *cyperi* (Hall)

Hind coxae with translucent pores; anal ring with double or triple row of pores ..... 5

5 (4). Dorsal setae conical; dorsal quinquelocular pores conspicuously larger than medioventral quinqueloculars ..... *raui*, n. sp.

Dorsal setae bristle shaped; dorsal quinquelocular pores about same size as medioventral quinqueloculars ..... 6

6 (5). Multilocular disk pores present near lateral margin of posterior two or three abdominal segments; anal-lobe cerarii with conspicuous basal sclerotization; anal-ring setae shorter than greatest diameter of ring; quinquelocular pores all approximately same size ..... *tritici* (Kiritchenko)

Multilocular disk pores absent near lateral margin of posterior abdominal segments; anal-lobe cerarii without conspicuous basal sclerotization; anal-ring setae longer than greatest diameter of ring; quinquelocular pores near lateral margin of posterior abdominal segments noticeably smaller than other quinqueloculars ..... *arenae* Ferris

## General Description of Adult Females

The following characters are present on all known fourth-instar females of *Heterococcus:*

Body elongate or oval. *Dorsum* with cerarii present at least on anal lobes; anal-lobe cerarii each with two associated cerarian setae, with or without auxiliary setae, and associated quinquelocular pores; remaining cerarii, when present, becoming progressively smaller and more indefinite anteriorly, with two associated setae and at least one quinquelocular pore. Quinquelocular pores present. Discoidal pores, oral-collar tubular ducts, and multilocular disk pores present or absent. With 19–76 dorsal setae on each of abdominal segments VIII–III.

Anal ring with three pairs of setae.

*Venter* with multilocular disk pores normally present, rarely absent, when present, normally with 10 loculi. Quinquelocular pores, oral-collar tubular ducts, and discoidal pores present. Body setae noticeably longer than those on dorsum.

Circulus present or absent. Legs normally with pores on at least one leg segment; with tibial digitules apically acute, claw digitules apically capitate; with denticle on claw. Antennae normally nine-segmented, rarely with six to eight segments.

**Notes.**—Fourth-instar females of *Heterococcus* differ from all other instars in possessing the following combination of characters: Vulva present, 19–76 setae on dorsum of abdominal segment V, ventral quinquelocular pores scattered over surface, legs with translucent pores, hind tibia/tarsus ratio 1.4–2.3, tibia-tarsus length 125–299 $\mu$, antennae six- to nine-segmented, oral-collar tubular ducts present, and multilocular disk pores normally present but absent on one species.

Fourth-instar females of *Heterococcus* differ from adult females of *Brevennia* in possessing two pairs of dorsal ostioles on all but one species, swirled trilocular pores absent, claw with denticle, and with eight- or nine-segmented antennae on all but one species. *Brevennia* has posterior pair of ostioles only, swirled trilocular pores in all but one species, claw without denticle on all but one species, and with six- or seven-segmented antennae.

Fourth-instar females of *Heterococcus* differ from adult females of *Phenacoccus dearnessi* in possessing quinquelocular pores scattered over dorsum, no trilocular pores, and body elongate. *P. dearnessi* has trilocular pores scattered over dorsum, no quinquelocular pores, and body rotund.

## Species Descriptions

### *Heterococcus abludens* Borchsenius

*Heterococcus abludens* Borchsenius 1962: 238; Miller and McKenzie 1970: 440.

**Suggested Common Name.**—Different mealybug.

**Type Material Examined.**—One paratype (ZAS).

**Field Features.**—Occurring in leaf sheath of its grass host.

#### Adult Female (Fig. 1)

**Recognition Characters.**—Same as general description of adult females except as follows: Mounted, 4.3 mm long, 1.9 mm wide.

*Dorsum* with one or two pairs of cerarii; anal-lobe cerarii with conical setae about 16 $\mu$ long, one auxiliary seta, several scattered quinquelocular pores, and weakly sclerotized basal area; remaining cerarii with widely separated conical setae and one or two quinquelocular pores. Discoidal pores rare, apparently restricted to posterior part of abdomen. Quinquelocular pores of one size, lightly scattered over surface. Multilocular disk pores near lateral margins of abdominal segments IX, VIII, and VII, also with one or two pores on medial or mediolateral areas of VII and VI. Oral-collar tubular ducts shorter than normal for species of *Heterococcus*, becoming progressively shorter anteriorly, present on abdominal segments VIII through III, with only one or two ducts on segments IV and III. Dorsal setae conical, those on medial portion of segment VIII about 10 $\mu$ long; segment V with 20 setae.

Anal ring apical, posterior portion bent over abdominal apex, with setae slightly longer than greatest diameter of ring, with three rows of pores, outer row well developed.

*Venter* with multilocular disk pores on posterior and anterior margins of abdominal segment IX, present on posterior margin of segments VII and VI. Quinquelocular pores of one size, scattered over surface, with small concentration near each spiracle. Discoidal pores scattered over surface. Oral-collar tubular ducts of same size as on dorsum, present on medial areas of abdominal segments VIII, VII, and VI, present laterally on segments IX through II, with one present on lateral margin near each posterior spiracle. Posterior seta about 180 $\mu$ long.

Circulus absent. Legs unusually short and robust for species of *Heterococcus*; hind coxae without pores; hind femora dorsally with 53 and 55 translucent pores, absent ventrally; hind tibiae dorsally with 36 and 39 translucent pores; hind tibia/tarsus ratio 1.5–1.6 (av. 1.5); hind tibia-tarsus length 198–203 (av. 200) $\mu$; apices

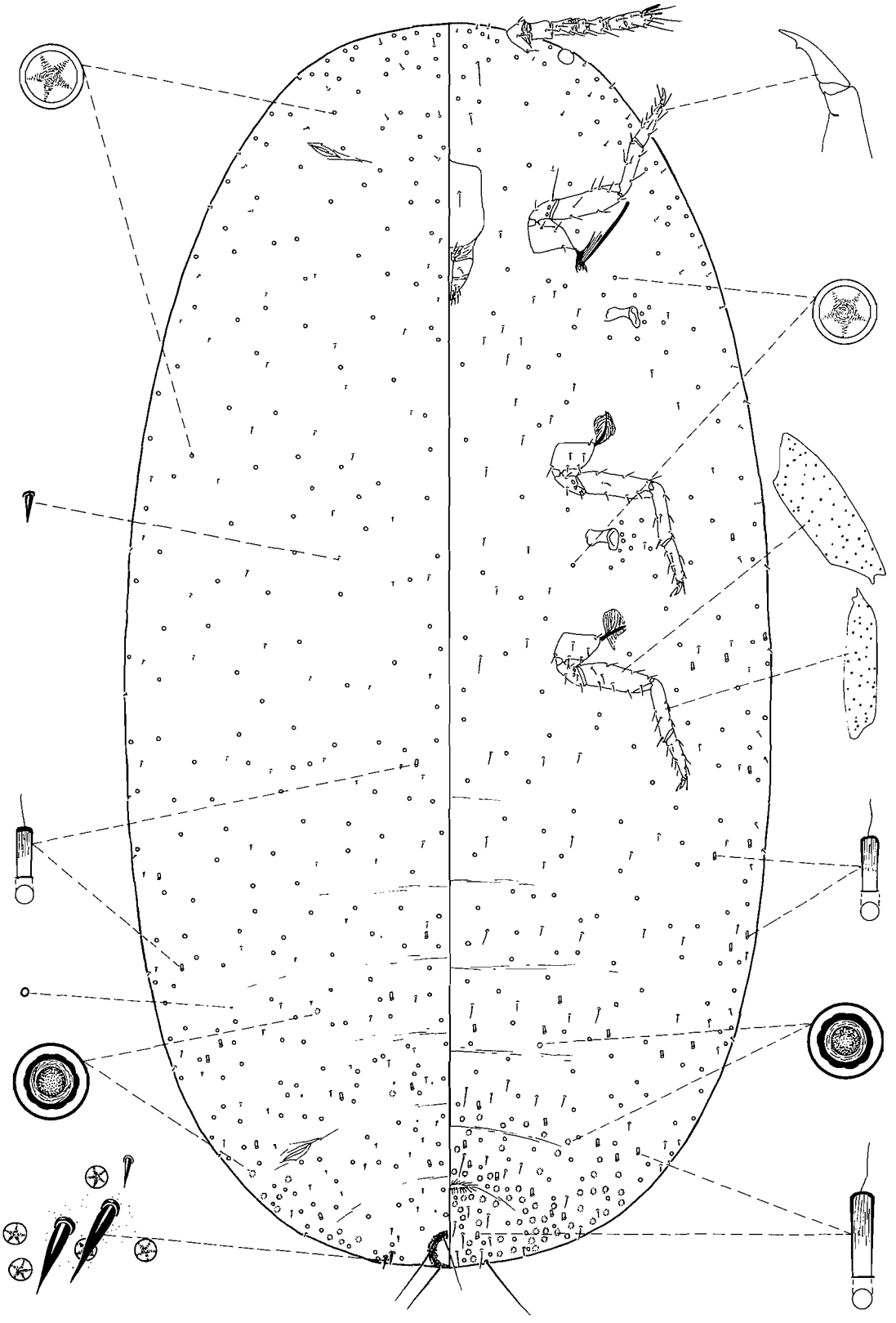


FIGURE 1.—*Heterococcus abludens* Borchsenius: Adult female.

of claw digitules equal, claws each with conspicuous denticle. Antennae six-segmented, with apical segment partially divided into seventh segment; length 195–215 (av. 203) $\mu$.

**Notes.**—This description is based on a single specimen, which was cut along the body margin with the dorsal and ventral surfaces mounted separately. Because parts of the venter are still attached to the dorsum and vice versa, it has been rather difficult to produce an accurate illustration and description. Therefore it may be necessary to make a few minor changes when more specimens become available.

The adult female of this species is most closely related to the adult female of *H. nudus*, but it differs in possessing six-segmented antennae, antennal length 195–215 (av. 203) $\mu$, and multilocular disk pores absent from thorax and head. *H. nudus* possesses seven-, eight-, or nine-segmented antennae, antennal length 248–318 (av. 282) $\mu$, and multilocular disk pores present along body margin of thorax and head.

**Specimens Examined.**—CHINA. Yunnan Province: Kingtung, IV–10–57, on grass (ZAS).

### *Heterococcus arenae* Ferris

*Heterococcus arenae* Ferris 1918: 65, 1919: 22; MacGillivray 1921: 144; Laing 1930: 21; Lindinger 1937: 186; Goux 1937: 256; Morrison 1945: 46; Borchsenius 1949: 266; Ferris 1953: 365; Williams 1961: 671, 1962: 29; Morrison and Morrison 1966: 93; DeLotto 1967: 4; McKenzie 1967: 189; Miller and McKenzie 1970: 440.

**Suggested Common Name.**—Sand mealybug.

**Type Material Examined.**—Lectotype (designated by Miller and McKenzie *1970*) and four paralectotypes (UCD).

**Field Features.**—This species is light yellow and is covered with a white bloom. The posterior body margin sometimes has one or two short pairs of waxy filaments. A small, indefinite ovisac is produced posteriorly.

This species infests the leaf sheaths of the host.

#### Adult Female

#### (Fig. 2)

**Recognition Characters.**—Same as general description of adult females except as follows: Mounted, 1.3–3.8 mm long, 0.4–1.6 mm wide.

*Dorsum* with two to four pairs of cerarii, normally two or three, all restricted to posterior abdominal segments; anal-lobe cerarii with bristle-shaped setae 22–70 (av. 31) $\mu$ long, with one to four auxiliary setae, three or four associated quinquelocular pores, without basal sclerotization; remaining cerarii each represented by one or two bristle-shaped setae noticeably more robust than other body setae and with or without associated quinquelocular pores. Discoidal pores varying from inconspicuous or absent to large and abundant. Quinquelocular pores of two sizes, smaller size limited to areas in and around cerarii, larger size scattered over remainder of surface. Multilocular disk pores absent. Oral-collar tubular ducts normally scattered over surface, rarely restricted to abdomen, variable in size from one specimen to next but basically of uniform size on single specimen, often showing signs of rim. Dorsal setae bristle shaped, those on medial portion of segment VIII 18–26 (av. 21) $\mu$ long; segment V with 29–41 (av. 34) setae.

Anal ring normally dorsal, sometimes bent over abdominal apex, with setae approximately 1½ times as long as greatest diameter of ring, normally with two rows of pores, rarely with three, outer row weakly developed.

*Venter* with multilocular disk pores present on posterior and anterior margins of abdominal segments IX and VIII and on posterior margin of segment VII, sometimes absent from segment VII or present on anterior margin of segment VII and posterior margin of segment VI, normally restricted to medial and submedial areas, rarely with one or two pores present near body margin; multiloculars variable, 17–101; specimens from desert areas with noticeably fewer multiloculars than specimens from mountainous or coastal areas. Quinquelocular pores of two sizes: Larger size scattered over body, smaller size restricted to lateral areas of posterior four or five abdominal segments. Discoidal pores normally scattered in small numbers over surface, rarely absent. Oral-collar tubular ducts elongate, basically same size as those on dorsum, most abundant on abdomen, becoming decreasingly abundant on thorax, normally absent on head, rarely with oral collars restricted to abdomen. Posterior seta 112–163 (av. 129) $\mu$ long.

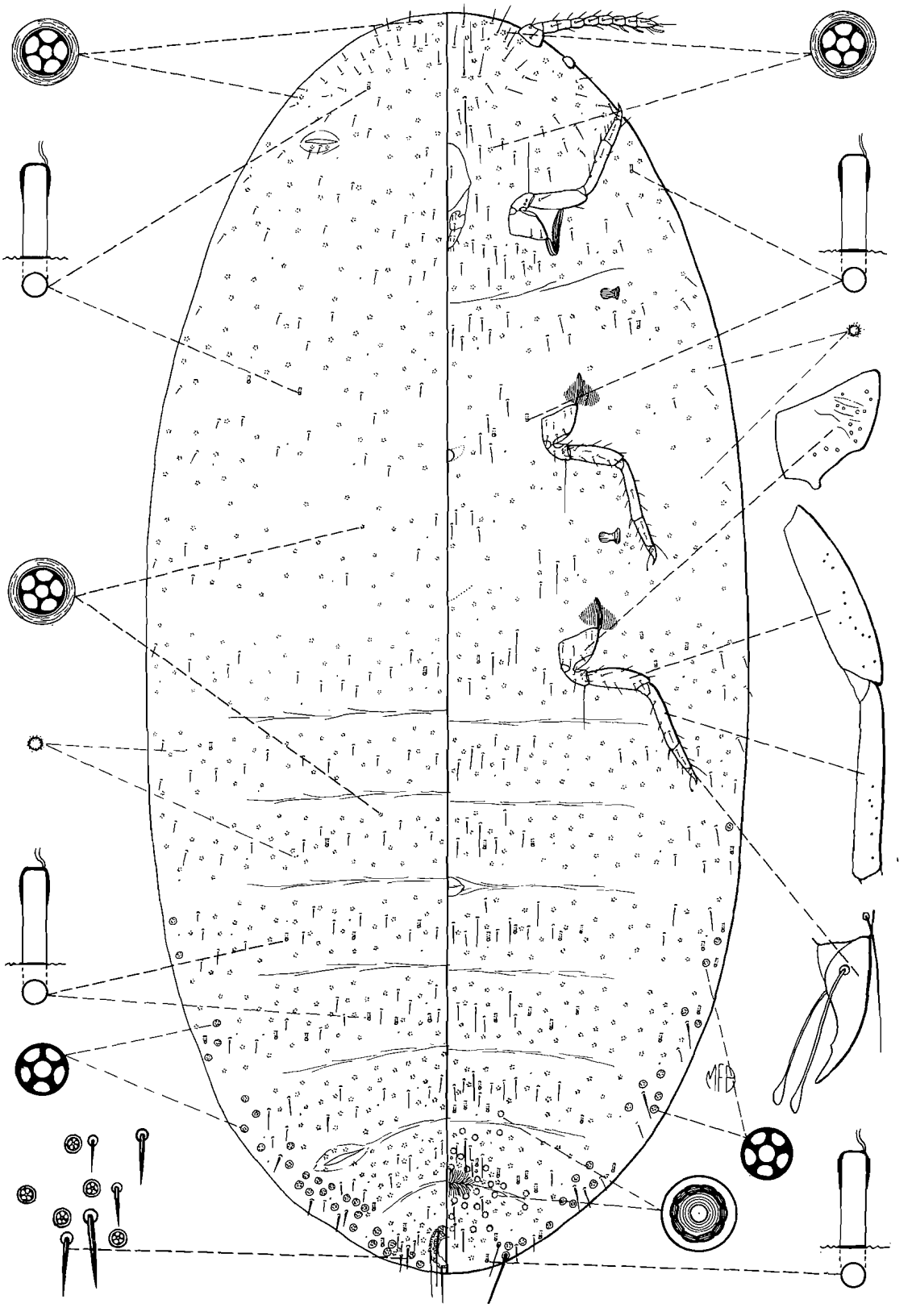



FIGURE 2.—*Heterococcus arenae* Ferris: Adult female.

Circulus present on 23 of 100 specimens; 3 localities yielded mixed infestations of specimens with and without this structure. Legs slender, hind coxae sometimes enlarged, dorsally with 10–66 (av. 33) translucent pores, ventrally with 4–49 (av. 28); hind femora dorsally with 4–22 (av. 9) pores, absent ventrally; hind tibia/tarsus ratio 1.4–1.8 (av. 1.6); hind tibia-tarsus length 178–208 (av. 196) $\mu$; apices of claw digitules unequal, claws with denticle. Antennae 9-segmented on 94 of 100 specimens; when 8-segmented, distal segment unusually elongate and composed of fused eighth and ninth segments; 4 localities yielded mixed infestations of specimens with 8- and 9-segmented antennae; length 262–320 (av. 290) $\mu$.

**Notes.**—This description is based on 100 specimens from 35 localities.

The adult female of this species is most closely related to *H. tritici,* but it differs as follows: Multilocular disk pores basically restricted to medial and submedial areas of ventral part of abdomen, anal-lobe cerarii without basal sclerotization, oral-collar tubular ducts elongate, anal-ring setae about 1½ times as long as greatest diameter of ring, tibia-tarsus length 178–208 (av. 196) $\mu$, and apices of claw digitules unequal. *H. tritici* has multilocular disk pores abundant on medial, submedial, and lateral areas of ventral part of abdomen, anal-lobe cerarii with definite area of basal sclerotization, oral-collar tubular ducts short, anal-ring setae about equal to greatest diameter of ring, tibia-tarsus length 219–263 (av. 247) $\mu$, and apices of claw digitules equal.

For an additional comparison, see "Notes" under *H. cyperi* and *H. raui.*

**Specimens Examined.**—ARIZONA. Yavapai Co.: Ashfork, IX–1–68, on Gramineae (UCD); Yampai, IX–1–68, on Gramineae (USNM).

CALIFORNIA. Alpine Co.: 3 mi. N. Markleeville, VIII–9–64, on Gramineae (UCD). Inyo Co.: Antelope Springs, VI–24–64, on *Elymus triticoides* (Gramineae) (UCD); between Big Pine and Deep Springs, VII–(?)–18, on "perennial grass" (UCD). Monterey Co.: Dunes near Pacific Grove, XII–1–17, on *Poa douglasii* (Gramineae) (UCD); Parkfield, VII–30–66, from Berlese funnel (UCD). Napa Co.: 4 mi. W. Spanish Flat, III–1–61, on Gramineae (UCD). Orange Co.: Modjeska Canyon, VI–12–64 and I–31–64, on *Stipa* sp. (Gramineae) (UCD). Placer Co.: 3 mi. W. Applegate, VIII–8–64, on Gramineae (UCD). Riverside Co.: 3 mi. S. Temecula, II–2–64, on *Aristida* sp. (Gramineae) (UCD). San Bernardino Co.: 1.5 mi. N. Cajon Pass, VI–12–60, on "soil-grass association" (UCD). San Diego Co.: 5 mi. S.E. Fallbrook, V–9–64, on Gramineae (UCD). San Luis Obispo Co.: 25 mi. W. New Cuyama, VI–28–66, on Gramineae (UCD). Santa Barbara Co.: Santa Cruz Island, Coches Prieto, VI–18–67, on *Festuca* sp. (Gramineae) (UCD); Santa Cruz Island, University of California Research Station, VI–16–67, on *Festuca* sp. (UCD); Santa Cruz Island, South Ridge, V–6–68, on Gramineae (USNM); Santa Cruz Island, Cascada, V–4–68, on Gramineae (USNM); San Miguel Island, San Miguel Mountain, VII–11–70, on Gramineae (USNM). Shasta Co.: 7 mi. W. Whiskeytown, VII–18–66, on Gramineae (UCD, USNM).

COLORADO. Montezuma Co.: 15 mi. S. Cortez, VII–4–70, on *Oryzopsis* sp. (Gramineae) (USNM). Powers Co.: 5 mi. E. Lamar, VI–29–70, on Gramineae (USNM).

IDAHO. Fremont Co.: Saint Anthony Sand Dunes, VIII–5–64, on *Festuca* sp. (UCD).

KANSAS. Ellis Co.: Hays, VI–17–54, on "western wheatgrass" (USNM).

MONTANA. Petroleum Co.: 1.5 mi. S.W. Winnett, VII–28–70, from Berlese funnel (USNM).

NEVADA. Lincoln Co.: 55 mi. N.W. Alamo, VII–5–70, on Gramineae (USNM).

NEW MEXICO. Eddy Co.: Near Otis, VII–19–47, on *Agropyron* sp. (Gramineae) (UCD). San Miguel Co.: Las Vegas, IV–28–(?), on (?) (USNM). Taos Co.: Tres Piedras, VII–3–70, on Gramineae (USNM).

OREGON. Coos Co.: Bandon, VIII–6–68, on Gramineae (UCD). Harney Co.: Burns, VIII–3–70, on Gramineae (USNM). Lake Co.: 1 mi. N. Valley Falls, VIII–4–68, on Gramineae (UCD). Lane Co.: Florence, VIII–6–68, on Gramineae (UCD). Malheur Co.: 5 mi. N. Ontario, VIII–5–70, on Gramineae (USNM). Namorf, VIII–4–70, on Gramineae (USNM).

UTAH. San Juan Co.: 3 mi. S. Monticello, IX–7–68, on *Festuca* sp. (UCD).

WYOMING. Sublette Co.: 10 mi. S. Daniels, VIII–31–64, on Gramineae (UCD).

### *Heterococcus biporus* (Goux)

*Phenacoccus* (*Heterococcus ?*) *biporus* Goux 1937: 253.
*Phenacoccus biporus* Goux, Kiritchenko 1940: 123 (misidentification of *Heterococcus tritici* (Kiritchenko)); Goux 1942: 40.
*Heterococcus biporus* (Goux), Morrison 1945: 45; Miller and McKenzie 1970: 442.

**Suggested Common Name.**—Two pore mealybug.

**Type Material Examined.**—Unfortunately I have been unable to see the Goux collection. The type data, according to Goux (*1937*), are Tamaris, France, July 1934, on *Brachypodium pinnalum* (Gramineae) by L. Goux. There are apparently four paratypes and one holotype.

**Field Features.**—No information.

## Adult Female

The following description is based on the original description.

**Recognition Characters.**—Same as general description of adult females except as follows: Mounted, about 2.3 mm long, 0.8 mm wide.

*Dorsum* with one or two pairs of cerarii restricted to abdomen; anal-lobe cerarii probably with conical setae, no auxiliary setae, associated quinquelocular pores, no basal sclerotization; remaining cerarii each with two associated setae, no quinquelocular pores. Discoidal pores not mentioned in description. Quinquelocular pores of one size, scattered over surface. Multilocular disk pores and oral-collar tubular ducts absent. Dorsal setae described as "spines."

Anal ring with two rows of pores.

*Venter* with multilocular disk pores absent. Quinquelocular pores of same size as on dorsum, scattered over surface. Discoidal pores not mentioned. Oral-collar tubular ducts restricted to lateral areas of abdomen and thorax.

Circulus absent. Legs short, hind coxae and tibiae without pores; hind femora dorsally with about 20 translucent pores, apparently absent ventrally; hind tibia/tarsus ratio about 1.5; hind tibia-tarsus length about 125 $\mu$; claws with small denticle. Antenna nine- or eight-segmented; when eight-segmented with segment 3 partially divided, length about 230 $\mu$. Anterior ostioles absent.

**Notes.**—The adult female of this species differs from the adult female of all other species of *Heterococcus* in that it lacks multilocular disk pores and anterior ostioles.

**Specimens Examined.**—None.

### *Heterococcus cyperi* (Hall)

*Phenacoccus cyperi* Hall 1926: 4, 1926a: 155; Goux 1937: 255, 1942: 40.
*Heterococcus cyperi* (Hall), Ezzat 1960: 47, 1962: 160; Miller and McKenzie 1970: 442.

**Suggested Common Name.**—Egyptian sedge mealybug.

**Type Material Examined.**—Eight paratypes (labeled "cotypes") (BM).

**Field Features.**—Occurring in leaf sheath of host.

## Adult Female
## (Fig. 3)

**Recognition Characters.**—Same as general description of adult females except as follows: Mounted, 2.4–3.2 mm long, 1.3–1.5 mm wide.

*Dorsum* with cerarii represented only by one pair of loosely associated setae on each anal lobe; anal-lobe cerarii with bristle-shaped setae 20–25 (av. 23) $\mu$ long, without auxiliary setae, associated quinquelocular pores, or basal sclerotization; remaining cerarii absent. Discoidal pores scattered over surface. Quinquelocular pores of one size, abundant over surface. Multilocular disk pores absent. Oral-collar tubular ducts of one size, present in small numbers over surface, normally most abundant near body margin. Dorsal setae bristle shaped, those on medial portion of segment VII 17–20 (av. 19) $\mu$ long; segment V with 19–32 (av. 27) setae.

Anal ring dorsal, placed about one-half its own diameter from posterior apex of abdomen, with setae slightly longer than greatest diameter of ring, each seta with slightly swollen apex, with one row of pores.

*Venter* with multilocular disk pores present on anterior and posterior margins of abdominal segments IX and VIII, restricted to posterior margin of segments VII and VI, sometimes absent on segment VI. Quinquelocular pores of

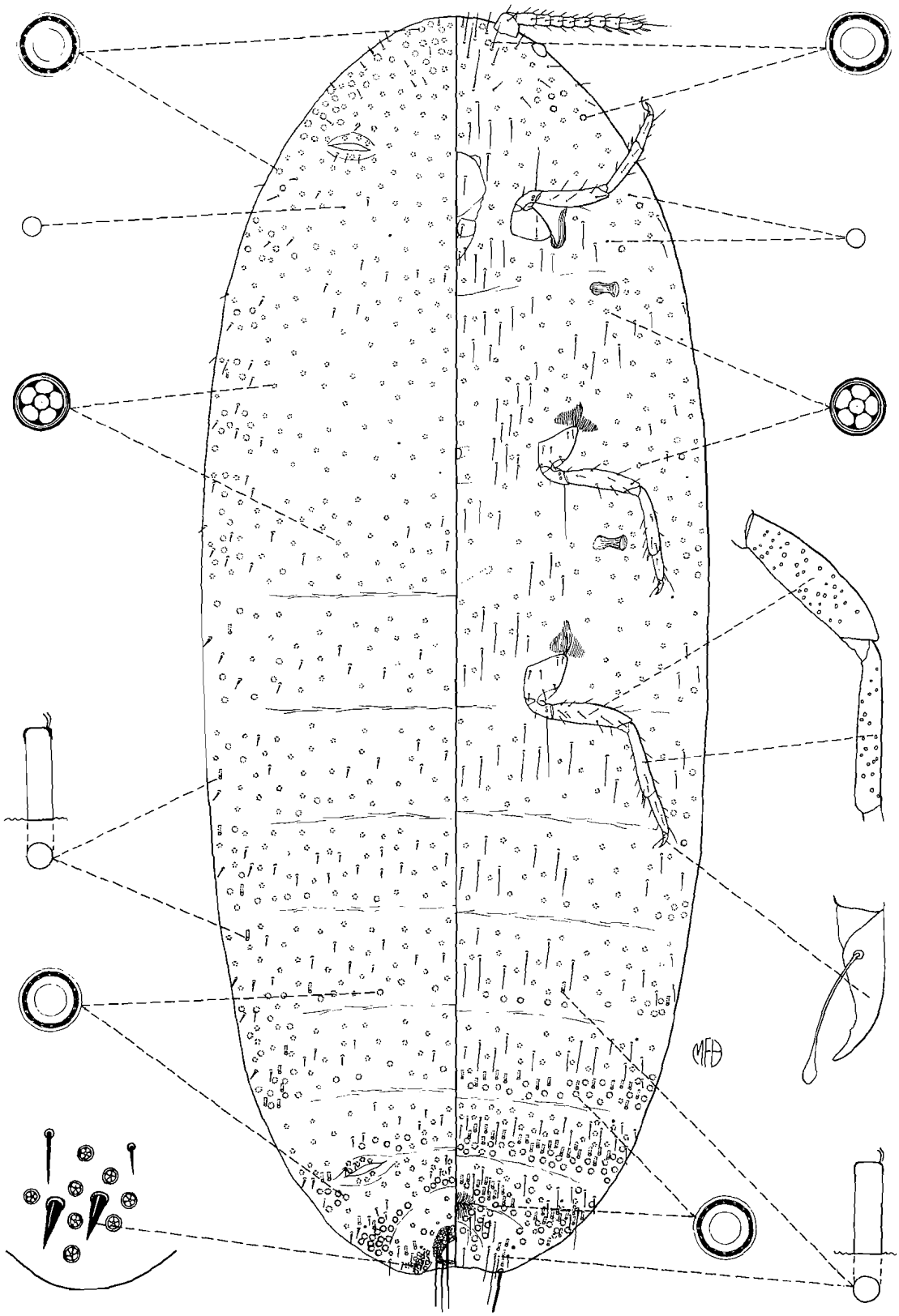


FIGURE 4.—*Heterococcus nudus* (Green): Adult female.

*Dorsum* with five to eight pairs of cerarii, posterior two or three pairs definite, remaining two to five pairs indefinite except single ocular pair, which is normally rather evident; anal-lobe cerarii with conical setae 18–23 (av. 21) $\mu$ long, one or two auxiliary setae, three to eight quinquelocular pores, no basal sclerotization; remaining abdominal cerarii with conical setae, zero to six quinquelocular pores; ocular cerarii with two to four conical setae and three to six quinquelocular pores. Discoidal pores lightly scattered over surface, normally most abundant on abdomen and rare on thorax. Quinquelocular pores of one or two sizes: Larger size associated with posterior cerarii, smaller size scattered over remainder of surface. Multilocular disk pores on posteromedial areas of abdominal segments VIII–VI, V, IV, or III, present around body. Oral-collar tubular ducts normally absent medially, rarely with one or two ducts on medial areas of segments VIII or VII, present laterally on segments VIII–V, IV, or III, rarely with one or two ducts on thorax and head. Dorsal setae conical, those on medial portion of segment VIII 9–13 (av. 11) $\mu$ long; segment V with 30–37 (av. 33) setae.

Anal ring dorsal, with setae normally about 1½ times as long as greatest diameter of ring, rarely as large as two times or as little as one-half (*occidentalis* type) times as long as ring, normally with two rows of pores, rarely with three.

*Venter* with multilocular disk pores present medially on posterior and anterior margins of abdominal segments IX and VIII, present on posterior margin of segments VII–V or IV; present laterally on all abdominal segments, normally restricted to marginal area between anterior spiracle and eye on thorax, sometimes with few pores scattered along remainder of thoracic margin, present or absent on margin of head. Quinquelocular pores of one or two sizes, when of two sizes, larger size present near posterior or anterior margins of segments, smaller size present on other areas. Discoidal pores variable, normally lightly scattered over surface, rarely with only two or three such pores. Oral-collar tubular ducts elongate, same size as those on dorsum, present on medial areas on abdominal segments IX–VI, V, or IV, present laterally on segments IX–IV or III, occasionally with one or two pores on posterior thorax, absent from head. Posterior seta about 50 $\mu$ on *occidentalis* type, others 133–163 (av. 148) $\mu$ long.

Circulus present on 1 of 195 specimens. Legs slender, hind coxae normally without pores, dorsal surface with 0–2 (av. 0.3), absent ventrally; hind femora dorsally with 22–91 (av. 51), absent ventrally; hind tibiae dorsally with 18–44 (av. 28), absent ventrally; hind tibia/tarsus ratio 1.6–1.8 (av. 1.7); tibia-tarsus length 204–260 (av. 227) $\mu$; apices of claw digitules unequal, claw with denticle. Of 315 antennae examined, 160 were 9-segmented, 144 were 8-segmented, 11 were 7-segmented; there were 38 specimens with an 8-segmented antenna on one side and a 9-segmented antenna on the other, 6 specimens with 7 and 8 segments, and 1 with 7 and 9 segments; when antennae were less than 9-segmented, normally segment 8 was unusually long and partially divided although segments 4 or 3 rarely showed these characteristics; antennal length 248–318 (av. 282) $\mu$.

**Notes.**—This description is based on 195 specimens from 49 localities.

The adult female of this species is most closely related to that of *H. abludens*. For a comparison, see "Notes" under that species.

**Specimens Examined.**—ENGLAND. Ken Surrey, VIII–18–62, VIII–25–62, VI–8–63, VI–15–63, on *Arrhenatherum elatius* (Gramineae) (BM); VIII–25–62, on *Bromus carinatus* (Gramineae) (BM); V–8–63, on *Hordeum murinum* (Gramineae) (BM); VI–16–63, on *Agropyron repens* (Gramineae) (BM); Silwood Park, VIII–4–49, on *Holcus* sp. (Gramineae) (BM); VIII–8–49, host (?) (BM).

GERMANY. S.W. of Oberammergau, VIII–(?)–55, on *Agrostis alba* (Gramineae) (Schmutterer collection).

POLAND. Mount Cergowa, Krosno, IX–20–68, on *Festuca* sp. (Gramineae) (USNM); Mount Dalin, near Sutkowice, II–8–71, on *Sieglingia decumbens* (Gramineae) (USNM); Potok Pieniński Stream, Pieniny Mountains, Nowy Targ, VI–24–63, on *Briza media* (Gramineae) (USNM); Tenczynek, Chrzanow, VIII–26–67, on *Festuca* sp. (USNM).

U.S.A. CALIFORNIA. Kern Co.: U.S. Cotton Field Station, Shafter, VII–17–62, on *Phleum* sp. (Gramineae) (UCD). Modoc Co.: 8 mi. E. Tulelake, V–31–61, on *Poa* sp. (Gramineae) (UCD). Riverside Co.: Hemet, X–26–38, in soil (USNM). Shasta Co.: W. of Redding (900 ft. el.), VII–18–66, on Gramineae (USNM). Siskiyou Co.: Southern Pacific Railroad Yards, Dunsmuir, VIII–17–65, on *Elymus glaucus* (Gramineae) (CDA). Yolo Co.: Davis, VIII–25–58, on "lawn grass" (Gramineae) (UCD); Agronomy Greenhouse, University of California, Davis, VIII–20–65, on *Lolium perenne* (Gramineae) (CDA, USNM).

DISTRICT OF COLUMBIA. Date (?), on "bluegrass lawn" (USNM); VIII–13–44, on *Setaria viridis* (Gramineae) (USNM).

IDAHO. Franklin Co.: 6 mi. N.E. Minkcreek, VIII–3–67, on Gramineae (UCD). Nez Perce Co.: 4 mi. N. Lewiston, VIII–7–70, on Gramineae (USNM).

KANSAS. Douglas Co.: 5 mi. S. Lawrence, VI–27–70, on Gramineae (USNM). Norton Co.: Locality (?), VII–29–53, on *Agropyron* sp. (Gramineae) (USNM).

MARYLAND. Prince Georges Co.: Beltsville, VIII–(?)–54, on "wheat and bromegrass" (Gramineae) (USNM).

MINNESOTA. Ramsey Co.: Locality (?), VIII–4–53, "at base of corn roots" (Gramineae) (USNM).

NEW HAMPSHIRE. Strafford Co.: Durham, VIII–5–21, "under leaf of blue grass" (Gramineae) (USNM).

NEW JERSEY. Bergen Co.: Fort Lee, V–24–38, "in grass sheath" (Gramineae) (UCD, USNM).

NEW YORK. Nassau Co.: Hicksville, IX–9–65, "on bluegrass" (Gramineae) (USNM). Saratoga Co.: Saratoga Springs, VII–25–36, on "grass" (Gramineae) (USNM).

NORTH DAKOTA. Cass Co.: Fargo, III–27–58 and XI–7–58, "from stubble, wild rice" (Gramineae) (USNM). Grand Forks Co.: Northwood, XI–25–60, "roadside sod adjacent to barley field" (USNM).

OHIO. Hamilton Co.: Kent, VIII–24–69, on (?) (USNM). Wayne Co.: Wooster, VI–13–44, VI–22–44, VII–1–44, VII–10–44, VIII–1–44, on *Phleum* sp. (USNM).

OREGON. Baker Co.: Baker, IX–6–63, on "grass" (Gramineae) (UCD). Jackson Co.: Central Point, IX–10–55, on "bluegrass" (UCD). Lane Co.: Noti, VIII–5–68, on (?) (Gramineae) (UCD); 8 mi. W. Noti, VIII–5–68, on (?) (Gramineae) (UCD). Multnomah Co.: Portland, V–12–44, on *Poa* sp. (USNM). Union Co.: 10 mi. S. La Grande, VIII–5–70, on Gramineae (UCD).

PENNSYLVANIA. Bradford Co.: Troy, XI–13–38, "in moss and leaves" (USNM). Centre Co.: State College, X–25–41 and (?)–(?)–42, on *Festuca* sp. and *F. rubra* (Gramineae) (UCD, USNM). Cumberland Co.: Doubling Gap, VI–12–71, on *Festuca* sp. (USNM).

VIRGINIA. Giles Co.: Mountain Lake, X–24–70, on "grass" (USNM).

WASHINGTON. Jefferson Co.: 2 mi. E. Discovery Bay, VIII–20–66, on "grass" (USNM). Whitman Co.: Pullman, VI–13–57, on "orchard grass" (Gramineae) (USNM), VII–24–58, on *Alopecurus* sp. (Gramineae) (UCD), IV–2–60, IV–4–60, IV–14–60, IV–15–60, IV–17–60, IV–19–60, VI–24–60, VI–26–60, VIII–29–60, IX–17–60, on (?) (USNM). Yakima Co.: Yakima, VIII–28–40, on "grass" (USNM).

U.S.S.R. Dnepropetrovsk Oblast, Sinel'nikovsk Village, VIII–16–53, under leaf sheath of *Bromus inermis* (Gramineae) (USNM).

### *Heterococcus raui*, n. sp.

**Suggested Common Name.**— Rau mealybug.

**Type Material Examined.**—Holotype adult female (1 specimen on slide) and 58 paratypes in USNM. One additional paratype is deposited in each of the following museums: BM, CDA, FNM, MNC, SA, UCD, UH, VPI, ZAS.

**Field Features.**—According to Rau's notes, "Feeding on stems and in sheaths just above ground."

## Adult Female

## (Fig. 5)

**Recognition Characters.**—Same as general description of adult females except as follows: Holotype, mounted, 1.8 mm long, 0.8 mm wide (paratypes 1.9–3.1 mm long, 0.7–1.2 mm wide).

*Dorsum* with one definite pair of cerarii and two or three more, which are weakly indicated;

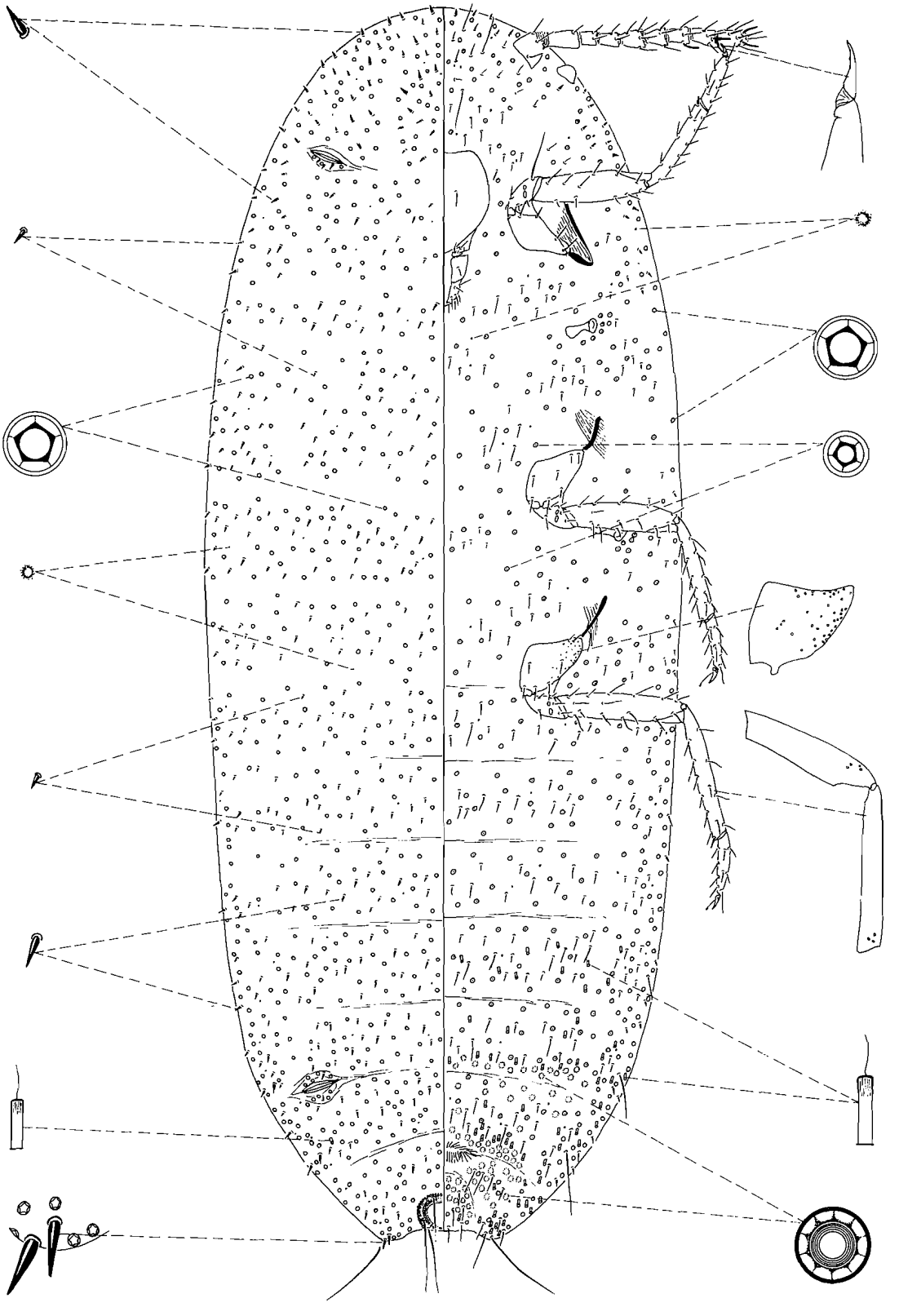


FIGURE 5.—*Heterococcus raui*, n. sp.: Adult female.

anal-lobe cerarii with conical setae 20 μ long (paratypes 15–22 (av. 18) μ), no auxiliary setae, two or three quinquelocular pores, no basal sclerotization; penultimate cerarii each with conical setae more widely spaced than on anal-lobe lobes and without basal cluster of quinquelocular pores; antepenultimate cerarii each represented by widely separated conical setae. Discoidal pores present in small numbers over surface. Quinquelocular pores of one size, abundant. Multilocular disk pores absent. Oral-collar tubular ducts same size and shape as on venter, with one duct present on sublateral area of abdominal segment VIII, absent elsewhere. Dorsal setae conical, those on medial portion of segment VIII 13 μ long (paratypes 10–13 (av. 12)μ); segment V with 63 setae (paratypes 47–76 (av. 58)).

Anal ring dorsal, touching apex of abdomen, with setae about 1½ times as long as greatest diameter of ring, with three rows of pores, outer rows weakly sclerotized.

*Venter* with multilocular disk pores on anterior and posterior margins of abdominal segments IX and VIII, restricted to posterior margin of segment VII, with one septelocular present on segment VI, absent elsewhere. Quinquelocular pores of two sizes, numerous over surface, larger size restricted to lateral margins, same size as on dorsum; smaller size on medial and sublateral areas. Discoidal pores lightly scattered over surface. Oral-collar tubular ducts elongate, becoming increasingly smaller anteriorly, present on abdominal segments IX through VI. Single body seta near each margin of abdominal segments VIII, VII, and VI unusually elongate, becoming progressively shorter from segment VIII anteriorly. Posterior seta 177 μ long (paratypes 146–177 (av. 153)μ).

Circulus absent. Legs slender, hind coxae dorsally with 39 and 40 translucent pores (paratypes with 24–64 (av. 39)), ventrally with 25 and 28 (paratypes wth 19–35 (av. 25)); hind femora dorsally with 3 and 4 translucent pores (paratypes with 0–8 (av. 6)), absent ventrally; hind tibiae dorsally with 3 translucent pores (paratypes with 1–6 (av. 4)), absent ventrally; hind tibia/tarsus ratio 2.2 and 2.3; hind tibia-tarsus length 293 μ (paratypes 274–299 (av. 293)μ); apices of claw digitules about equal, claw with small denticle. Antennae eight-segmented, eighth segment partially divided; length 390 μ (paratypes 354–390 (av. 371)μ).

**Variation.**—Paratypes differ from holotype as follows: Normally with 4 pairs of cerarii sometimes with 5; with 0–3 (av. 1.2) dorsal oral-collar tubular ducts on abdominal segment VIII, with 0–1 (av. 0.2) on VII, dorsomedial oral collars normally with larger orifices than those on dorsal submargin; dorsal oral collars without trace of rims; anal ring sometimes bent over abdominal apex, rarely with 2 rows of pores; anterior margin of ventral abdominal segment VII with 0–2 (av. 0.5) multilocular disk pores, posterior margin of segment VI ventrally with 0–12 (av. 5); of 42 antennae examined, 26 were 8-segmented and 16 were 9-segmented; there were 2 specimens with an 8-segmented antenna on 1 side and a 9-segmented antenna on the other.

**Notes.**—This description is based on 68 specimens from 1 locality.

The adult female of this species is most closely related to that of *H. arenae*. It differs as follows: Dorsal setae conical, mediodorsal quinqueloculars noticeably larger than those on medioventral area, abdominal segment V dorsally with 47–76 (av. 58) setae, hind tibia/tarsus ratio 2.0–2.4 (av. 2.2), hind tibia-tarsus length 274–299 (av. 293) μ), and antennal length 354–390 (av. 371) μ. *H. arenae* has dorsal setae bristle shaped, mediodorsal quinquelocular pores about same size as those on medioventral area, abdominal segment V dorsally with 29–41 (av. 34) setae, hind tibia/tarsus ratio 1.4–1.8 (av. 1.6), hind tibia-tarsus length 178–208 (av. 196) μ, and antennal length 262–320 (av. 290) μ.

**Specimens Examined.**—SOUTH CAROLINA. Charleston Co.: Folly Beach, IX–21–44, on *Andropogon virginicus* (Gramineae), G. Rau (BM, CDA, FNM, MNC, SA, UCD, UH, USNM, VPI, ZAS).

### *Heterococcus tritici* (Kiritchenko)

*Trionymus tritici* Kiritchenko 1932: 136; Borchsenius 1937a: 245; Kiritchenko 1940: 123.

*Erium tritici* (Kiritchenko), Lindinger 1935: 122, 1936: 167, 1957: 549, 1958: 371.

*Heterococcus tritici* (Kiritchenko), Borchsenius 1937: 55 (misidentification of *Heterococcus borkhsenii* Morrison); Borchsenius 1949: 268, 1950: 102, 1950a: 368, 1963: 233; Danzig 1964: 630; Miller and McKenzie 1970: 447.

*Phenacoccus biporus* Goux, Kiritchenko 1940: 123 (misidentification).

*Phenacoccus biporus* Kiritchenko, Borchsenius 1949: 268. (Kiritchenko never described this species as new.)

*Heterococcus confertus* Borchsenius 1949: 267, 1950: 102; Bazarov 1963: 67, 1968: 74; Miller and McKenzie 1970: 442. (New synonymy.)

**Suggested Common Name.**—Wheat mealybug.

**Type Material Examined.**—Two paratypes of *tritici* and five specimens labeled "Holotypus" of *confertus*.

**Field Features.**—According to original description, "body is pale-pink . . . covered with thinly grained white mealy substance, the waxy marginal appendages wanting. Ovisac porous, snow white." Occurring in leaf sheaths of host.

## Adult Female
## (Fig. 6)

**Recognition Characters.**—Same as general description of adult females except as follows: Mounted, 2.4–4 mm long, 0.8–1.4 mm wide.

*Dorsum* with one to four pairs of cerarii; anal-lobe cerarii with bristle-shaped setae 20–25 (av. 22) $\mu$ long, with one auxiliary seta, with two to four associated quinquelocular pores, and with or without basal sclerotization; remaining cerarii each with bristle-shaped setae and one or two quinquelocular pores. Discoidal pores scattered over surface. Quinquelocular pores of one size, abundant over surface. Multilocular disk pores absent, except rarely one or two septelocular pores may be present near body margin. Oral-collar tubular ducts of two sizes, smaller size restricted to lateral margins of posterior abdominal segments, larger size unusually short for *Heterococcus* species, sometimes showing signs of rim, present in small numbers over surface. Dorsal setae bristle shaped, those on medial portion of segment VIII 15–24 (av. 20) $\mu$ long; segment V with 20–41 (av. 33) setae.

Anal ring dorsal, or bent over posterior apex of abdomen, with setae slightly shorter than greatest diameter of ring, with two rows of pores, outer row weakly developed.

*Venter* with multilocular disk pores present on posterior and anterior margins of abdominal segments IX, VIII, and VII, restricted to posterior margin of abdominal segment VI, some specimens with these pores absent on segment VI and anterior margin of segment VII; with one to five such pores near each posterior spiracle, with zero to one near each anterior spiracle. Quinquelocular pores of one size, abundant over surface. Discoidal pores uncommon. Oral-collar tubular ducts of same two sizes as on dorsum, larger size present near body margin, absent on head, smaller size scattered over surface, normally absent on head. Posterior seta 101–130 (av. 115) $\mu$ long.

Circulus absent. Legs slender; hind coxae unusually enlarged, dorsally with 64–102 (av. 78) translucent pores, ventrally with 69–84 (av. 74); hind femora dorsally with 5–15 (av. 10) pores, absent ventrally; hind tibiae with 8–21 (av. 17) pores, absent ventrally; hind tibia/tarsus ratio 1.7–1.9 (av. 1.8); hind tibia-tarsus length 219–263 (av. 274) $\mu$; apices of claw digitules equal, claws with denticle. Of 18 antennae examined, 17 were 9-segmented and 1 was 8-segmented, length 270–358 (av. 324) $\mu$.

**Notes.**—This description is based on 10 specimens from 3 localities.

Based on type material of *H. tritici* and *H. confertus*, I have decided that these species are synonyms. Borchsenius (*1949*) separated them as follows: *H. tritici* with one pair of cerarii, anal-lobe cerarii with definite basal sclerotization, and tubular ducts of limited distribution; *H. confertus* with two pairs of cerarii, anal-lobe cerarii without distinct basal sclerotization, and tubular ducts scattered over both body surfaces. It is known from the examination of long series of specimens of other species of *Heterococcus* that the distribution of oral-collar tubular ducts and the numbers of cerarii show considerable variation. Critical examination of some specimens of *H. tritici* reveals one pair of cerarii on one side of the body and two on the other. Although specimens labeled *H. confertus* have more oral-collar tubular ducts, *H. tritici* has basically the same duct distribution pattern. The sclerotization surrounding the anal-

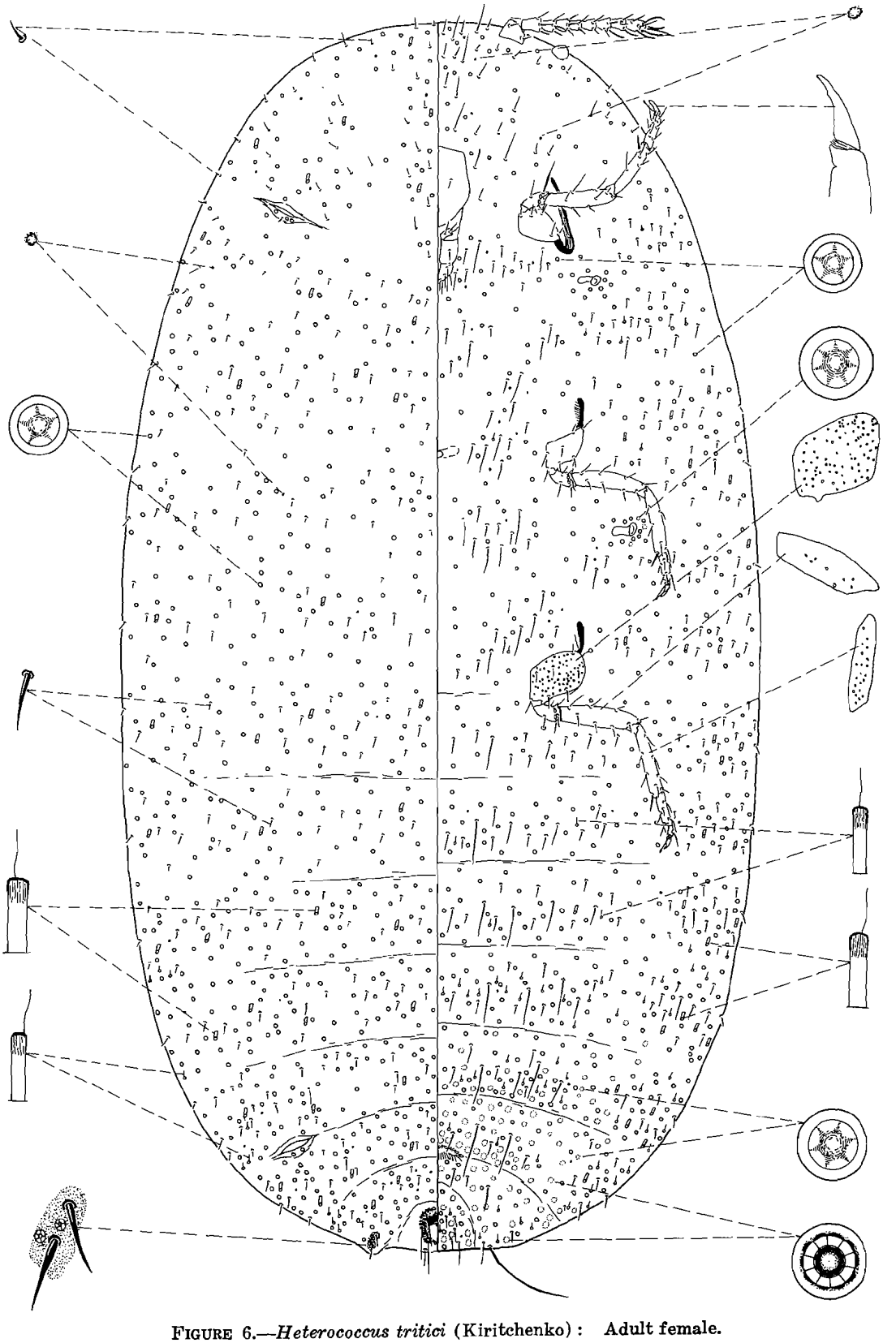


FIGURE 6.—*Heterococcus tritici* (Kiritchenko): Adult female.

lobe cerarii is clearly evident on the available specimens of *H. tritici* and is difficult to see on material of *H. confertus*. This might be expected, because the specimens of *H. tritici* are well stained, whereas those of *H. confertus* appear to be unstained. Careful examination of the specimens of *H. confertus* with phase microscopy reveals a sclerotized area surrounding the base of the anal-lobe cerarii similar to the area on *H. tritici*.

This species is most closely related to *H. arenae*. For a comparison, see "Notes" under that species.

**Specimens Examined.**—U.S.S.R., Tadzhik S.S.R., spur of Hissar Range, banks of Vorzob River, VI–18–40, in glumes of wild rye (Gramineae) (ZAS); Turkmenyia, Missarky Mountains, VI–18–40, on "secale" (BM); Ukrainian S.S.R., near Odessa, Luzanovka, VI–12–36, on *Bromus* sp. (Gramineae) (ZAS).

## Key to Third-Instar Females

1. Ventromedial quinquelocular pores noticeably smaller than those on dorsum; posterior setae 140–150 (av. 145) μ long; antennae 275–300 (av. 288) μ long; tibia/tarsus ratio 1.4—1.5 (av. 1.4) ..... *raui*, n. sp.
   Ventromedial quinquelocular pores about same size as those on dorsum; posterior setae 98–128 (av. 114) μ long; antennae 203–253 (av. 224) μ long; tibia/tarsus ratio 1.1–1.3 (av. 1.2) ..... 2

2 (1). Dorsal body setae elongate, bristle shaped; longest cerarian seta on anal lobe 18–25 (av. 23) μ long ..... *arenae* Ferris
   Dorsal body setae short, conical; longest cerarian seta on anal lobe 14–18 (av. 15) μ long ..... *nudus* (Green)

## General Description of Third-Instar Females

The following characters are present on all known third-instar females of *Heterococcus:*

Body elongate. *Dorsum* with cerarii present at least on abdomen; anal-lobe cerarii each with two associated cerarian setae, normally one seta is longer and more robust than the others; remaining cerarii becoming progressively smaller and more indefinite anteriorly, with two associated setae and at least one associated quinquelocular pore. Quinquelocular pores present. Discoidal pores and oral-collar tubular ducts present or absent. Multilocular disk pores absent. With 15–29 dorsal setae on each of abdominal segments VIII–III.

Anal ring with three pairs of setae.

*Venter* without multilocular disk pores. Quinquelocular and discoidal pores present. Oral-collar tubular ducts present or absent. Body setae noticeably longer than those on dorsum.

Legs without pores; with tibial digitules apically acute, claw digitules apically capitate. Antennae six- or seven-segmented.

**Notes.**—Third-instar females of *Heterococcus* differ from all other instars in possessing the following combination of characters: 15–29, normally 21–29, setae on dorsum of abdominal segment V, ventral quinquelocular pores scattered over surface, tibia/tarsus ratio 1.1–1.5, tibia-tarsus length 142–220 μ, antennae 6- or 7-segmented, oral-collar tubular ducts rarely present, and multilocular disk pores absent.

Third-instar females of *Heterococcus* differ from those of *Phenacoccus dearnessi* in possessing quinquelocular pores on dorsum, swirled triloculars absent, and normally without oral-collar tubular ducts. *P. dearnessi* has swirled trilocular pores on dorsum, quinqueloculars absent, and with oral-collar tubular ducts.

## Species Descriptions

### *Heterococcus arenae* Ferris
### Third-Instar Female
### (Figs. 7 and 8)

**Recognition Characters.**—Same as general description of third-instar females except as follows: Mounted, 1.1–1.6 mm long, 0.4–0.6 mm wide.

*Dorsum* with three to five pairs of cerarii, normally with four; anal-lobe cerarii with

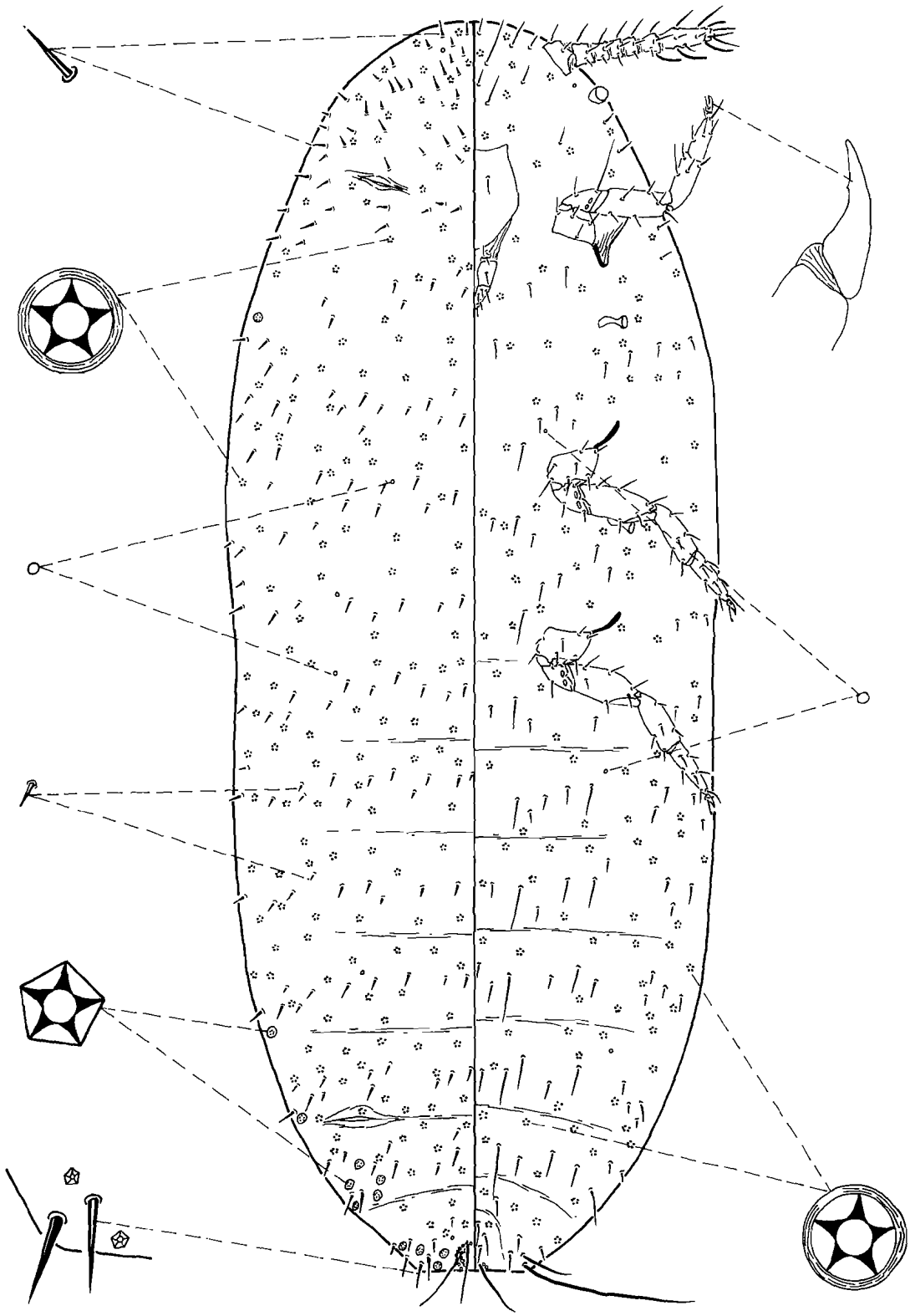


FIGURE 7.—*Heterococcus arenae* Ferris: Third-instar female.

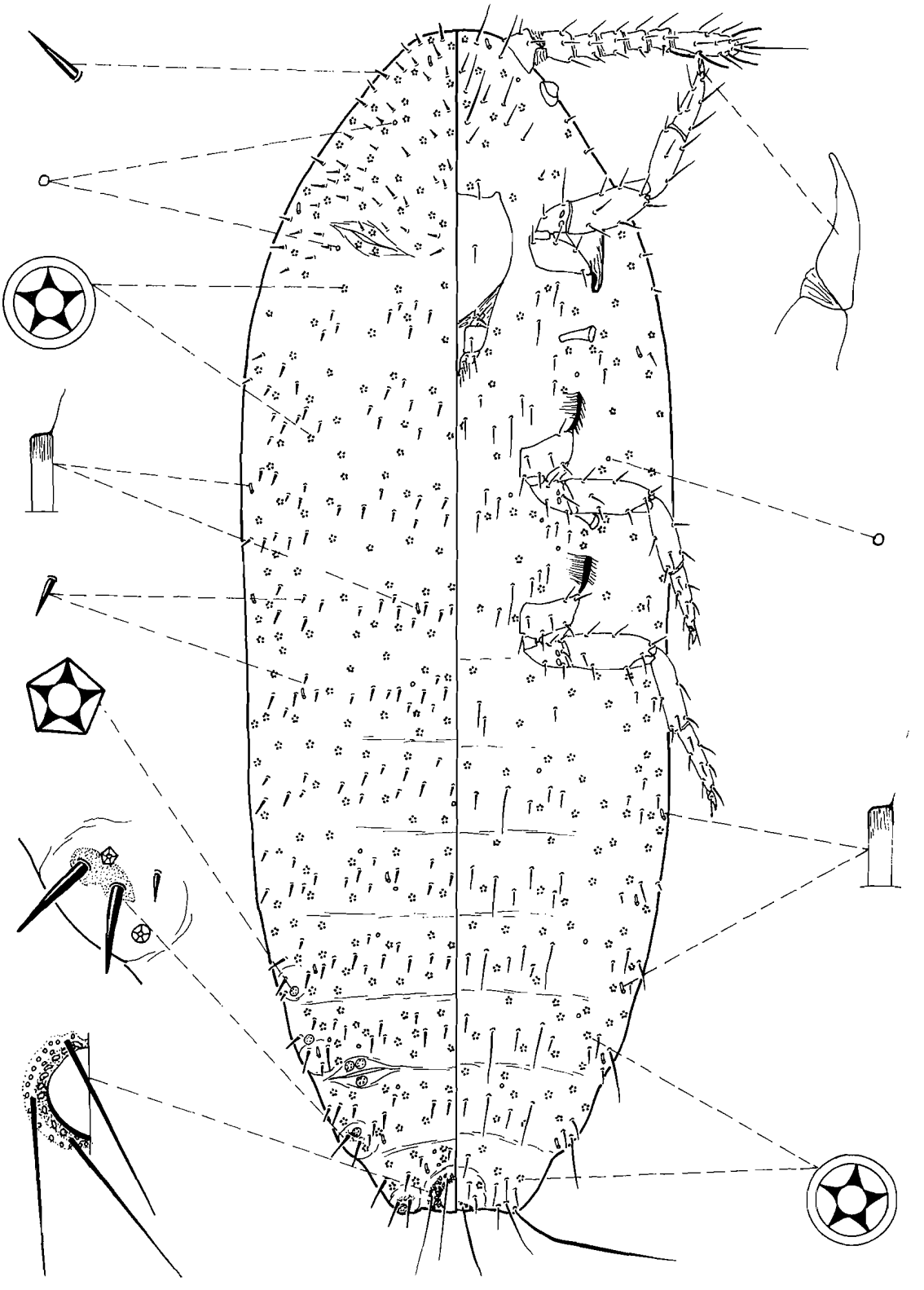


FIGURE 8.—*Heterococcus arenae* Ferris: Third-instar female.

bristle-shaped setae 18–25 (av. 23) μ long, with zero to two auxiliary setae, one to four quinquelocular pores, with or without small amount of basal sclerotization; penultimate pairs of cerarii definite, remaining cerarii each represented by one large and one small bristle-shaped seta. Discoidal pores varying from totally absent to scarce to abundant; absent on 6 of 18 specimens, 1 locality yielded a mixed infestation of specimens with and without these structures. Oral-collar tubular ducts variable, when present, normally restricted to area near lateral margin of body, some ducts with weakly developed rim, varying in number from 0 to 23 (av. 2); oral collars absent on 8 of 18 specimens examined, 1 locality yielded a mixed infestation of specimens with and without these structures. Quinquelocular pores of two sizes, smaller size normally restricted to lateral areas on posterior abdominal segments, larger size present over remainder of dorsum. Body setae bristle shaped, those on medial portion of segment VIII 14–18 (av. 16) μ long; segment V with 19–27 (av. 21) setae.

Anal ring normally bent over abdominal apex, with setae about 1½ times as long as greatest diameter of ring, with two rows of pores.

*Venter* with smaller quinquelocular pores normally restricted to areas in and around cerarii, rarely present on lateral areas of anterior abdominal segments and thorax. Discoidal pores present at least in submarginal row on abdomen, sometimes lightly scattered over entire surface. Oral-collar tubular ducts normally absent, rarely with one or two near body margin and near legs. Posterior setae 98–128 (av. 110) μ long.

Circulus absent. Legs with hind tibia/tarsus ratio 1.1–1.2 (av. 1.2); hind tibia-tarsus length 142–172 (av. 159) μ; claw digitules with apices unequal in size. Antennae seven-segmented, third and fourth segments sometimes partially fused; length 205–253 (av. 226) μ long.

**Notes.**—This description is based on 18 specimens from 7 localities.

The third-instar females of this species are most similar to the same instar female of *H. nudus*. It differs in possessing bristle-shaped dorsal setae, longest anal-lobe cerarian seta 18–25 (av. 23) μ, and some of posterolateral quinquelocular pores smaller than dorsomedial quinqueloculars. *H. nudus* has conical dorsal setae, longest anal-lobe cerarian seta 14–18 (av. 15) μ, and some of posterolateral quinquelocular pores larger than dorsomedial quinquelocularis.

## *Heterococcus nudus* (Green)

### Third-Instar Female

### (Fig. 9)

**Recognition Characters.**—Same as general description of third-instar females except as follows: Mounted, 1–1.3 mm long, 0.4–0.6 mm wide.

*Dorsum* with 8–14 pairs of cerarii, with 7–10 on abdomen and posterior thorax, rarely with 1 near anterior spiracle, normally with 1 near eye; anal-lobe cerarii with conical setae 14–18 (av. 15) μ long, with 0–2 auxiliary setae, with 4 or 5 associated quinquelocular pores; remaining cerarii each with conical setae and 0–3 quinquelocular pores. Discoidal pores sometimes difficult to see, scattered over surface in small numbers. Oral-collar tubular ducts absent. Quinquelocular pores of one basic size, although marginal pores appearing slightly larger. Body setae conical, those on medial portion of segment VIII 7–10 (av. 9) μ long; segment V with 20–25 (av. 22) setae.

Anal ring either bent over posterior apex of abdomen or dorsal, touching abdominal apex, with setae about two times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores of same size as on dorsum. Discoidal pores varying from scattered over venter to restricted to longitudinal line along each submargin. Oral-collar tubular ducts absent. Posterior setae 113–125 (av. 119) μ long.

Circulus present on one of nine specimens. Legs with hind tibia/tarsus ratio 1.1–1.3 (av. 1.2); hind tibia-tarsus length 158–183 (av. 168) μ; claw digitules with apices unequal in size. Antennae normally seven-segmented; antennae six-segmented on two specimens, six-segmented on one side and seven-segmented on the other on two specimens, and seven-segmented on four specimens; when six-segmented, segment 3 appears to be the undivided segment; antennae 203–233 (av. 222) μ long.

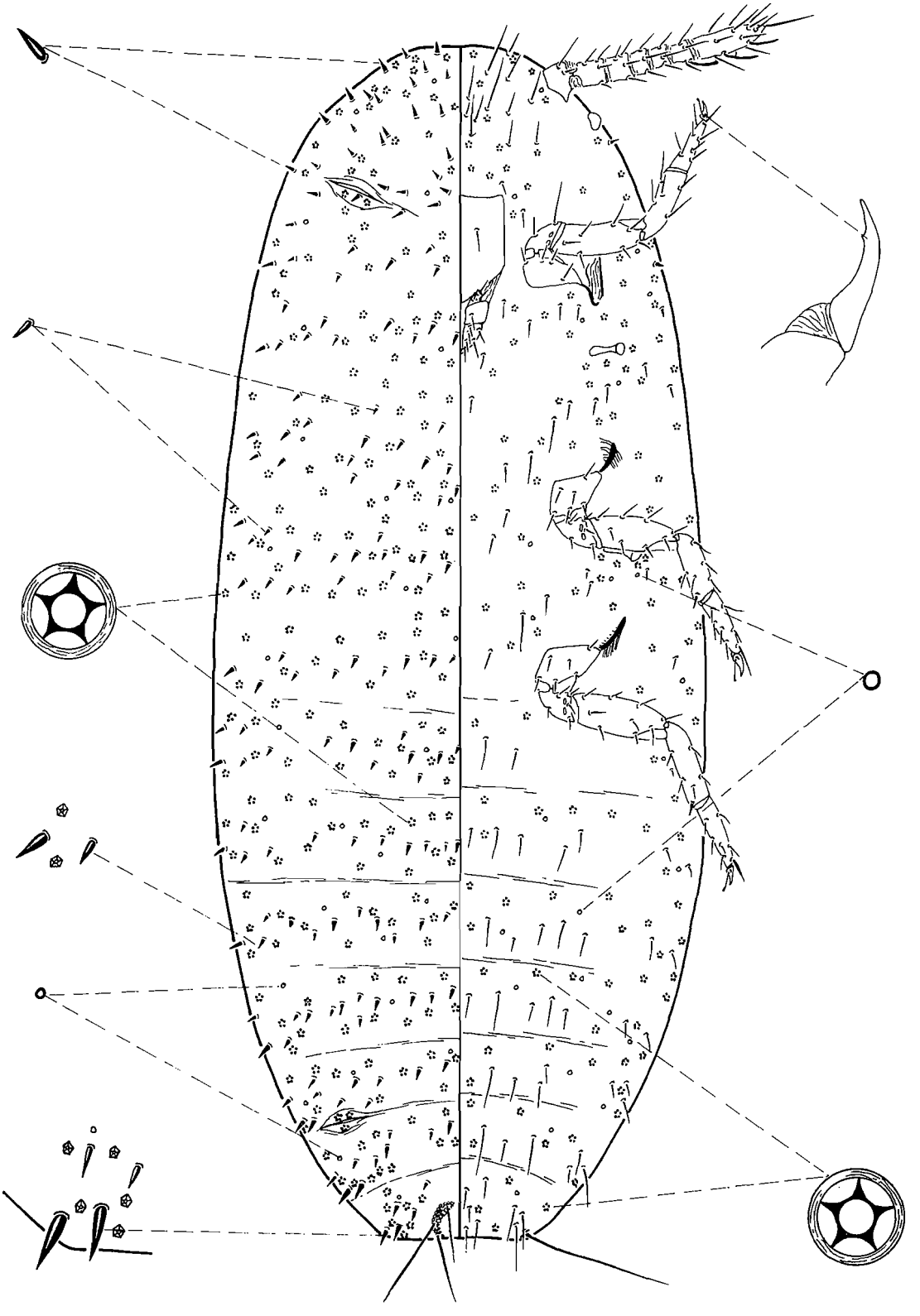


FIGURE 9.—*Heterococcus nudus* (Green): Third-instar female.

**Notes.**—This description is based on nine specimens from six localities.

The third-instar females of this species are most similar to the same instar female of *H. arenae*. For a comparison, see "Notes" under the description of the third-instar female of *H. arenae*.

### *Heterococcus raui*, n. sp.

### Third-Instar Female

### (Fig. 10)

**Recognition Characters.**—Same as general description of third-instar females except as follows: Mounted, 1.2–1.7 mm long, 0.4–0.7 mm wide.

*Dorsum* with five to seven pairs of cerarii, all present on abdomen; anal-lobe cerarii with conical setae 15–17 (av. 16) $\mu$ long, with zero to two auxiliary setae, with three or four associated quinquelocular pores; remaining cerarii each with conical setae and zero to two quinquelocular pores. Discoidal pores variable, often very uncommon, rarely present in larger numbers, scattered over surface. Oral-collar tubular ducts absent. Quinquelocular pores of one size, although marginal pores slightly larger. Body setae conical, those on medial portion of segment VIII 8–11 (av. 10) $\mu$ long; segment V with 25–31 (av. 29) setae.

Anal ring bent over posterior apex of abdomen, with setae about two times as long as greatest diameter of ring, with two or three rows of pores.

*Venter* with quinquelocular pores of two sizes, smaller size on medial and mediolateral areas, noticeably smaller than those on dorsum, larger size present along margin, same size as those on dorsum. Discoidal pores scattered over surface. Oral-collar tubular ducts absent. Posterior setae 140–150 (av. 145) $\mu$ long.

Circulus absent. Legs with hind tibia/tarsus ratio 1.4–1.5 (av. 1.4); hind tibia-tarsus length 205–220 (av. 211) $\mu$ ; claw digitules with apices equal in size. Antennae seven-segmented; length 275–300 (av. 288) $\mu$.

**Notes.**—This description is based on five specimens from one locality.

The third-instar females of this species differ from other known third-instar females in possessing ventromedial quinquelocular pores noticeably smaller than those on dorsum, posterior setae 140–150 (av. 145) $\mu$ long, hind tibia/tarsus ratio 1.4–1.5 (av. 1.4), hind tibia-tarsus length 205–220 (av. 211) $\mu$ long, and antennae 275–300 (av. 288) $\mu$ long.

## Key to Second-Instar Females

1. Dorsal body setae elongate, bristle shaped; marginal quinquelocular pores noticeably smaller than remaining dorsal quinqueloculars..... ..... *arenae* Ferris
   Dorsal body setae short, conical; marginal quinquelocular pores slightly larger than or same size as remaining dorsal quinqueloculars ..... 2

2 (1). Medioventral quinquelocular pores same size as those on dorsum; hind tibia tarsus 146–161 (av. 154) $\mu$ long; antennae 215–230 (av. 222) $\mu$ long; posterior setae 130–140 (av. 134) $\mu$ long ..... *raui*, n. sp.
   Medioventral quinquelocular pores noticeably smaller than those on dorsum; hind tibia tarsus 128–141 (av. 134) $\mu$ long; antennae 163–188 (av. 178) $\mu$ long; posterior setae 88–108 (av. 101) $\mu$ long .... *nudus* (Green)

## General Description of Second-Instar Females

The following characters are present on all known second-instar females of *Heterococcus:*

Body elongate. *Dorsum* with cerarii present at least on abdomen; anal-lobe cerarii each with two associated cerarian setae, normally one seta is longer and more robust than the other, one quinquelocular pore, and one auxiliary seta; remaining cerarii becoming progressively smaller and more indefinite anteriorly, with two associated setae and at least one associated sessile pore. Discoidal and quinquelocular pores present. Multilocular disk pores and oral-collar

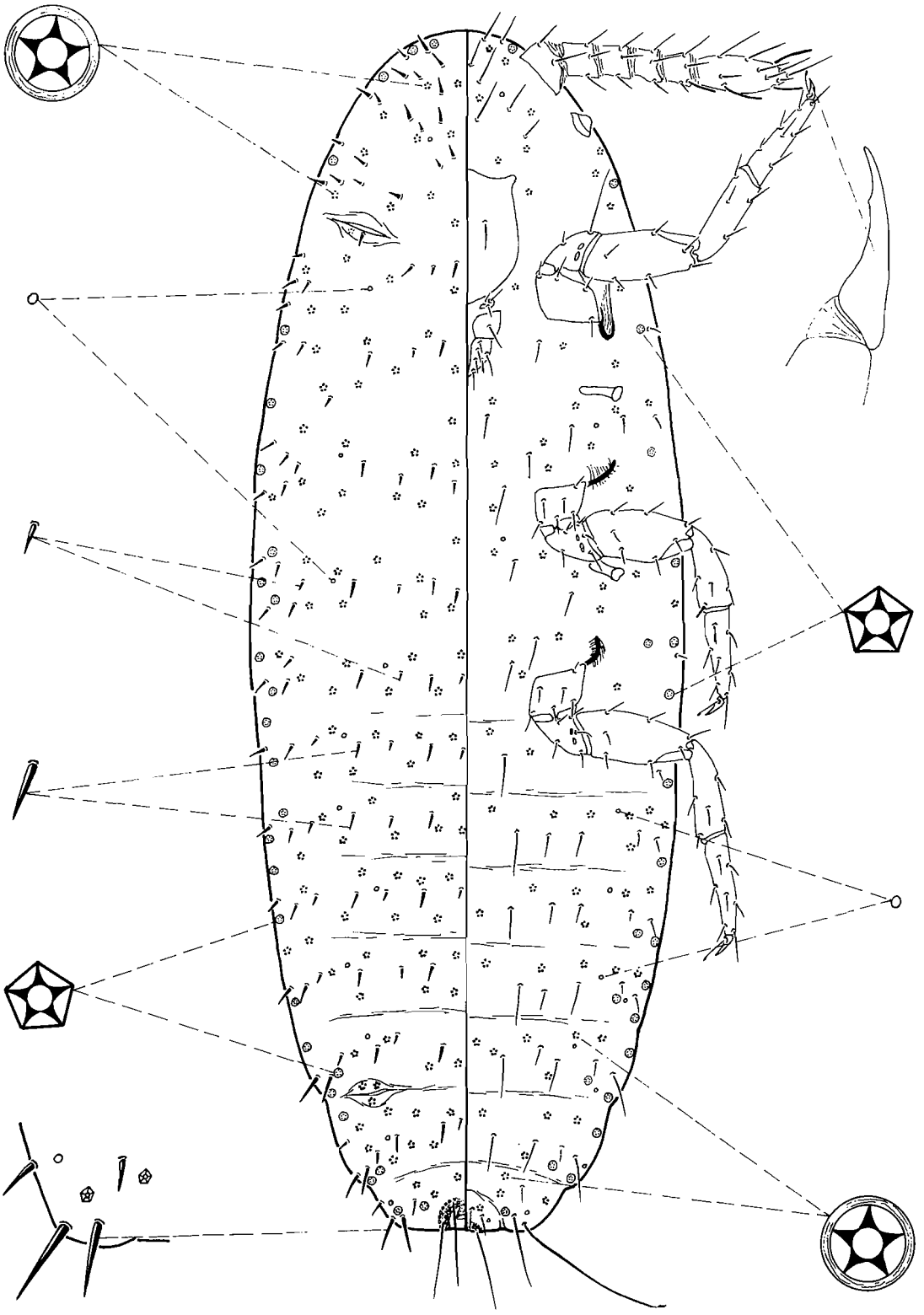


FIGURE 11.—*Heterococcus arenae* Ferris: Second-instar female.

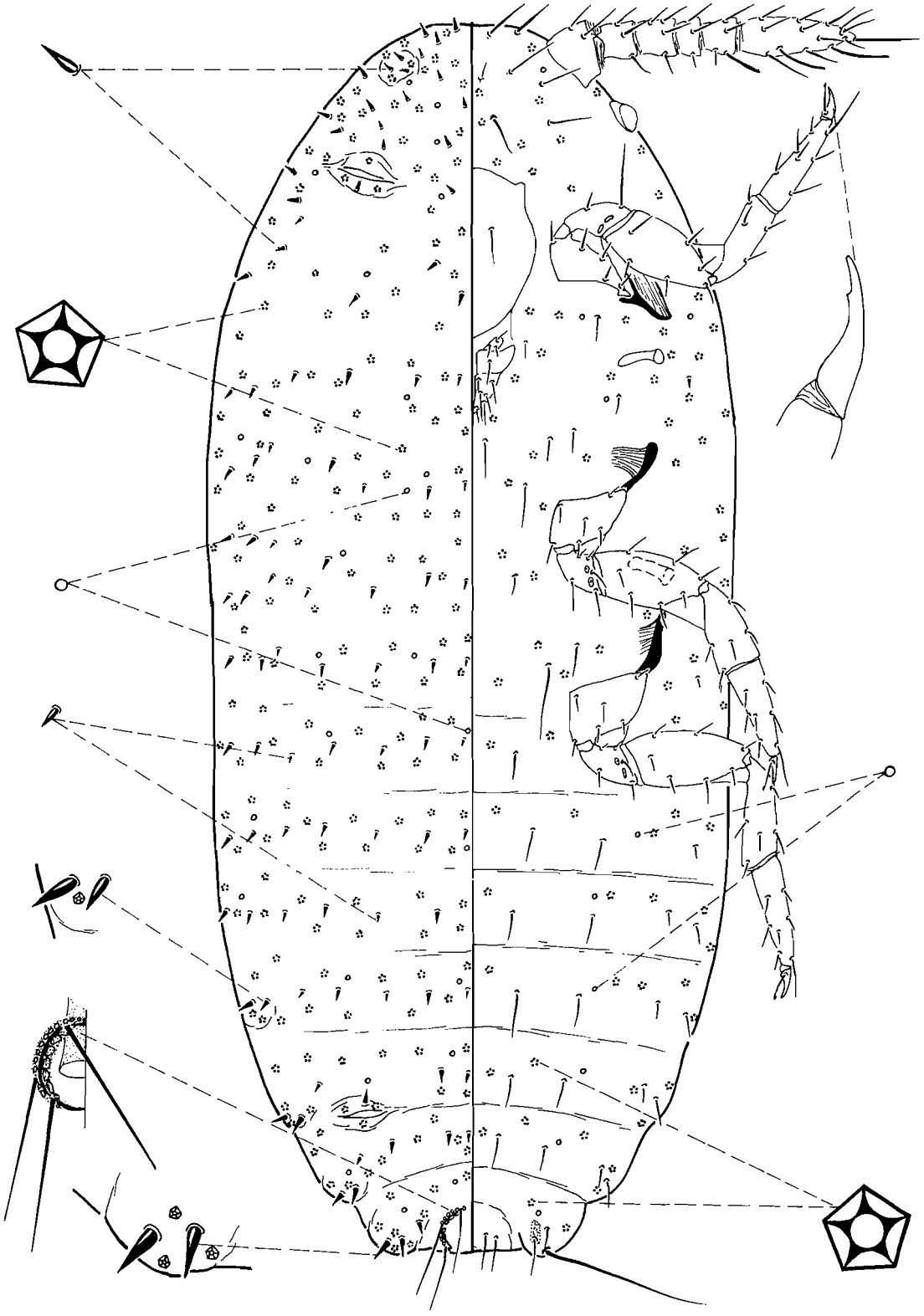


FIGURE 12.—*Heterococcus nudus* (Green): Second-instar female.

*Venter* with quinquelocular pores of same size as those on dorsum, lightly scattered over surface. Posterior setae 88–108 (av. 101) $\mu$ long.

Circulus absent even on specimens associated with first instars that possess this structure. Legs with hind tibia/tarsus ratio 0.9–1 (av. 1), tibia normally slightly shorter than tarsus; hind tibia-tarsus length 128–141 (av. 134) $\mu$; claw with denticle; claw digitules with apices unequal in size. Antennae 163–188 (av. 178) $\mu$ long.

**Notes.**—This description is based on 19 specimens from 7 localities.

The second-instar females of this species are most similar to the same instar female of *H. raui*. It is easily separated in possessing only one distinct size of quinquelocular pore, short appendages and posterior setae, and claw digitules with apices unequal in size. *H. raui* has two sizes of quinquelocular pores, long appendages and posterior setae, and claw digitules with apices equal in size.

### *Heterococcus raui*, n. sp.

Second-Instar Female

(Fig. 13)

**Recognition Characters.**—Same as general description of second-instar females except as follows: Mounted, 0.7–1.2 mm long, 0.3–0.5 mm wide.

*Dorsum* with 8–10 pairs of cerarii located on abdomen and posterior thorax; anal-lobe cerarii with longest conical seta 12–15 (av. 13) $\mu$, with 2–4 associated quinquelocular pores; remaining cerarii each with conical setae and 0–2 quinquelocular pores. Discoidal pores present in small numbers. Quinquelocular pores of one size, although one or two marginal pores rarely slightly larger than rest, scattered over surface. Body setae conical, those on medial portion of segment VIII 7–10 (av. 9) $\mu$ long.

Anal ring bent over abdominal apex, with setae about two times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores of two sizes, larger size along margin, same size as on dorsum, smaller size on medial and mediolateral areas. Posterior setae 130–140 (av. 134) $\mu$ long.

Legs with hind tibia/tarsus ratio 1–1.2 (av. 1.1); hind tibia-tarsus length 146–161 (av. 154) $\mu$; claw with denticle small or absent; claw digitules with apices equal in size. Antennae 215–230 (av. 222) $\mu$ long.

**Notes.**—This description is based on 10 specimens from 1 locality.

The second-instar females of this species are most similar to the same instar female of *H. nudus*. For a comparison, see "Notes" under the description of the second-instar female of *H. nudus*.

## Key to First Instars

1. Dorsal setae elongate, bristle shaped ..... 2
   Dorsal setae short, conical ..... 3

2 (1). Anal ring with two rows of pores; marginal quinquelocular pores on posterior abdominal segments noticeably smaller than those on dorsomedial areas ..... *arenae* Ferris
   Anal ring with one row of pores; marginal quinquelocular pores of same size as those on dorsomedial areas ..... *cyperi* (Hall)

3 (1). Posterior setae 110–146 (av. 126) $\mu$ long; quinquelocular pores arranged in three pairs of longitudinal lines on dorsum of abdomen; ventral quinquelocular pores noticeably smaller than those on dorsomedial area of abdomen ..... *raui*, n. sp.
   Posterior setae 73–85 (av. 80) $\mu$ long; quinquelocular pores arranged in four pairs of longitudinal lines on dorsum of abdomen; ventral quinquelocular pores about same size as those on dorsomedial area of abdomen ..... *nudus* (Green)

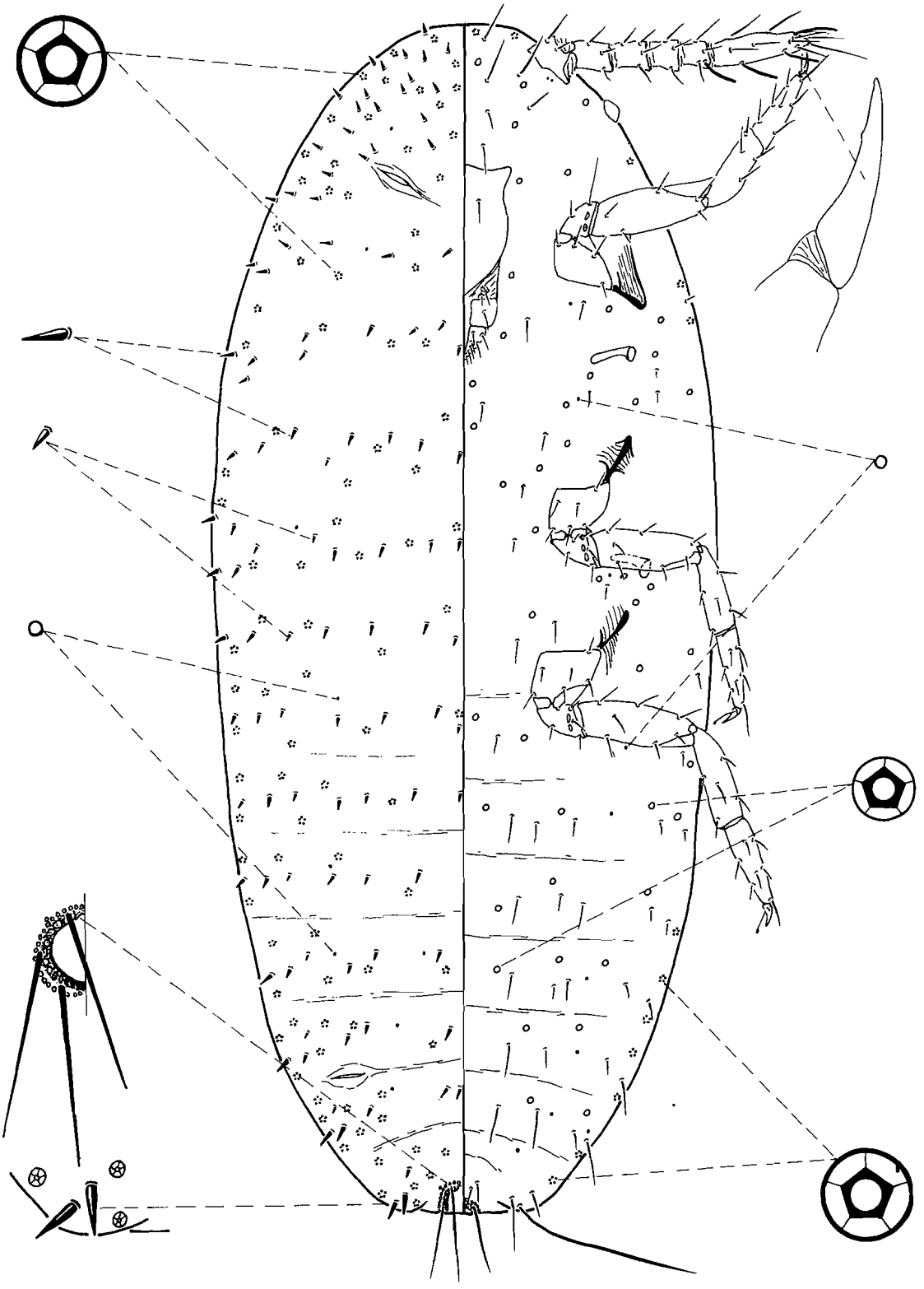


FIGURE 13.—*Heterococcus raui*, n. sp.: Second-instar female.

## General Description of First Instars

The following characters are present on all known first instars of *Heterococcus:*

Body elongate. *Dorsum* with cerarii present at least on anal lobe; anal-lobe cerarii each with two associated cerarian setae, normally one seta is longer and more robust than the other, one quinquelocular pore, no auxiliary setae; remaining cerarii becoming progressively smaller and more indefinite anteriorly, with two associated setae and one sessile pore. Quinquelocular pores present, with distribution relatively constant. Discoidal pores present or absent. Multilocular disk pores and oral-collar tubular ducts absent. Normally with eight, rarely seven, setae on each of abdominal segments VIII–III.

Anal ring with three pairs of setae, ring bent over posterior apex of abdomen.

*Venter* without multilocular disk pores. Quinquelocular pores present, with distribution relatively constant. Discoidal pores in longitudinal line along submargin. Oral-collar tubular ducts absent. Body setae noticeably longer than those on dorsum.

Legs without pores; hind tibia/tarsus ratio 0.8–0.9 (av. 0.9); tibial digitules with apices acute; claw digitules with apices capitate. Antennae six-segmented.

**Notes.**—The first instars of *Heterococcus* differ from all other instars in possessing the following combination of characters: Seven or eight setae on dorsum of abdominal segment V, one pair of longitudinal lines of ventral quinquelocular pores on abdomen, hind tibia/tarsus ratio 0.8 or normally 0.9, hind tibia-tarsus length 80–123 $\mu$, antennae six-segmented, and oral-collar tubular ducts and multilocular disk pores absent.

The first instars of *Heterococcus* differ from those of *Brevennia* in possessing ostioles on both the abdomen and head, claw with or rarely without a denticle, and without swirled trilocular pores. *Brevennia* has ostioles on the abdomen only, claw without a denticle, and swirled trilocular pores.

The first instars of *Heterococcus* differ from those of *Phenacoccus dearnessi* in possessing quinquelocular pores on dorsum, swirled triloculars absent, and three or four pairs of longitudinal lines of pores on dorsum of abdomen. *P. dearnessi* has swirled triloculars on dorsum, quinqueloculars absent, and five or six pairs of longitudinal lines of pores on dorsum of abdomen.

## Species Descriptions

### *Heterococcus arenae* Ferris

First Instar

(Fig. 14)

**Recognition Characters.**—Same as general description of first instars except as follows: Mounted, 0.4–0.8 mm long, 0.2–0.3 mm wide.

*Dorsum* with three to seven pairs of cerarii with three to seven on abdomen and rarely with one near anterior ostioles; anal-lobe cerarii with longest bristle-shaped seta 15–30 (av. 21) $\mu$, each cerarius with zero to one quinquelocular pore; remaining cerarii each with bristle-shaped setae and zero to one quinquelocular pore. Discoidal pores absent. Large quinquelocular pores arranged in three pairs of longitudinal lines on abdomen, scattered over thorax and head; small quinqueloculars present along body margin. Body setae bristle shaped, those on medial portion of segment VIII 10–15 (av. 13) $\mu$ long.

Anal ring with setae about 1½ times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores of large size only, normally distributed as in figure 14, rarely with only one pore near anterior spiracle and on each side of mouth parts. Posterior setae 65–95 (av. 76) $\mu$ long.

Circulus absent. Legs with hind tibia-tarsus length 101–118 (av. 109) $\mu$; claw with small denticle. Antennae 138–170 (av. 153) $\mu$ long.

**Notes.**—This description is based on 16 specimens from 3 localities.

The first instar of this species is most closely related to that of *H. cyperi. H. arenae* differs in possessing two rows of pores around the anal

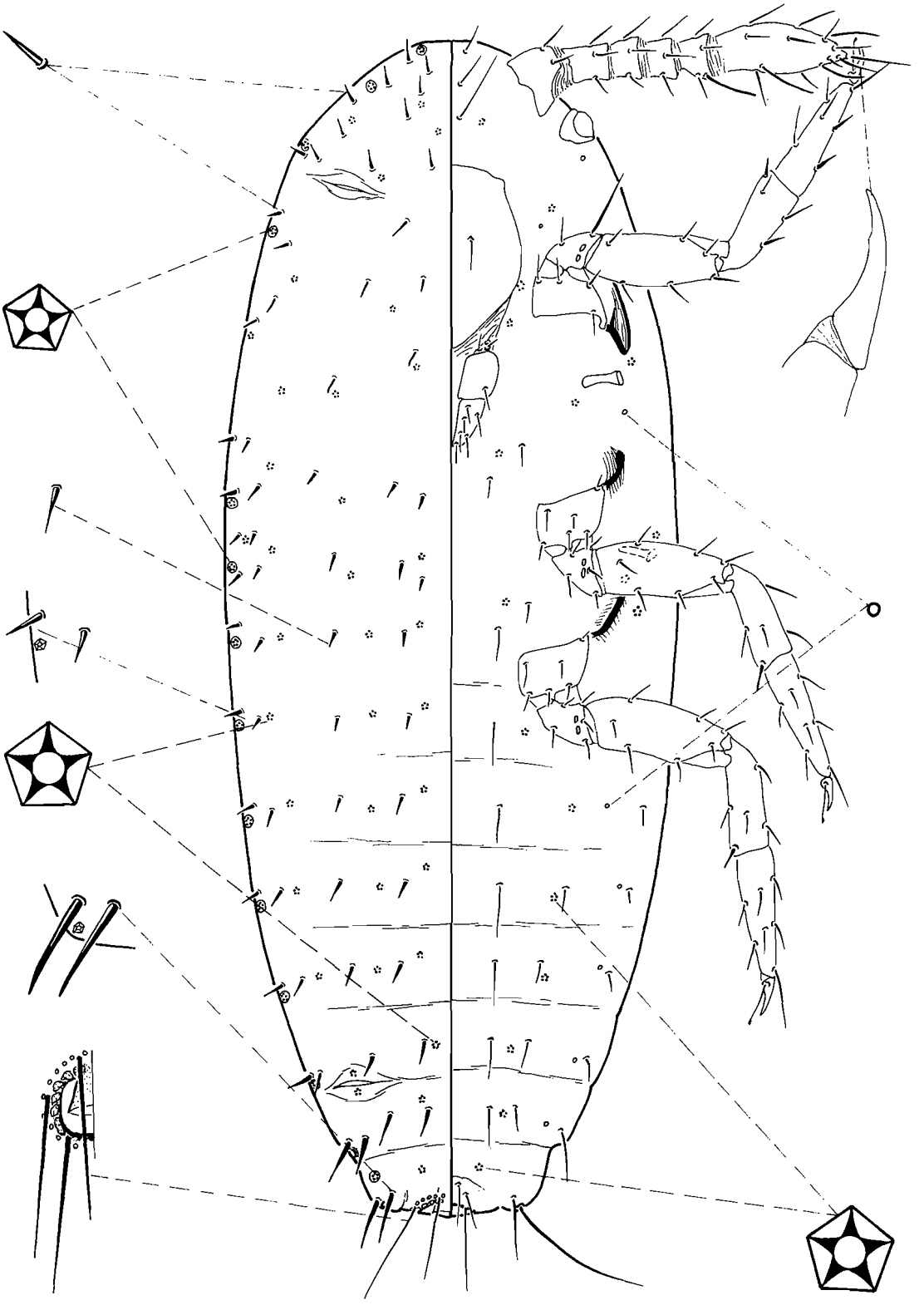


FIGURE 14.—*Heterococcus arenae* Ferris: First instar.

ring, two sizes of quinquelocular pores, and marginal quinquelocular pores smaller than those on remainder of dorsum. *H. cyperi* possesses one row of pores around the anal ring, one size of quinquelocular pore, and marginal quinquelocular pores of same size as those on remainder of dorsum.

If first instars of *H. tritici* were available, it is likely that they would be very similar to those of *H. arenae*.

### *Heterococcus cyperi* (Hall)

#### First Instar (Fully Developed Embryo)

**Recognition Characters.**—Same as general description of first instars except as follows: Mounted, 0.4–0.5 mm long, 0.2–0.3 mm wide.

*Dorsum* with 4–11 pairs of cerarii on abdomen and posterior thorax; anal-lobe cerarii with longest bristle-shaped seta 11–15 (av. 13) $\mu$, each cerarius with 1 quinquelocular pore; remaining cerarii each with bristle-shaped setae and 0–1 quinquelocular pore. Discoidal pores apparently absent. Quinquelocular pores one size, with four pairs of longitudinal lines on abdomen, scattered on thorax and head. Body setae bristle shaped, those on medial portion of segment VIII 10–13 (av. 11) $\mu$ long.

Anal ring with setae slightly longer than greatest diameter of ring, with one row of pores.

*Venter* with quinquelocular pores of same size as those on dorsum, of same distribution pattern as *H. arenae*. Posterior setae 57–65 (av. 61) $\mu$ long.

Circulus absent. Legs with hind tibia-tarsus length about 102 $\mu$; claw with small denticle. Antennae 140–150 (av. 146) $\mu$ long.

**Notes.**—This description is based on 33 specimens from 1 locality.

Unfortunately only embryos were available for this study. Because some of the characteristics were difficult to see, no illustration was made. It is possible when more material is collected that minor changes in the preceding description will be necessary.

The first instar of this species differs from that of all other species of *Heterococcus* in possessing only one row of pores around the anal ring. It is most closely related to *H. arenae*. For a comparison, see "Notes" under the description of the first instar of *H. arenae*.

### *Heterococcus nudus* (Green)

#### First Instar

#### (Fig. 15)

**Recognition Characters.**—Same as general description of first instars except as follows: Mounted, 0.4–0.7 mm long, 0.2–0.3 mm wide.

*Dorsum* with 7–12 pairs of cerarii on abdomen and posterior thorax; anal-lobe cerarii with longest conical seta 7–13 (av. 11) $\mu$, each cerarius with 1 quinquelocular pore; remaining cerarii each with conical setae and 1 quinquelocular pore. Discoidal pores present in small numbers, normally most abundant on thorax and head. Larger quinquelocular pores present along body margin; small quinqueloculars in three pairs of longitudinal lines on abdomen, scattered on thorax and head. Body setae conical, those on medial portion of segment VIII 5–7 (av. 6) $\mu$ long.

Anal ring with setae about two times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores of small size only, normally distributed as shown in figure 15, rarely with only one pore near each anterior spiracle. Posterior setae 73–85 (av. 80) $\mu$ long.

Circulus present on 11 of 31 specimens; 1 locality yielded a mixed infestation of specimens with and without this structure. Legs with hind tibia-tarsus length 106–115 (av. 110) $\mu$; claw with small denticle. Antennae 145–160 (av. 152) $\mu$ long.

**Notes.**—This description is based on 40 specimens from 6 localities.

The first instar of this species is most closely related to the first instar of *H. raui*. *H. nudus* differs in possessing shorter posterior setae (about 80 $\mu$), four pairs of longitudinal lines of quinquelocular pores on dorsum of abdomen, two sizes of quinquelocular pores, and two quinquelocular pores associated with each posterior spiracle. *H. raui* possesses long posterior setae (about 125 $\mu$), three pairs of longitudinal lines of quinquelocular pores on dorsum of abdomen, three sizes of quinquelocular pores, and one quinquelocular pore associated with each posterior spiracle.

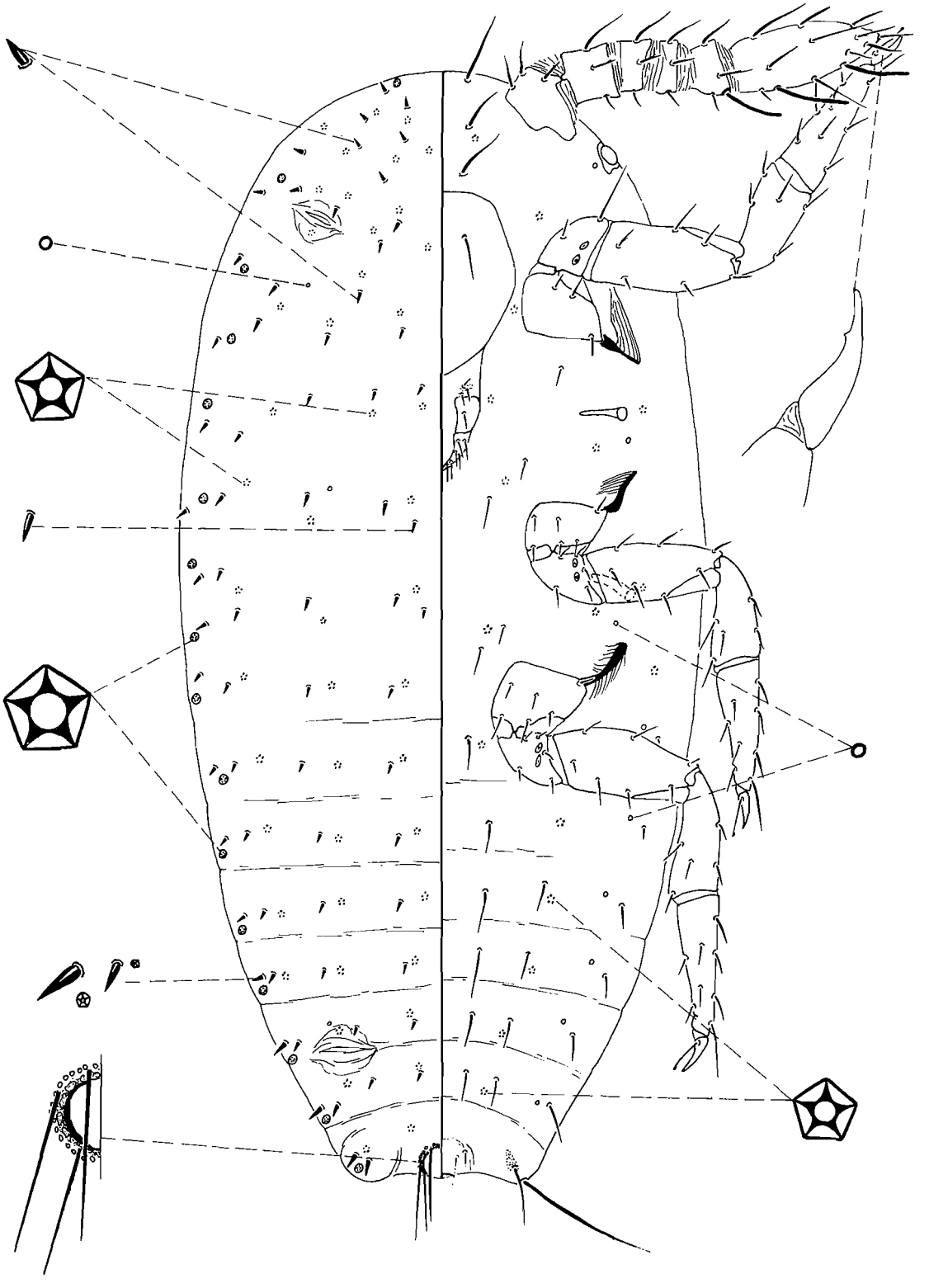


FIGURE 15.—*Heterococcus nudus* (Green): First instar.

### *Heterococcus raui*, n. sp.

First Instar

(Fig. 16)

**Recognition Characters.**—Same as general description of first instars except as follows: Mounted, 0.5–0.7 mm long, 0.2–0.3 mm wide.

*Dorsum* with six to eight pairs of cerarii on abdomen and posterior thorax; anal-lobe cerarii with longest conical seta 10 to 15 (av. 12) $\mu$, each cerarius with one quinquelocular pore; remaining cerarii each with conical setae and one quinquelocular pore. Discoidal pores absent. Quinquelocular pores of two sizes, larger pores along body margin, smaller ones in two pairs of longitudinal lines on abdomen, scattered on thorax and head. Body setae conical, those on medial portion of segment VIII 5–7 (av. 6) $\mu$ long.

Anal ring with setae about 1½ times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores smaller than those on dorsum, sometimes with only three or four loculi, normally distributed as shown in figure 16. Posterior setae 110–146 (av. 126) $\mu$ long.

Circulus absent. Legs with hind tibia-tarsus length 107–123 (av. 116) $\mu$; claw without denticle. Antennae 163–183 (av. 174) $\mu$ long.

**Notes.**—This description is based on 11 specimens from 1 locality.

The first instar of this species is easily distinguished from the first instar of all other species of *Heterococcus* in possessing only three pairs of longitudinal lines on dorsum of abdomen. It is most closely related to *H. nudus*. For a comparison, see "Notes" under the description of the first instar of *H. nudus*.

## Key to Adult Males

1. With conspicuous interocular ridge; with small posterior ostioles; ocelli about 15 $\mu$ in diameter; postocular ridge divided near ocellus . . *nudus* (Green)
   Without interocular ridge; ostioles absent; ocelli about 25 $\mu$ in diameter; postocular ridge undivided . . . . . *raui*, n. sp.

## General Description of Adult Males

The following characters are present on all known fifth-instar males of *Heterococcus:*

Body elongate. *Dorsum* with two pairs of tail-forming pore clusters, one on abdominal segment IX and one on VIII. Multilocular derm pores and discoidal pores present. Scutum sclerotized throughout. Prescutum round or triangular, prescutal ridge well developed. Hamulohaltera present, each with one apical seta. Postocular and preocular ridges present.

Penial sheath divided; posterior portion of sheath sclerotized on both surfaces, sclerotized anteriorly on venter only. Medial lobes absent. Basal rod of aedeagus absent.

*Venter* with multilocular derm pores and discoidal pores. Metepisterna each with two precoxal ridges, anterior ridge long and well developed, touching sternal apophysis. Mesosternal marginal ridge entire. Prosternum and prosternal ridge well developed, with heavily sclerotized area anterior to prosternal ridge. Midcranial ridge poorly developed. Postocular and preocular ridges separate. Cranial apophysis heavily sclerotized.

Legs with mesothoracic pair shortest, metathoracic legs longest; leg setae apically acute; tarsal and claw digitules apically acute.

**Notes.**—The fifth-instar males of *Heterococcus* differ from all other instars in possessing well-developed wings, an aedeagus, tail-forming pore clusters, 3 pairs of eyes, 10-segmented antennae, and no tubular ducts.

The fifth-instar males of *Heterococcus* differ from adult males of *Brevennia* in possessing two pairs of tail-forming pore clusters, preocular and postocular ridges separate though sometimes bridged by interocular ridge, prosternal ridge heavily sclerotized, marginal ridge of basisternum present, inner margin of proepisternum with sclerotized ridge, and basal rod attachment of aedeagus absent. *Brevennia* has one pair of tail-forming pore clusters, preocular

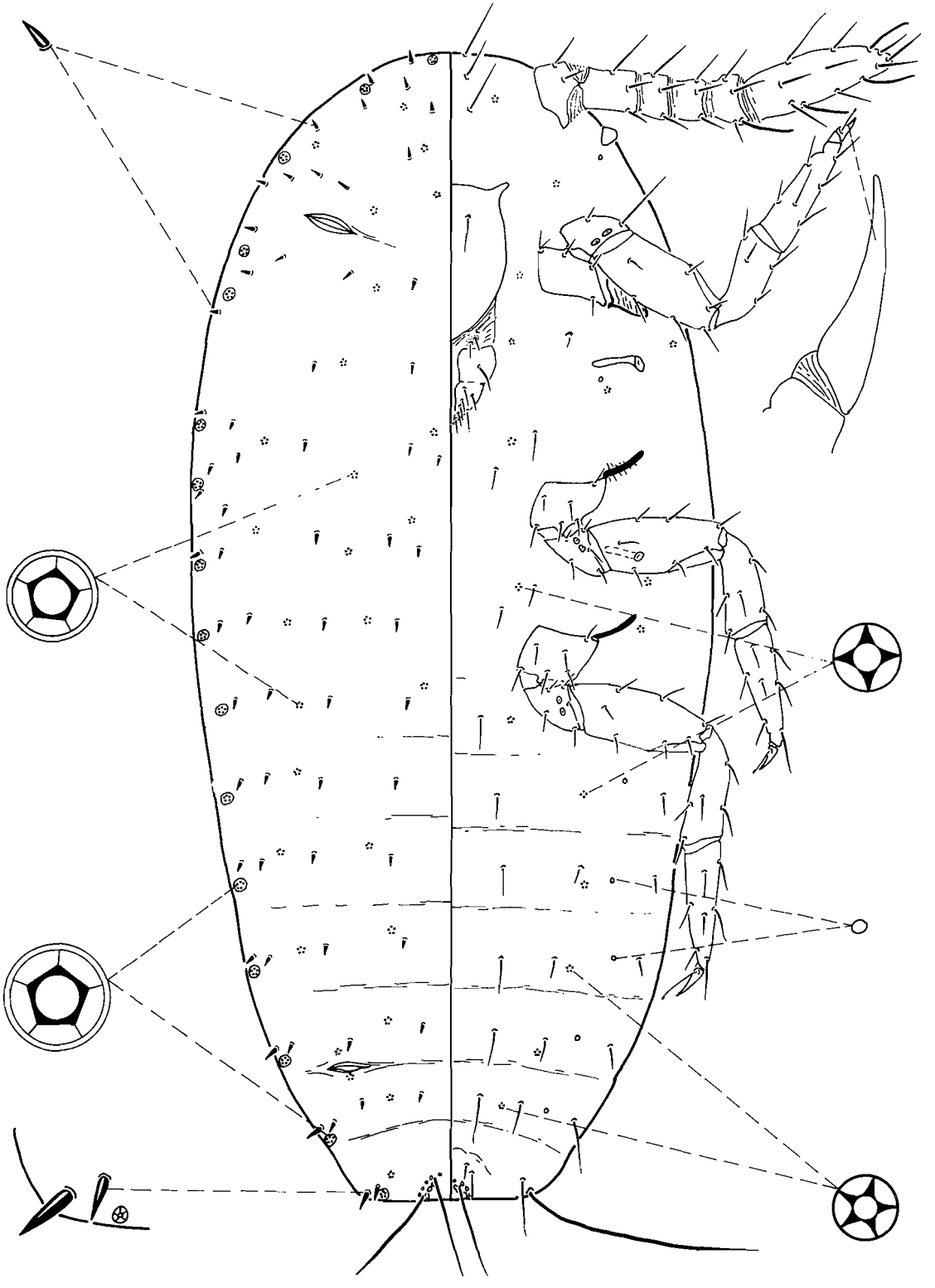


FIGURE 16.—*Heterococcus raui*, n. sp.: First instar.

and postocular ridges fused forming single ocular ridge, prosternal ridge absent, marginal ridge of basisternum absent, inner margin of proepisternum without sclerotized ridge, and basal rod attachment of aedeagus present.

The fifth-instar males of *Heterococcus* and *Phenacoccus dearnessi* are remarkably similar, separable only by characters that appear to be specific rather than generic. *Heterococcus* possesses a weakly developed midcranial ridge, ridge on dorsal side of ocellus bridging preocular and postocular ridges small or absent, interocular ridge well developed or absent, and penial sheath 78–100 μ long. *P. dearnessi* has well-developed midcranial ridge, ridge on dorsal side of ocellus bridging preocular and postocular ridges well developed, interocular ridge small or absent, and penial sheath 125–145 μ long.

## Species Descriptions

### *Heterococcus nudus* (Green)

Adult Male

(Fig. 17)

**Recognition Characters.**—Same as general description of adult males except as follows: Mounted, 0.8–1.1 mm long, 0.2–0.3 mm wide.

*Dorsum* with tail-forming pore clusters on segment IX each with 2 setae 152–205 μ long, 1 seta 20–25 μ long, 27–55 multilocular derm pores, and 1–4 discoidal pores; each cluster on VIII with 2 setae 150–210 μ long, 1 seta 12–20 μ long, 19–35 multilocular derm pores, and 1–4 discoidal pores. Multilocular derm pores normally with four, five, or six loculi, rarely with three or nine, arranged in two pairs of longitudinal lines (mediolateral, lateral), normally distributed as shown in figure 17, sometimes without pore on mediolateral area of abdominal segment VIII, with two or three pores on lateral margin of abdominal segment II, and with one or two pores on lateral margin of prothorax. Discoidal pores of 2 kinds: Clear center pores normally associated with multilocular derm pores and head pores varying from 10 to 16 at base of each antenna. Body setae slightly longer than those on venter, present on all body segments. Abdominal sclerotization weak or absent, when present represented by thin submedial areas near anterior segmental lines of abdominal segments IX, V, IV, III, and sometimes VI and VII. Metapostnotal ridge normally present. Posterior ostioles present, often inconspicuous. Prescutum varying from round to triangular. Mesothoracic wings each with two or three circular sensoria, which may or may not be attached to radial vein, with two setae near wing base. Midcranial ridge either absent or weakly indicated, never touching postoccipital ridge. Postoccipital ridge variable, normally present, often weakly sclerotized, rarely well developed. Ocular and dorsomedial sclerites lightly sclerotized. Dorsal eye 20–28 μ in diameter.

Penial sheath 80–100 μ long, width/length ratio 0.50–0.84; apical portion of sheath narrow, with slightly rounded to acute apex. Ventral slit indefinite, difficult to distinguish anteriorly. Aedeagus 55–75 μ long.

*Venter* with multilocular derm pores with three, four, five, or six loculi, distributed as follows: Rarely with two pores on medial area of abdominal segment IV, normally absent; normally with two pores on medial area of abdominal segment III, rarely absent; rarely with two pores on medial area of abdominal segment II, normally absent; normally with two pores on medial area of metathorax, rarely with three; normally with one pore near each posterior and anterior spiracle, rarely absent; normally with two pores on medial area of prothorax, rarely with three; normally with one pore at base of each antenna. Discoidal pores of clear center type only. Body setae slender, present on all body segments. Postocular ridge well developed, divided near ocellus. Interocular ridge and ridge present on some Phenacoccini dorsad of ocellus, weakly indicated or absent. Preoral ridge weakly developed, unusually elongate for pseudococcid. Mouth small, inconspicuous. Ventral eye 25–30 μ in diameter. Ocellus 13–18 μ in diameter. Head setae present in areas anterior to ventral eyes.

Legs with claws with small denticle. Body length 1.6–1.9 times longer than antennal length;

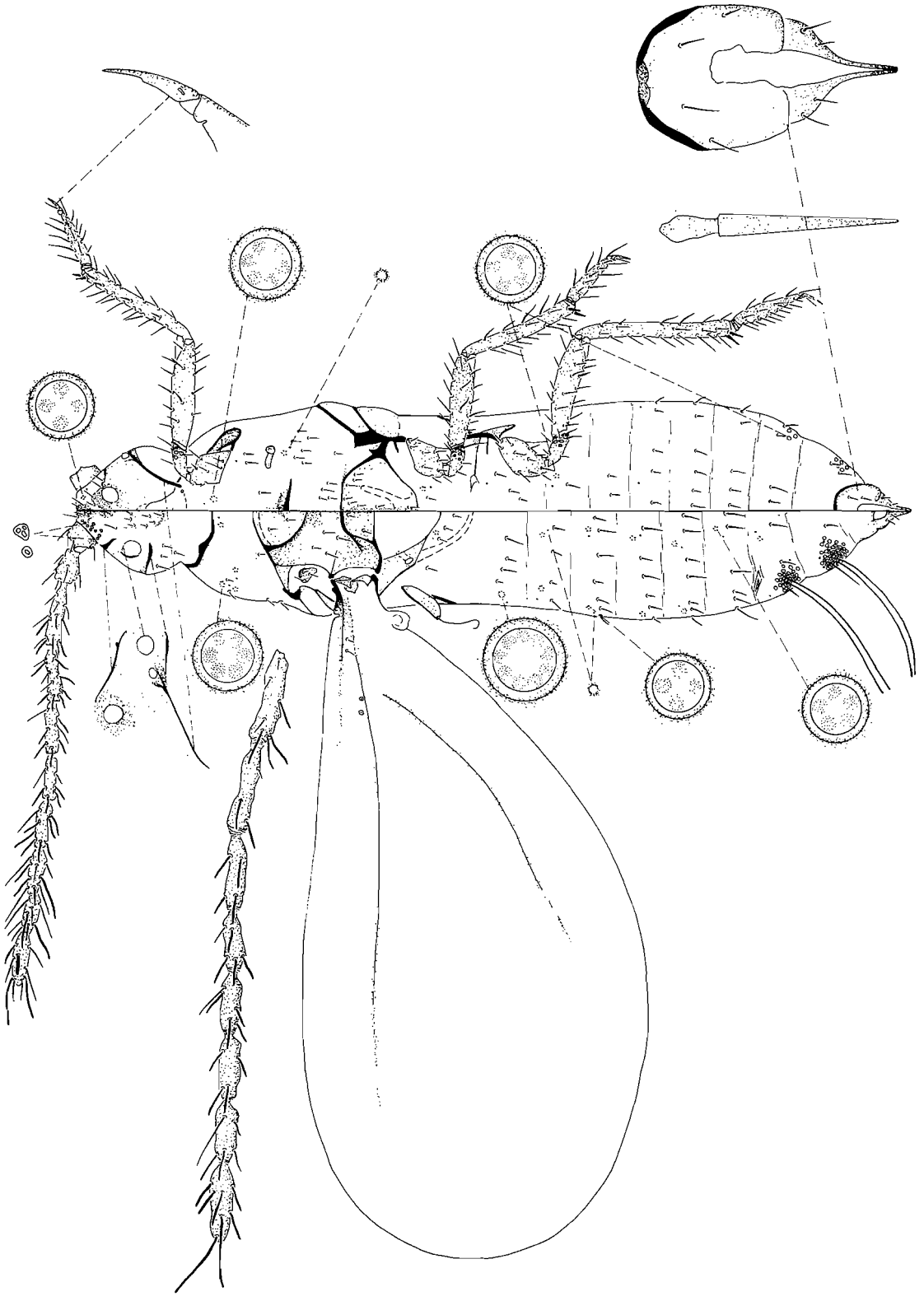


FIGURE 17.—*Heterococcus nudus* (Green): Adult male.

antennae 10-segmented; apical antennal segment noticeably shorter than third antennal segment, ratio of apical segment/segment 3 varies from 0.6 to 0.8. Antennal setae as follows: Thin fleshy setae on segments 3 through 10; hairlike setae on all segments; subapical sensory setae and capitate sensory setae absent; terminal three segments each with at least one antennal bristle.

**Notes.**—This description is based on 22 specimens from 3 localities.

Adult males are known for only two *Heterococcus* species—*H. nudus* and *H. raui*. *H. nudus* differs in possessing postocular ridge that is divided near ocellus, no interocular ridge, small ostiole, multilocular derm pores predominantly with five or six loculi, ocelli about 15 $\mu$ in diameter, and differently shaped penial sheath. *H. raui* has postocular ridge that is undivided, large interocular ridge, ostioles absent, multilocular derm pores predominantly with four loculi, ocelli about 25 $\mu$ in diameter, and differently shaped penial sheath.

### *Heterococcus raui*, n. sp.

Adult Male

(Fig. 18)

**Recognition Characters.**—Same as general description of adult males except as follows: Allotype mounted, 1.1 mm long, 0.3 mm wide.

*Dorsum* with tail-forming pore clusters; on segment IX each with 2 setae approximately 100 $\mu$ long, 1 or 2 setae about 15 $\mu$ long, 30–41 multilocular derm pores, and 3 or 4 discoidal pores; each cluster on segment VIII with 2 setae about 160 $\mu$ long, 1 or 2 setae about 12 $\mu$ long, 24–47 multilocular derm pores, and 1 or 2 discoidal pores. Multiocular derm pores normally with four loculi, rarely with five, arranged in two pairs of longitudinal lines (mediolateral, lateral) on abdomen, with one pore on each side of prothorax, absent on head. Discoidal pores of two kinds: Clear center pores normally associated with multilocular derm pores, head pores varying from one to three at base of each antenna. Body setae slightly longer than those on venter, present over surface. Abdominal sclerotization present on medial area near anterior margin of abdominal segments IX, VIII, VII, VI, IV, and III. Metapostnotal ridge present. Ostioles absent. Prescutum triangular. Mesothoracic wings each with one circular sensoria and three setae near wing base. Midcranial ridge poorly developed, most conspicuous at anterior end of head, never touching postoccipital ridge. Postoccipital ridge weakly sclerotized. Ocular sclerites lightly sclerotized. Dorsomedial sclerite sclerotized only near midcranial and postoccipital ridges. Dorsal eye 23–25 $\mu$ in diameter.

Penial sheath 78 $\mu$ long, width/length ratio about 0.68; apical portion of sheath narrow, with acute apex. Ventral slit not seen. Aedeagus 70 $\mu$ long.

*Venter* with multilocular derm pores with four loculi, distributed as follows: One present on segment III, one near each anterior spiracle, and one between each posterior and each anterior pair of legs. Discoidal pores of clear center type, normally associated with multilocular derm pores. Body setae slender, present over surface. Postocular ridge well developed, not divided near ocellus. Interocular ridge well developed. Preoral ridge elongate. Mouth not found. Ventral eye 23–28 $\mu$ in diameter. Ocellus about 25 $\mu$ in diameter. Head setae present anterior to ventral eyes.

Legs with claws with denticle represented only by small swollen area. Antennae broken.

**Notes.**—This description is based on a single specimen.

Adult males are known only for *H. nudus* and *H. raui*. For a comparison of these species, see "Notes" under *H. nudus*.

## Fourth-Instar Males (Pupae)

Because the fourth-instar male is known for only one species of *Heterococcus*, it is impossible to present a general description of this instar.

**Notes.**—The fourth-instar males of *Heterococcus* differ from all other instars in possessing lateral sclerotized plates on posterior abdominal segments, 10-segmented antennae, wing buds, and no tubular ducts.

The fourth-instar males of *Heterococcus* and

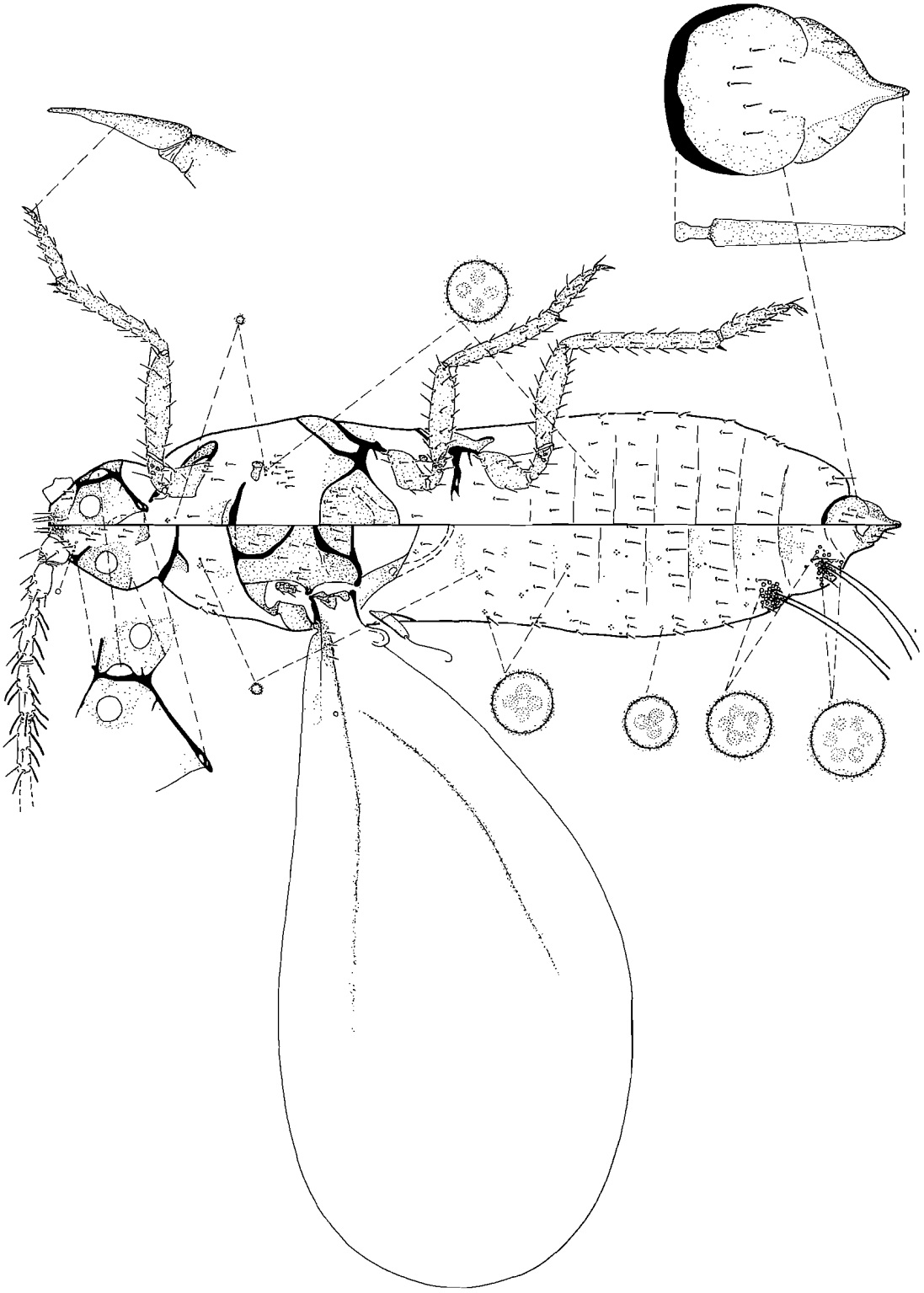


FIGURE 18.—*Heterococcus rawi*, n. sp.: Adult male.

*Brevennia* are apparently similar. The pupae of *Heterococcus* have two pairs of lateral plates, whereas those of *Brevennia* have only one. More differences may exist, but because no good material of *Brevennia* pupae has been available, these differences must await the discovery of more specimens.

The fourth-instar males of *Heterococcus* differ from the pupae of *Phenacoccus dearnessi* in possessing two pairs of lateral sclerotized plates on abdomen and ostioles are present. *P. dearnessi* possesses four lateral sclerotized plates and ostioles are absent.

## Species Description

### *Heterococcus nudus* (Green)

Fourth-Instar Male (Pupa)

(Fig. 19)

**Recognition Characters.**—Mounted, 1 mm long, 0.3 mm wide.

*Dorsum* with one pair of elongate, lateral setae on each margin of abdominal segments IX and VIII, these setae all about equal in size, approximately 33 $\mu$ long, without associated pores. Multilocular disk pores variable in size, not divided into loculi, present on submedial and sublateral areas of each of abdominal segments VIII-II, also on metathorax, prothorax, and anterior margin of head, absent on abdominal segments X and IX and mesothorax. Discoidal pores associated with multilocular disk pores. Oral-collar tubular ducts absent. Body setae noticeably robust and elongate on posterior abdominal segments, becoming progressively thinner and shorter anteriorly. Hamulohaltera present, wing shaped. Front wing buds about 340 $\mu$ long, partially sclerotized. Sclerotization present on lateral areas of abdominal segments IX and VIII, also in small patches on medial and sublateral areas of abdominal segments IX, VIII, and VII. Posterior ostioles present. Postocular ridge represented by broad sclerotized band, ocular sclerites not sclerotized, dorsal eye not evident.

Penial sheath undivided, sclerotized dorsally and ventrally; anal opening dorsal. Genital slit represented by small invagination. Width/length ratio of capsule about 0.8.

*Venter* with each lateral margin of abdominal segments IX and VIII with heavily sclerotized, posteriorly projecting plates; each plate normally with simple apex and one seta on anterior margin, plate on abdominal segment IX at least twice as long as plate on segment VIII. Multiloculars of same variable types as on dorsum, present on sublateral and lateral areas of abdominal segments VIII–IV or III, also present near each leg, spiracle, and antenna, sometimes present on lateral margin near anterior spiracle. Discoidal pores associated with multiloculars. Oral-collar tubular ducts absent. Body setae noticeably shorter than those on dorsum except on head where slightly longer. Postocular ridge present. Ventral eyes not evident. Sclerotization between eyes absent. Mesothoracic apophysis (furca) readily apparent. Mouth and ventral cavity weakly indicated.

Legs well developed, setae obvious. Antennae weakly divided into 10 segments.

**Notes.**—This description is based on three specimens from two localities.

The lateral plates on the margin of the abdomen of this pseudococcid make it a typical member of the "Phenacoccus group." For additional information on the pupae of the group, see Miller and Appleby (*1971*).

The pupae of *H. nudus* and *Phenacoccus dearnessi* are remarkably similar. *P. dearnessi* differs in possessing four pairs of lateral plates on the abdomen and large, heavily sclerotized postocular ridges. *H. nudus* has two pairs of lateral plates and small, weakly sclerotized postocular ridges.

## Third-Instar Males (Prepupae)

Because the third-instar male is known for only one species of *Heterococcus*, it is impossible to present a general description of this instar.

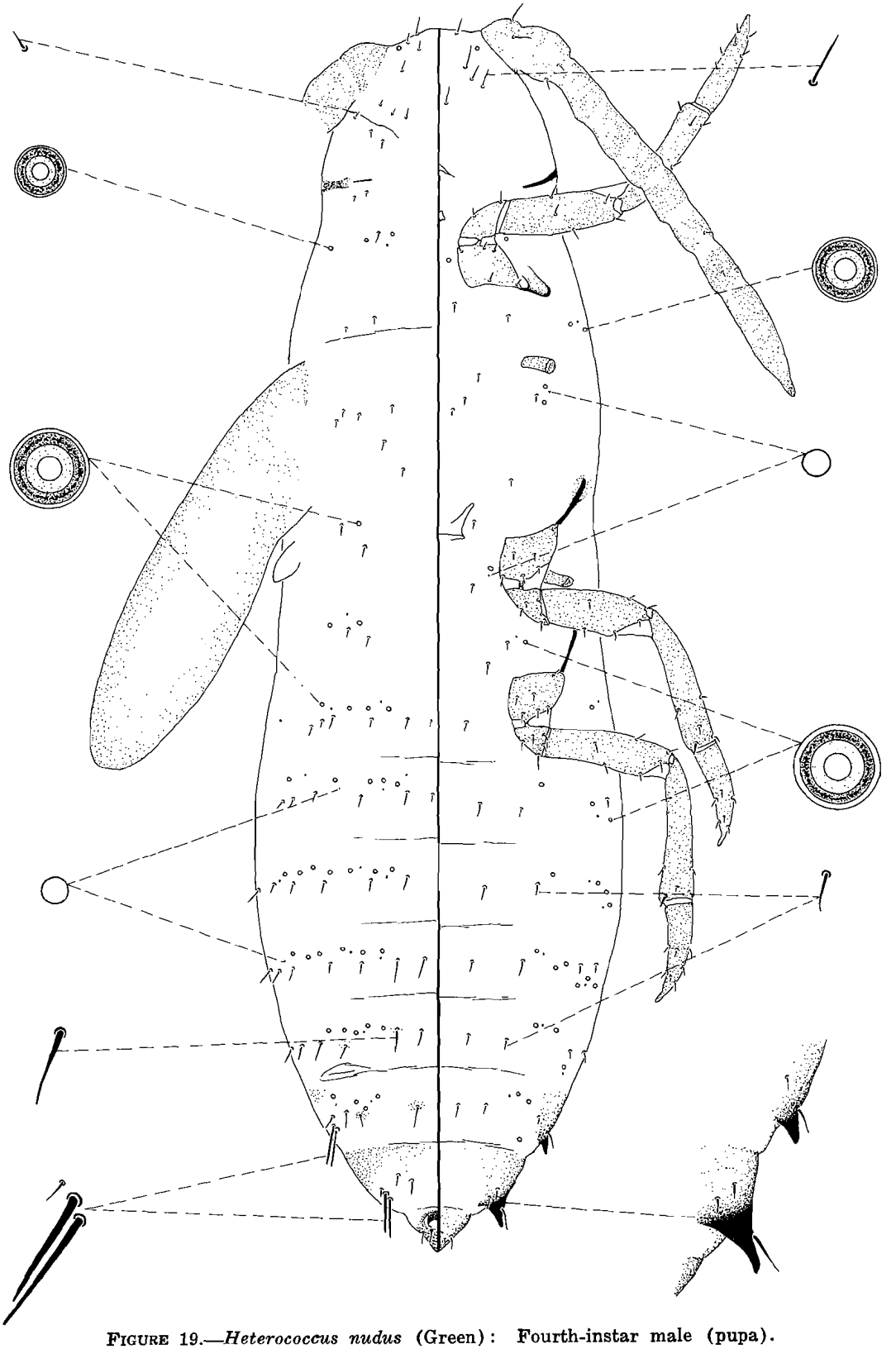


FIGURE 19.—*Heterococcus nudus* (Green): Fourth-instar male (pupa).

**Notes.**—The third-instar males of *Heterococcus* differ from all other instars in possessing wing buds, abortive anal ring, nine-segmented antennae, no lateral sclerotized plates, and no tubular ducts.

The third-instar males of *Brevennia* have not been available for this study.

The third-instar males of *Heterococcus* differ from the prepupae of *Phenacoccus dearnessi* in possessing lateral margins of abdominal segment IX produced into lobes, "cerarian" cluster of setae on lateral margins of segments IX and VIII, multilocular disk pores normally with 11 loculi, and no oral-collar tubular ducts. *P. dearnessi* has lateral margins of abdominal segments IX–VII or VI produced into lobes and with "cerarian" clusters, multilocular disk pores with five to nine loculi, and oral-collar tubular ducts on both body surfaces.

## Species Description

### *Heterococcus raui*, n. sp.

### Third-Instar Male (Prepupa)

**Recognition Characters.**—Mounted, 0.9–1.1 mm long, about 0.4 mm wide.

*Dorsum* with lateral margins of abdominal segment IX produced into posterior lobe. Marginal areas of abdominal segments IX and VIII each with one pair of elongate setae about 33 $\mu$ long giving appearance of cerarii. Multilocular disk pores with 8–13 loculi, normally with 11, present on abdominal segment VIII–head, becoming less numerous anteriorly. Discoidal pores rare or absent, not associated with multilocular disk pores. Oral-collar tubular ducts absent. Body setae noticeably robust on posterior abdominal segments, becoming progressively thinner anteriorly. Hamulohaltera indicated only by small wrinkled area. Front wing buds about 113 $\mu$ long, lightly sclerotized. Sclerotization restricted to lateral areas of posterior abdominal segments. Posterior ostioles present.

Abdominal segment X with complete sclerotized ring, without associated pores or setae. Anal ring dorsal, touching abdominal apex.

*Venter* with multilocular disk pores of same kinds as on dorsum, present over surface except on segments X and IX, most abundant on lateral areas of abdominal segments VIII and VII. Discoidal pores apparently absent. Oral-collar tubular ducts absent. Body setae noticeably shorter than those on dorsum. Entire surface unsclerotized.

Legs small and poorly developed. Antennae weakly divided into nine segments.

**Notes.**—This description is based on two very poor specimens from one locality.

## Key to Second-Instar Males

1. Ventromedial quinquelocular pores noticeably smaller than those on dorsum; posterior setae 115–138 (av. 127) $\mu$ long ..... *raui*, n. sp.
   Ventromedial quinquelocular pores about same size as those on dorsum; posterior setae 68–115 (av. 97) $\mu$ long ..... 2

2 (1). Dorsal body setae elongate, bristle shaped; with few posteromarginal quinqueloculars noticeably smaller than remaining quinquelocular pores; longest cerarian seta 20–25 (av. 20) $\mu$ ..... *arenae* Ferris
   Dorsal body setae short, conical; posteromarginal quinqueloculars either equal to or larger than remaining quinquelocular pores; longest cerarian seta 11–18 (av. 12) $\mu$ ..... *nudus* (Green)

## General Description of Second-Instar Males

The following characters are present on all known second-instar males of *Heterococcus:*

The general characteristics of the second-instar female apply to the second-instar male except as follows:

*Dorsum* with anal-lobe cerarii each with two

to four sessile pores; remaining cerarii with or without associated quinquelocular pores. Oral-collar tubular ducts present.

*Venter* with oral-collar tubular ducts.

Circulus normally absent, rarely present. Legs with claw denticle.

**Notes.**—The second-instar males of *Heterococcus* differ from all other instars in possessing the following combination of characters: 12–14, normally 13, setae on dorsum of abdominal segment V, ventral quinquelocular pores scattered over surface, hind tibia/tarsus ratio 1–1.2, hind tibia-tarsus length 114–151 μ, antennae 6-segmented, oral-collar tubular ducts present, and no multilocular disk pores.

The second-instar males of *Heterococcus* differ from those of *Phenacoccus dearnessi* in possessing quinquelocular pores on dorsum, no swirled triloculars, and six-segmented antennae. *P. dearnessi* has swirled trilocular pores on dorsum, no quinquelocular pores, and seven-segmented antennae.

## Species Descriptions

### *Heterococcus arenae* Ferris

### Second-Instar Male

### (Fig. 20)

**Recognition Characters.**—Same as general description of second-instar males except as follows: Mounted, 0.8–1.4 mm long, 0.3–0.5 mm wide.

*Dorsum* with three to seven pairs of cerarii, all on abdomen; anal-lobe cerarii with bristle-shaped setae 20–25 (av. 22) μ long and no basal sclerotization; remaining cerarii each with bristle-shaped setae and zero to three quinquelocular pores. Discoidal pores few, forming longitudinal line on submargin. Oral-collar tubular ducts often with associated rim, present over surface, most abundant along body margin, sometimes absent on medial area of abdomen. Quinquelocular pores of two sizes, larger size pores scattered over surface, smaller size restricted to marginal areas, present around entire margin or restricted to posterior abdominal segments. Body setae bristle shaped, those on medial portion of segment VIII 11–16 (av. 13) μ long.

Anal ring either bent over apex of abdomen or dorsal, touching abdominal apex; setae about 1½ to two times as long as greatest diameter of ring, with two, rarely three, rows of pores.

*Venter* with quinquelocular pores normally of one size, same as large size on dorsum, rarely with few smaller pores along body margin. Oral-collar tubular ducts often smaller than those on dorsum, scattered along body margin, normally with one present near each leg, absent medially on abdomen. Posterior setae 68–110 (av. 93) μ long.

Circulus present on one of six specimens. Legs with hind tibia/tarsus ratio 1–1.1 (av. 1.1); tibia-tarsus length 114–144 (av. 130) μ; claw digitules with apices unequal in size. Antennae 170–195 (av. 188) μ long.

**Notes.**—This description is based on six specimens from four localities.

The second-instar male of this species differs from other known second-instar males in possessing bristle-shaped dorsal setae and a few small marginal quinquelocular pores. The second-instar males of *H. tritici* would probably be similar to those of *H. arenae* if available.

### *Heterococcus nudus* (Green)

### Second-Instar Male

### (Fig. 21)

**Recognition Characters.**—Same as general description of second-instar males except as follows: Mounted, 0.6–0.9 mm long, 0.3–0.4 mm wide.

*Dorsum* with 7–12 pairs of cerarii, with 6–11 on abdomen and posterior thorax, 0–2 located near anterior spiracle, and 0–1 located near eye; each ocular pair, when present, with 3 setae; anal-lobe cerarii with conical setae 11–18 (av. 15) μ long and sometimes with small amount of basal sclerotization; remaining cerarii each with conical setae and 1–4 quinquelocular pores. Discoidal pores scattered over surface. Oral-collar tubular ducts present over surface, normally most abundant laterally and medially. Quinquelocular pores basically of one size, lateral pores sometimes slightly larger. Body setae conical, those on medial portion of segment VIII 7–11 (av. 9) μ long.

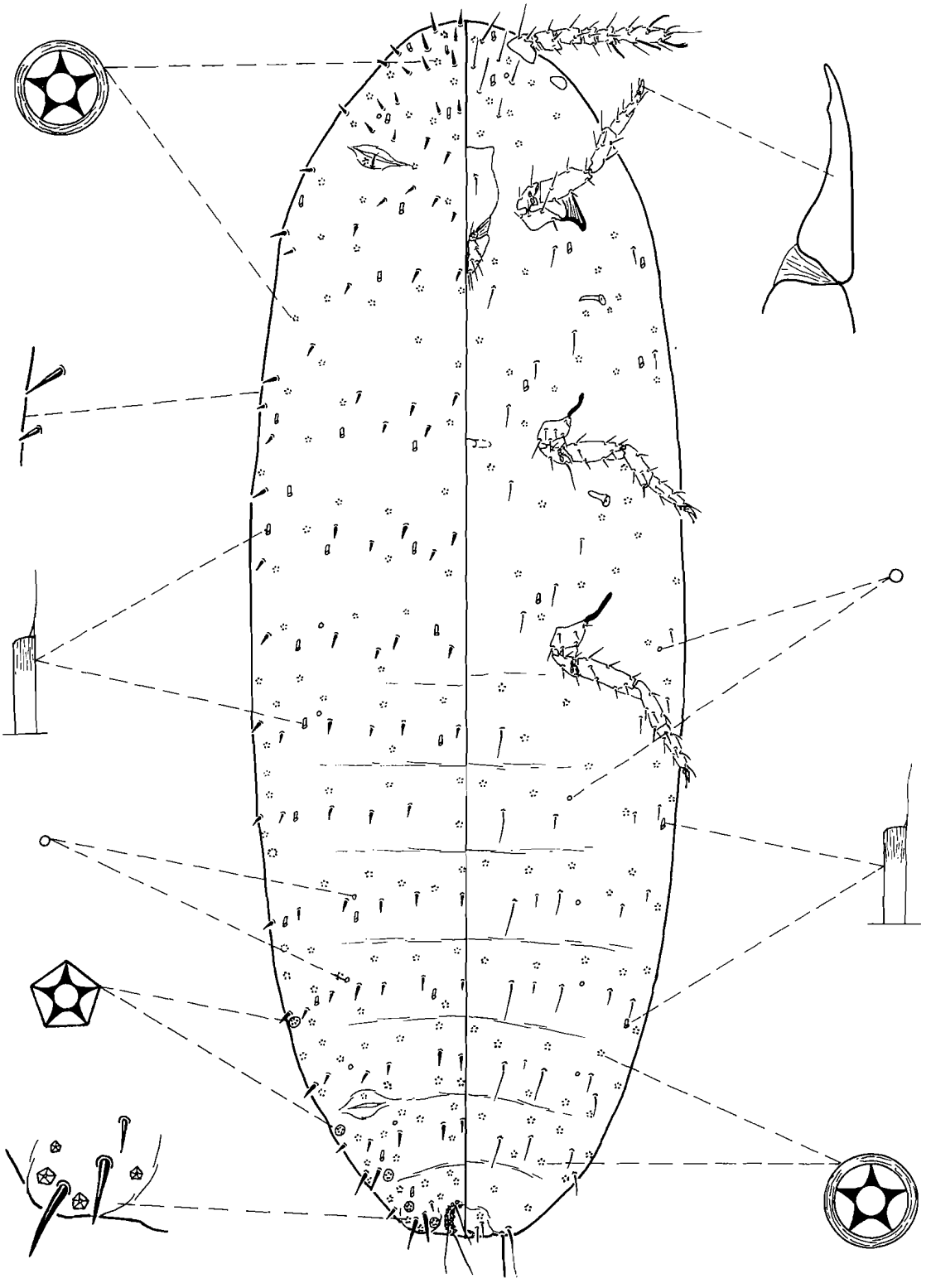


FIGURE 20.—*Heterococcus arenae* Ferris: Second-instar male.

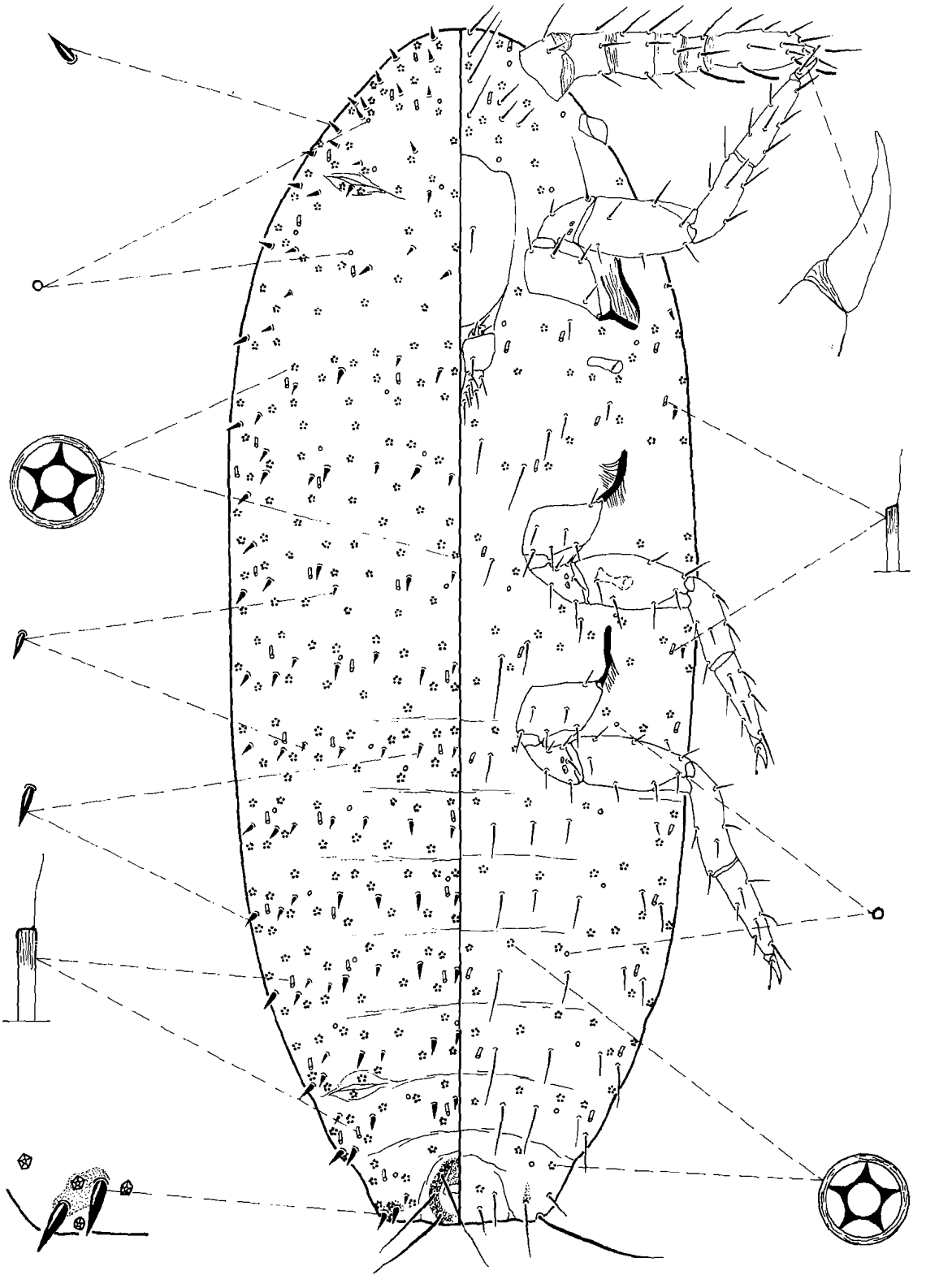


FIGURE 21.—*Heterococcus nudus* (Green): Second-instar male.

Anal ring either bent over posterior apex of abdomen or dorsal, touching abdominal apex; setae about two times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores smaller than those on dorsum, present over surface. Oral-collar tubular ducts of same size as on dorsum, present on abdomen medially and laterally, scattered over thorax and head. Posterior setae 93–115 (av. 103) $\mu$ long.

Circulus absent. Legs with hind tibia/tarsus ratio 1–1.1 (av. 1.1); tibia-tarsus length 124–141 (av. 131) $\mu$; claw digitules with apices unequal in size. Antennae 168–185 (av. 177) $\mu$ long.

**Notes.**—This description is based on 21 specimens from 9 localities.

The second-instar males of this species are most similar to the same instar male of *H. raui*. It is easily separated in possessing dorsomedial quinquelocular pores that are about the same size as those on the venter and posterior setae 93–115 (av. 103) $\mu$ long. *H. raui* has dorsomedial quinquelocular pores that are conspicuously larger than those on the venter and posterior setae 115–138 (av. 127) $\mu$ long.

### *Heterococcus raui*, n. sp.

Second-Instar Male

(Fig. 22)

**Recognition Characters.**—Same as general description of second-instar males except as follows: Mounted, 0.7–1.1 mm long, 0.3–0.5 mm wide.

*Dorsum* with five to seven pairs of cerarii, normally restricted to abdomen, rarely with one on head; anal-lobe cerarii with conical setae about 10 $\mu$ long, without basal sclerotization; remaining cerarii each with conical setae and zero to two quinquelocular pores. Discoidal pores few, normally restricted to longitudinal line on submargin. Oral-collar tubular ducts present over surface. Quinquelocular pores of one size, although marginal pores sometimes appearing slightly larger than those on medial area. Body setae conical, those on medial portion of segment VIII 7–8 (av. 7) $\mu$ long. Segment V with 12 or 13 (av. 13) setae.

Anal ring bent over abdominal apex; setae about 1½ to two times as long as greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores of two sizes, larger size present along margin, same as on dorsum, smaller size present on medial and mediolateral areas. Oral-collar tubular ducts of same size as on dorsum, scattered over surface, most abundant along body margin. Posterior setae 115–138 (av. 127) $\mu$ long.

Circulus absent. Legs with hind tibia/tarsus ratio 1.1–1.2 (av. 1.1); hind tibia-tarsus length 136–151 (av. 145) $\mu$; claw digitules with apices equal in size. Antennae 173–213 (av. 197) $\mu$ long.

**Notes.**—This description is based on six specimens from one locality.

The second-instar males of this species are most similar to the same instar male of *H. nudus*. For a comparison, see "Notes" under the second-instar male of *H. nudus*.

## Genus BREVENNIA Goux

Because of the confusion surrounding *Brevennia* and *Heterococcus*, a generic diagnosis and a description of a characteristic species of *Brevennia* are included so that they may be compared with the generic diagnosis and the species descriptions of *Heterococcus*.

*Brevennia* Goux 1940: 58 (as a sub. gen. of *Ripersia*). Type-species: *Ripersia* (*Brevennia*) *tetrapora* Goux 1940. Orig. design. and monotypy.

**Diagnosis.**—*Fourth-instar female (adult).*—Dorsal and ventral quinquelocular pores more numerous than other pores; swirled trilocular pores present in small numbers at least in anal-lobe cerarii or near spiracles (apparently absent on one species); claw without denticle (present on one species); ostioles on abdomen only (also on thorax on one species); antennae six- or seven-segmented (eight- or nine-segmented on one species); elongate body; at least one pair of cerarii; oral-collar tubular ducts at least two times longer than wide; circulus absent; tarsal digitules with acute apices; multilocular disk pores larger than quinqueloculars.

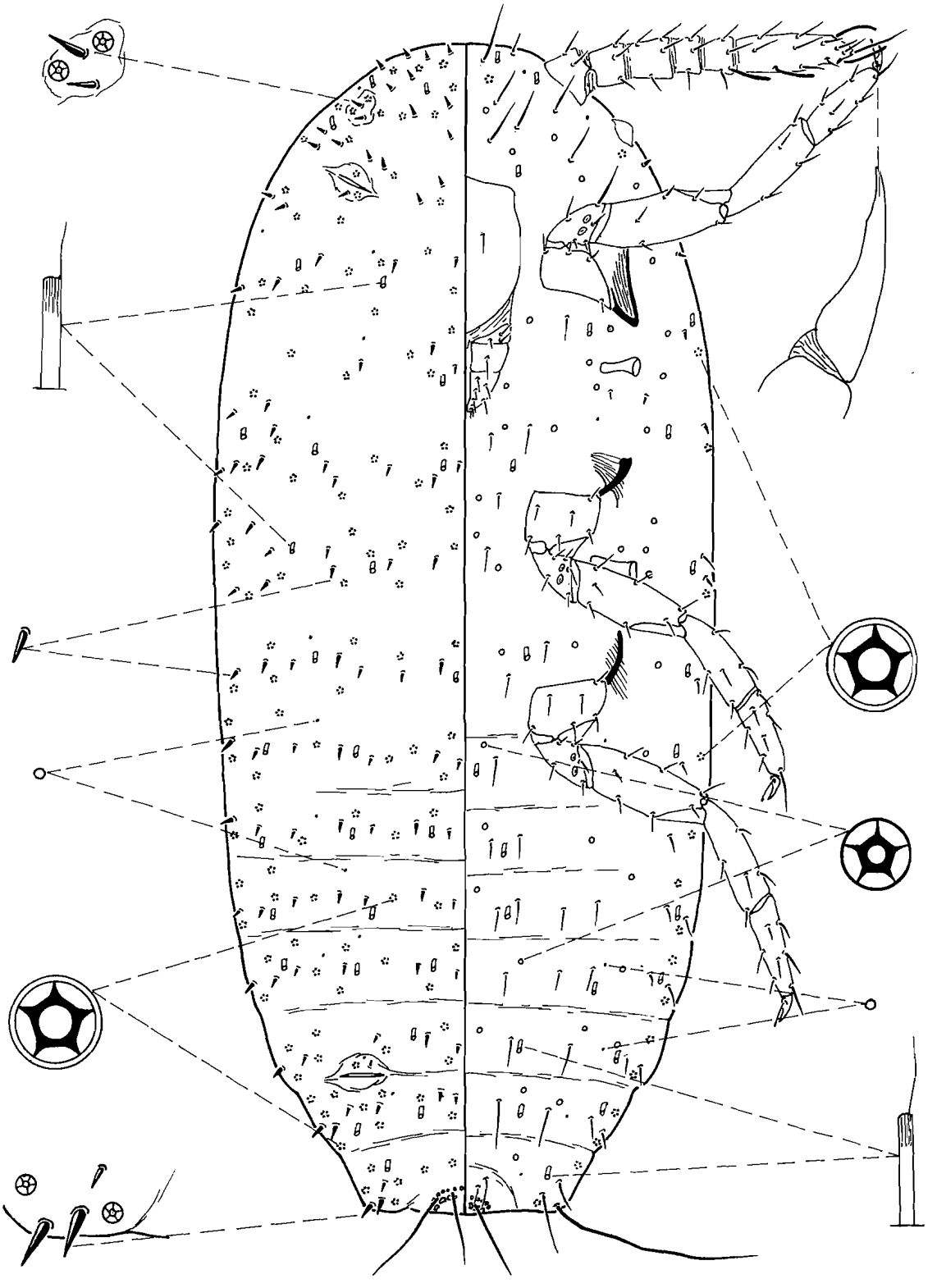


FIGURE 22.—*Heterococcus raui*, n. sp.: Second-instar male.

*Third-instar female, second-instar female, first instar, and second-instar male.*—Quinquelocular pores on both body surfaces; swirled trilocular pores present in small numbers; claw without denticle; anterior ostioles absent; without multilocular disk pores.

*Fifth-instar male (adult).*—One pair of tail-forming pore clusters; preocular and postocular ridges fused; prosternal ridge absent; marginal ridge of basisternum absent; basal rod attachment of aedeagus present.

*Fourth-instar male (pupa).*—With one lateral sclerotized plate.

*Third-instar male (prepupa).*—Unknown.

**Notes.**—Unfortunately material of the type-species has been unavailable for this study. It has therefore been necessary to depend entirely on Goux's original description of *B. tetrapora.*

Although Goux's description agrees relatively well with the preceding diagnosis, there are two characters that differ and are worth consideration. Goux mentioned nonlocular pores, which I assume must be the same as discoidal pores, and stated that on the holotype they are more numerous and more uniformly dispersed than the quinquelocular pores. To my knowledge, this does not occur on any other species of *Brevennia.* However, at the end of his discussion, under "Variations," he stated that some specimens possess many more quinqueloculars than mentioned in his original description. Therefore it is possible that the holotype is aberrant and that the rest of the series is more like a typical species of *Brevennia.* Goux was also very positive that trilocular pores are absent. If this is so, it would also be the only instance of a *Brevennia* species lacking this type of pore. Because trilocular pores have often been overlooked on other species of *Brevennia,* it is entirely possible that Goux missed them when describing *B. tetrapora.*

If Goux's description of the type-species of *Brevennia* is correct, it will be necessary to describe a new genus for the remaining species included here in this genus and leave *Brevennia* monotypic. However, because *B. tetrapora* is very similar to the other species, it seems best to leave the genus as it is until material of *B. tetrapora* can be examined.

The following species are here considered as members of the genus *Brevennia:*

(1) *asphodeli* (Bodenheimer) (new combination)
(2) *femoralis* Borchsenius
(3) *filictus* (DeLotto) (new combination)
(4) *krishtali* Tereznikova
(5) *nigeriensis* (Williams) (new combination)
(6) *pulverarius* (Newstead) (new combination)
(7) *rehi* (Lindinger)
(8) *tetrapora* (Goux)

## *Brevennia rehi* (Lindinger)

*Ripersia sacchari* Green, Maxwell-LeFroy 1908: 128 (misidentification).
*Ripersia sacchari niger* Fletcher 1916: 62 (nomen nudum).
*Ripersia sacchari oryzae* Fletcher 1917: 177 (junior primary homonym of *Ripersia oryzae* Kuwana 1908).
*Ripersia oryzae* Green 1931: 557.
*Ripersia rehi* Lindinger 1943a: 152.
*Tychea rehi* (Lindinger), Lindinger 1943: 264.
*Heterococcus rehi* (Lindinger), Williams 1970: 141.
*Heterococcus tuttlei* Miller and McKenzie 1970: 447.
*Brevennia rehi* (Lindinger), Miller 1973: 372.

### Adult Female
### (Fig. 23)

**Recognition Characters.**—Mounted, 1.2–2.7 mm long, 0.5–1.3 mm wide.

*Dorsum* with one to four pairs of cerarii, normally two or three, all restricted to posterior abdominal segments; anal-lobe cerarii with somewhat robust, bristle-shaped setae 13–25 (av. 19) $\mu$ long, with auxiliary setae absent, two or three associated multilocular pores, and zero to three quinquelocular pores, without basal sclerotization; remaining cerarii each represented by one or two bristle-shaped setae noticeably more robust than other body setae and with two to five associated multilocular pores. Discoidal pores abundant over surface. Quinquelocular pores of one size scattered over surface. Multilocular disk pores present in medial areas on posterior margin of abdominal segments VIII–VII or VI, absent on anterior margins; present on lateral areas of abdominal segments IX–VIII, VI, or V and on head, present or absent on thoracic margin, when present, reduced to small numbers. Swirled trilocular

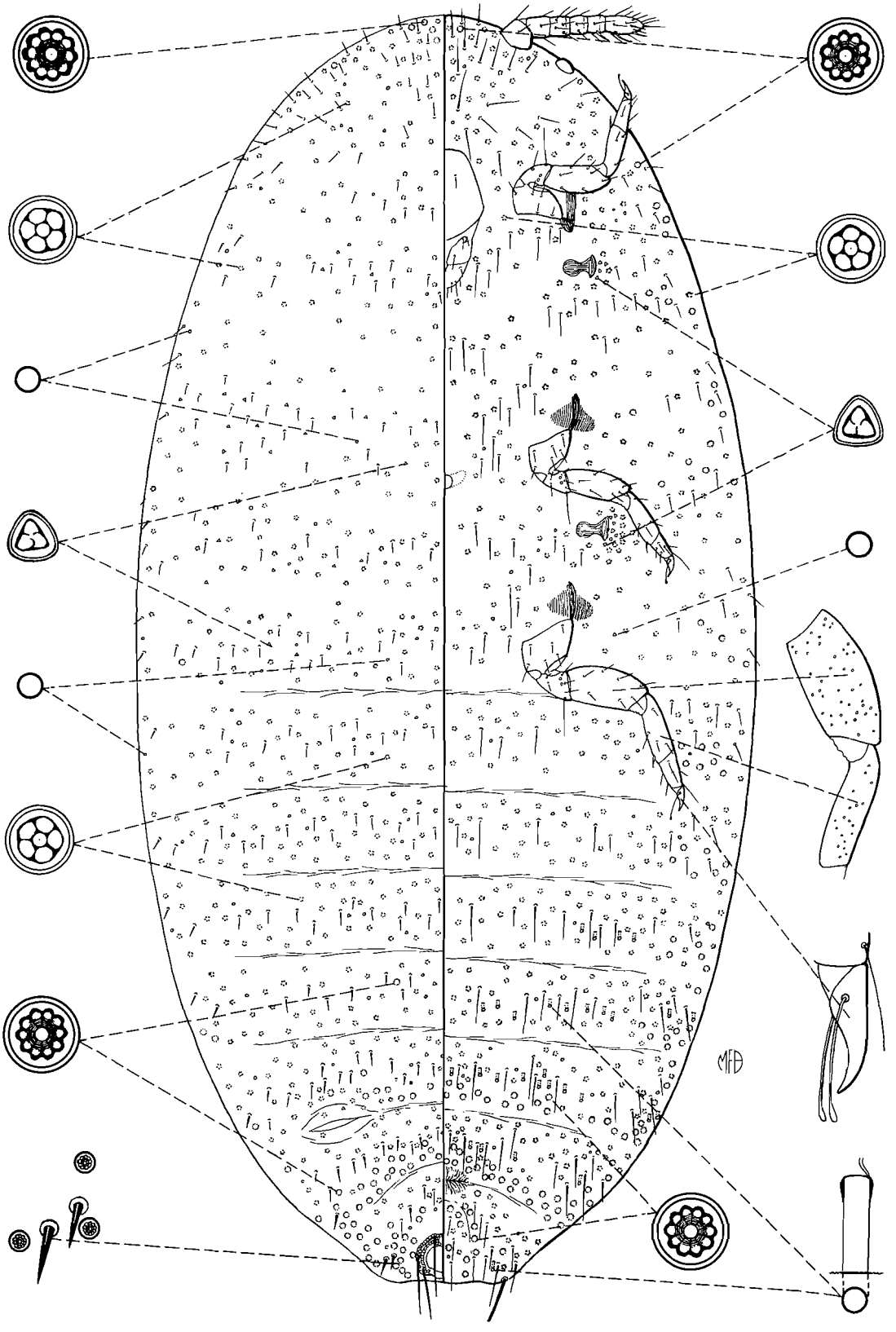


FIGURE 23.—*Brevennia rehi* (Lindinger): Adult female.

pores present from abdominal segments VII, VI, or V to anterior thorax or head, normally with one to three such pores present on anterior lip of each posterior spiracle. Oral-collar tubular ducts sometimes absent, when present, normally much smaller than those on venter, normally with one or two ducts on medial areas of abdominal segment VIII or VII and with a few ducts on lateral areas of segments VIII–VII, VI, or V. Dorsal setae bristle shaped, more robust than dorsal setae of *H. arenae*, those on medial portion of segment VIII 10–15 (av. 12) $\mu$ long; segment V with 25–29 (av. 27) setae.

Anal ring dorsal, incomplete anteriorly, with setae slightly longer than greatest diameter of ring, setal apices often slightly expanded, normally with two or 2½ rows of pores, outer row well developed.

*Venter* with multilocular disk pores present medially on posterior margins of abdominal segments IX–VII, VI, or V, normally absent on anterior margins; present near body margin on abdominal segment IX to anterior thorax, normally with one to three pores on head. Quinquelocular pores of one size, numerous over surface. Swirled trilocular pores in small numbers near spiracles. Discoidal pores relatively numerous, scattered over surface. Oral-collar tubular ducts of two sizes. Smaller size same as on dorsum, present in small numbers on lateral areas of abdominal segments VIII–VII, VI, V, or IV; larger size present on medial areas of segments IX–V. Posterior seta 108–155 (av. 134) $\mu$ long.

Circulus present on 1 of 39 specimens. Legs robust, femur on hind leg noticeably larger than femora on remaining legs; hind coxae without pores; hind femora dorsally with 26–95 (av. 55) translucent pores, ventrally with 0–4 (av. 3); hind tibiae dorsally with 15–20 (av. 18) pores, absent ventrally; hind tibia/tarsus ratio 1.4–1.8 (av. 1.5); hind tibia-tarsus length 145–168 (av. 154) $\mu$; apices of claw digitules normally unequal; claws without denticle. Of 71 antennae examined, 63 were 6-segmented and 8 were 7-segmented; on 6-segmented antennae third segment was often partially divided; 7 specimens were examined that possessed both 6- and 7-segmented antennae; antennae 183–208 (av. 196) $\mu$ long.

**Notes.**—This description is based on 39 specimens from 5 localities.

In the United States this species was previously identified as *Heterococcus tuttlei* Miller and McKenzie; however, it is now apparent that *tuttlei* is a junior synonym of *B. rehi*, a species recently redescribed and illustrated by Williams (*1970*).

*B. rehi* is known from Bangladesh, Burma, India, Java, Nepal, and Pakistan (Williams *1970*), where it is sometimes a minor pest of rice (Maxwell-LeFroy *1908*).

In the United States it is restricted to a small area in Florida and to the desert area of southeastern California and southwestern Arizona; in California and Arizona it is a pest of *Cynodon dactylon* grown for seed. The presence of *B. rehi* should cause concern to economic entomologists, because it is potentially a pest of rice and other grass crops.

**Specimens Examined.**—ARIZONA. Yuma Co.: Yuma, X–23–67, XI–14–68, X–7–71, on *Cynodon dactylon* (Gramineae) (UCD, USNM).

CALIFORNIA. Imperial Co.: Bard, XI–9–67, XII–1–67, on *C. dactylon* (CDA, UCD, USNM); Calexico, XII–22–70, on *Sorghum vulgare* (Gramineae) (USNM); El Centro, VII–29–68, on *Sorghum* sp. (CDA); Westmoreland, IX–16–70, on *Dactyloctenium aegyptium* (Gramineae).

FLORIDA. Broward Co.: Pompano Beach, IV–18–73, on *Cynodon dactylon* (FSCA, USNM).

PAKISTAN. Peshawar, X–16–61, on *Cyperus rotundus* (Gramineae) (BM).

## First Instar
## (Fig. 24)

**Recognition Characters.**—Mounted, 0.3–0.5 mm long, 0.1–0.2 mm wide.

*Dorsum* with 4–11 pairs of cerarii, present on abdomen and posterior thorax; anal-lobe cerarii with longest conical seta 7–9 (av. 8) $\mu$ long, each cerarius with either 1 quinquelocular pore (present on 6 specimens) or 1 swirled trilocular pore (present on 5 specimens); remaining cerarii each with conical setae and 1 quinquelocular or 1 trilocular pore. Discoidal pores absent. Larger quinquelocular pores normally present near lateral margin of each of

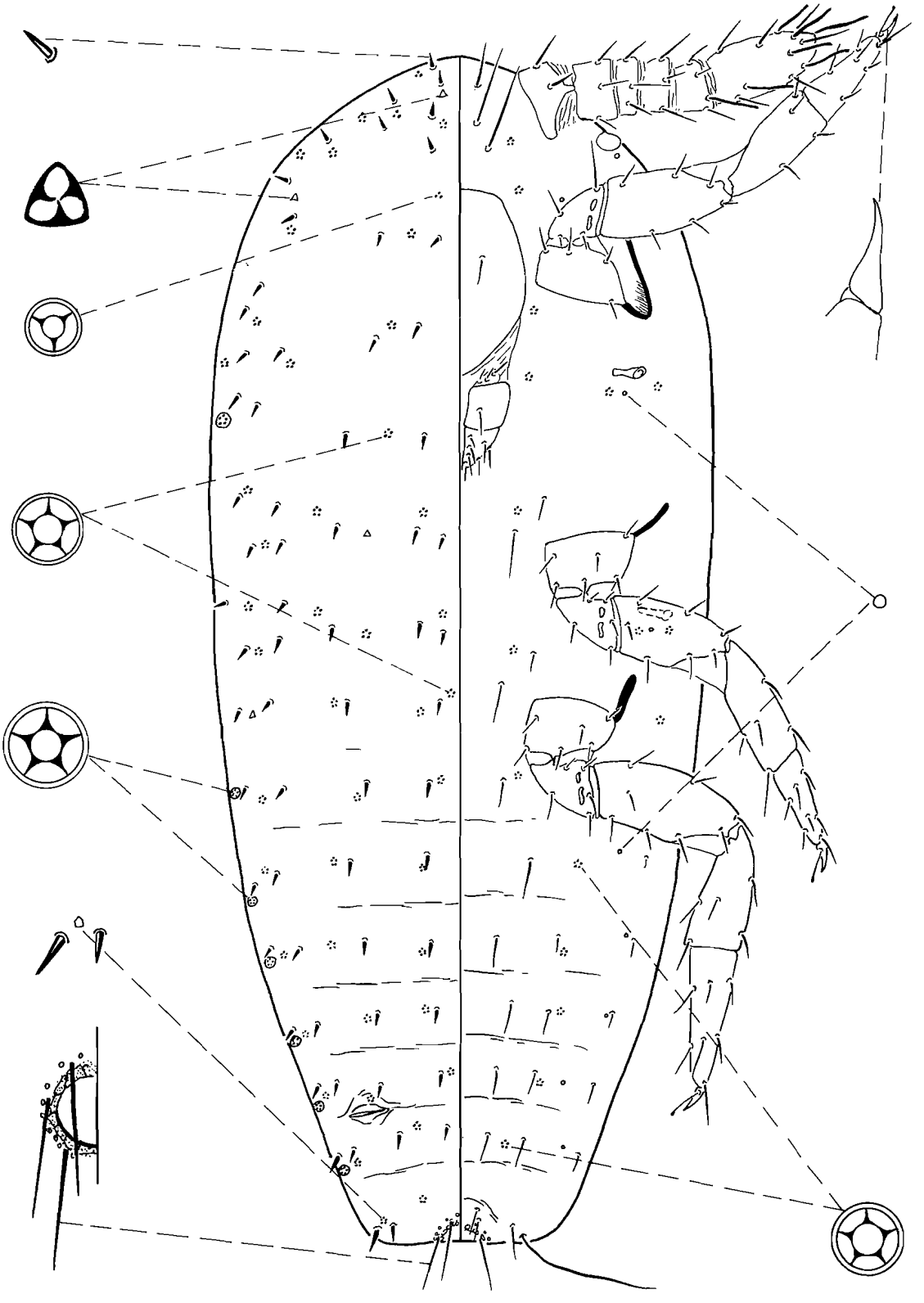


FIGURE 24.—*Brevennia rehi* (Lindinger): First instar.

abdominal segments VIII–III, with one pore on margin near each anterior spiracle, and rarely with one pore on margin near posterior portion of eye; small quinqueloculars present in three pairs of longitudinal lines on abdomen, scattered on thorax and head. Trilocular pores of 2 types, 1 type is merely a distorted quinqueloculars, the other is typical of most pseudococcids, with swirled locular structure; swirled trilocular pores variable in number, 2–18 (av. 6), normally present in 1–7 cerarii, and on thorax and head. Body setae conical, those on medial portion of segment VIII 7–9 (av. 7) $\mu$ long.

Anal ring with setae slightly longer than greatest diameter of ring, with two rows of pores.

*Venter* with quinquelocular pores of small size only, normally distributed as shown in figure 24. Trilocular pores absent. Posterior setae 78–118 (av. 94) $\mu$ long.

Circulus absent. Legs with hind tibia-tarsus length 80–100 (av. 93) $\mu$; without claw denticle. Antennae 115–128 (av. 122) $\mu$ long. Anterior ostioles absent.

**Notes.**—This description is based on 13 specimens from 1 locality.

Disregarding generic characters, the first instar of this species shows a superficial resemblance to *H. nudus*. *B. rehi* differs in possessing posterior setae 78–118 (av. 94) $\mu$ long, hind tibia tarsus 115–128 (av. 122) $\mu$ long, and dorsum without discoidal pores. *H. nudus* possesses posterior setae 73–85 (av. 80) $\mu$ long, hind tibia tarsus 106–115 (av. 110) $\mu$ long, and dorsum with small number of discoidal pores.

## Adult Male
## (Fig. 25)

**Recognition Characters.**—Mounted, 0.7–0.9 mm long, about 0.2 mm wide.

*Dorsum* with 1 pair of tail-forming pore clusters; each cluster with 2 setae 145–175 $\mu$ long, 1 or 2 setae about 20 $\mu$ long, and 23–30 multilocular derm pores. Multilocular derm pores normally of quadrilocular type, rarely with one or two quinqueloculars and triloculars; multilocular derm pores arranged in one pair of submedial longitudinal lines, abdominal segments VIII–II and metathoracic and prothoracic segments each with two submedial multilocular derm pores; these pores rarely present on lateral margins of abdominal segments VII, VI, or IV. Discoidal pores of 3 kinds: Clear center pores often associated with multilocular derm pores, also present near lateral margin of abdomen; dark center pores more numerous than clear center pores, present in transverse rows on submedial and lateral areas of abdominal segments VIII–II, also present in small numbers on thorax, absent on head; head pores present near antennae, varying in number from 8 to 14. Body setae noticeably more elongate than those on venter, present on each body segment. Abdominal sclerotization normally absent, one specimen with weakly indicated sclerotized area on medial areas of abdominal segments VIII–VI. Metapostnotal ridge absent. Posterior ostioles present. Scutum sclerotized throughout. Prescutum round, with prescutal ridge strongly developed. Hamulohaltera each with one apical seta. Mesothoracic wings each with one large circular sensorium, not attached to radial vein and two, rarely one, setae near wing base. Postocular and preocular ridges absent. Midcranial ridge weakly developed, restricted to interantennal area. Postoccipital ridge indicated only by darkly sclerotized area. Ocular and dorsomedial sclerites lightly sclerotized. Dorsal eye 20–25 $\mu$ in diameter.

Penial sheath about 70 $\mu$ long, width/length ratio varies from 0.8 to 0.9; apical portion of sheath narrow, with rounded apex; penial sheath undivided; posterior portion of sheath sclerotized on both surfaces; sclerotized anteriorly on venter only. Medial lobes absent. Ventral slit indefinite. Aedeagus about 50 $\mu$ long, attached to ventral surface by basal rod.

*Venter* with multilocular derm pores of quadrilocular type only, present between anterior pair of legs, absent elsewhere. Discoidal pores of same 3 kinds as on dorsum: Clear center discoidals rare, normally present only with multiloculars, sometimes present on lateral margins of abdomen; dark center pores present on lateral areas of abdomen, with 1 or 2 pores on lateral areas of thorax; head pores present near antennae, varying in number from 9 to 16. Body setae slender, present on all body segments. Metepisterna each with two conspicuous pre-

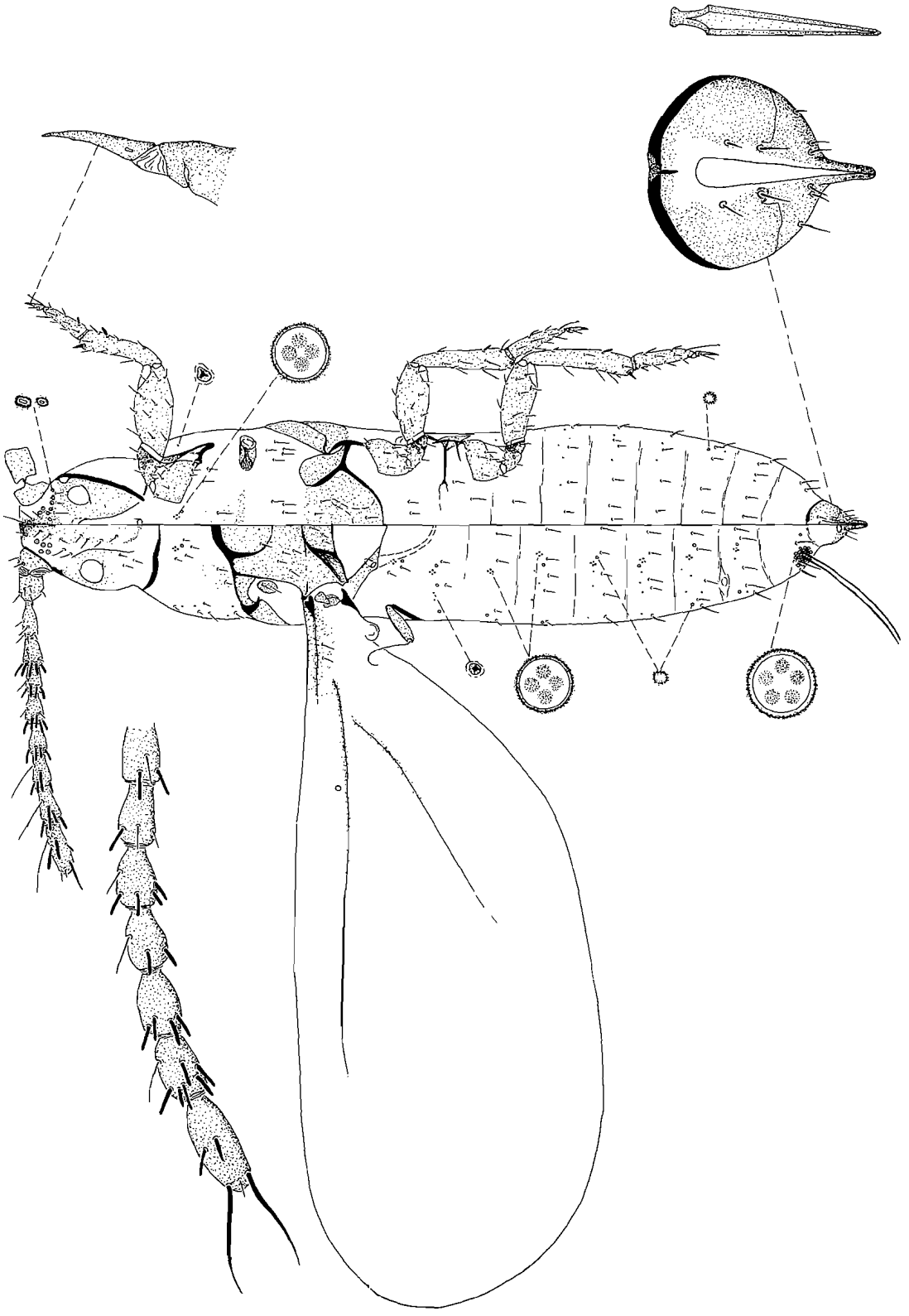


FIGURE 25.—*Brevennia rehi* (Lindinger): Adult male.

coxal ridges, anterior ridge longest often touching sternal apophysis. Proepisternum strongly sclerotized on dorsal margin, rarely with weakly sclerotized ridge on ventral margin also. Mesosternal marginal ridge absent anteriorly. Prosternum and prosternal ridge weakly sclerotized. Midcranial ridge indefinite, restricted to interantennal area. Postocular and preocular ridges apparenty fused, well developed. Ocelli on ventral side of this ridge and on ridge itself. Preocular ridge apparently developed only from antennal articulation to ocellus. Preoral ridge weakly developed, unusually elongate. Cranial apophysis heavily sclerotized and conspicuous. Mouth small. Ventral eye about same size as dorsal eye. Ocellus 10–13 $\mu$ in diameter. Head setae restricted to areas anterior to ventral eyes.

Prothoracic and mesothoracic legs approximately equal, metathoracic legs longest; leg setae apically acute except with one or two fleshy setae on outer margin of tibiae and tarsi; tarsal digitules slightly capitate; claw digitules apically acute; claw with or without small denticle. Body length 2.3–2.4 times longer than antennal length; antennae 10–segmented; apical antennal segment about equal to third antennal segment, ratio of apical segment/segment 3 varies from 1 to 1.2; antennal setae as follows: Fleshy setae present on segments 4 through 10; hairlike setae present on all segments; subapical sensory setae and capitate sensory setae absent; terminal 3 segments each with at least 1 antennal bristle.

**Notes.**—This description is based on eight specimens from three localities.

It is of interest that adult males of this species seem to be much more closely related to species of the "Saccharicoccus group" of Afifi (*1968*) than to those of the Phenacoccini (="Ceroputo group" of Afifi).

## Fourth-Instar Male (Pupa)

**Recognition Characters.**—Mounted, about 0.6 mm long, 0.2 mm wide.

*Dorsum* with one pair of elongate lateral setae on each margin of abdominal segment IX, these setae all about equal in size, approximately 23 $\mu$ long, without associated pores. Multilocular disk pores variable in size, not divided into loculi, present in longitudinal row on submedial and sublateral areas of abdominal segments VIII–II, also present on metathorax and prothorax, absent on abdominal segments X and IX and on mesothorax and head. Discoidal pores associated with multilocular disk pores. Oral-collar tubular ducts absent. Body setae noticeably robust and elongate on posterior abdominal segments, becoming progressively thinner and shorter anteriorly. Hamulohaltera present, wing shaped. Front wing buds about 300 $\mu$ long, partially sclerotized. Sclerotization present on lateral areas of abdominal segment IX. Ostioles not seen. Postocular ridge represented by sclerotized ridge, ocular sclerites unsclerotized, dorsal eye weakly indicated.

Penial sheath undivided, sclerotized dorsally and ventrally; anal opening dorsal. Genital slit represented by small invagination. Width/length ratio of capsule about 0.9.

*Venter* with each lateral margin of abdominal segment IX with heavily sclerotized, posteriorly projecting plate; each plate normally with a trifurcate apex and one long seta. Multiloculars of same type as on dorsum, present from abdominal segments VII–III, also present near posterior and anterior pairs of legs, and near each spiracle, absent on head. Discoidal pores associated with multilocular pores. Oral-collar tubular ducts absent. Body setae noticeably shorter than those on dorsum. Postocular ridge indicated near body margin. Ventral eyes evident. Sclerotization between antennae present. Mesothoracic apophysis (furca) readily apparent. Mouth and ventral cavity present.

Legs well developed, setae obvious. Antennae 10-segmented.

**Notes.**—This description is based on two very poor specimens from one locality.

This is the first pseudococcid pupa outside of the Phenacoccini or *Puto* that possesses plates on the margin of the posterior abdominal segments.

## DISCUSSION

The numerous similarities of the adult females of *Heterococcus* and *Brevennia* combined with the numerous dissimilarities of the adult males draw attention to a rather interesting point. It appears that two very different stocks of pseudococcids have invaded the grass sheath habitat. The instars of both ancestral stocks that have been restricted to this habitat appear to have converged morphologically. The nonrestricted instar—the adult males—has apparently been little affected by adaptation to the grass sheath habitat and shows only small differences from the ancestral stocks. Thus in this instance I believe that the adult males better demonstrate relationships with other genera than the adult females.

The morphology of the adult male has led me to reexamine the morphology of the adult female and has aided in solving a problem I was previously unable to solve with the adult female alone. The adult male has demonstrated the likely affinities of *Brevennia* and *Heterococcus* with other pseudococcid groups and has aided in demonstrating an interesting case of convergence. It is therefore becoming increasingly evident that all available male and female instars will be needed to formulate a usable classification of the Coccoidea.

Unfortunately not enough suitable material was available for a detailed study of the external morphology of *Heterococcus* species using the scanning electron microscope. However, it has been possible to view a limited amount of material of *H. nudus* and *H. raui*.

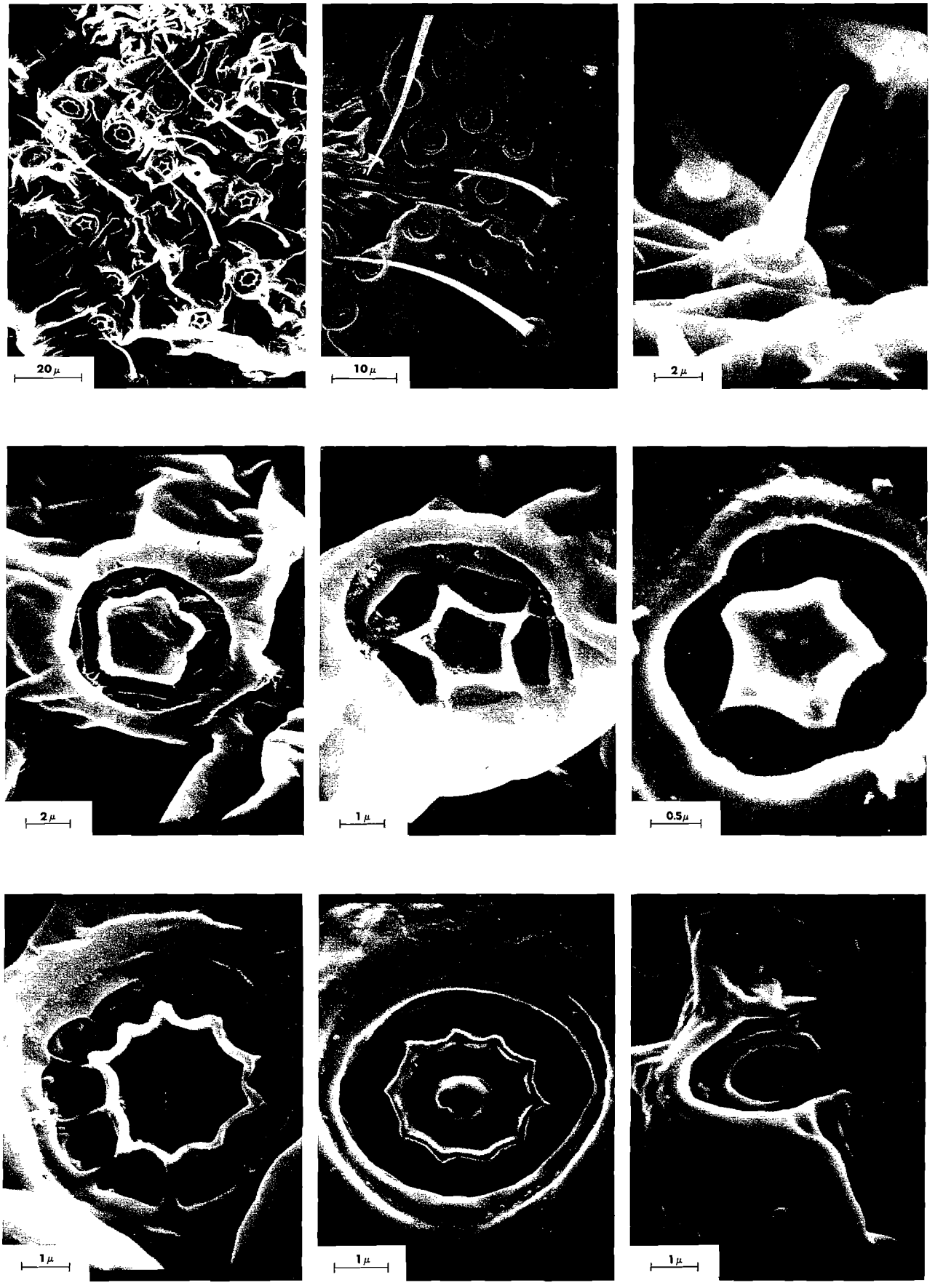
Based on this material, it appears that this microscope may be useful for work on the systematics and morphology of scale insects. *Heterococcus* specimens examined seem to have structural differences in the multilocular and quinquelocular pores. These taxonomic characters may be useful in separating species (fig. 26). In addition, morphological details not previously seen with the light microscope have also been discovered, such as locule orifices in the multilocular and quinquelocular pores.

## SUMMARY

The genus *Heterococcus* and its six species are redescribed and illustrated; one new species is also included. Detailed treatments are presented for each available instar, and keys separating the species and instars are given. Generic transfers from *Heterococcus* to *Brevennia* are listed for eight species. A diagnosis of *Brevennia* and detailed descriptions and illustrations of *B. rehi* (= *tuttlei*) are given.

PN-3739

FIGURE 26.—Photographs of *Heterococcus* species taken with scanning electron microscope: **Top:** *Left*, landscape view of venter just anterior of vulva, *H. nudus; center*, same as preceding except *raui; right*, cerarian seta, *nudus*. **Middle:** *Left*, large quinquelocular pore, *H. nudus; center*, small quinquelocular pore, *nudus; right*, same as preceding except *raui*. **Bottom:** *Left*, multilocular disk pore, *H. nudus; center*, same as preceding except *raui; right*, oral-collar tubular duct, *nudus*.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# INDEX TO SPECIES

Valid names are in roman and synonyms in italic.


abludens, Heterococcus 3, *4*, 13
Annulococcus 2
arenae, Heterococcus 2, 3, *6*, 11, 16, 19, 24, 26, 29, 31, 33, 43, 44, 51
asphodeli, Brevennia 49
biporus, Heterococcus 3, *9*,
*biporus, Phenacoccus* 9, 17
*biporus, Phenacoccus (Heterococcus?)* 9
*borchsenii, Heterococcus* 11
Boreococcus 2
*borkhsenii, Heterococcus* 11, 17
Brevennia 2, 4, 31, 35, 41, 43, *47*, 49, 56
Coleococcus 2
*confertus, Heterococcus* 17, 19
cyperi, Heterococcus 3, 8, *9*, 29, 31, 33
*cyperi, Phenacoccus* 9
dearnessi, Phenacoccus 1, 4, 19, 26, 31, 41, 43, 44
femoralis, Brevennia 49
filictus, Brevennia 49
*graminicola, Heterococcus* 11
Heterococcopsis 2
Heterococcus 1-4, 9, 17, 19, 24, 26, 31, 33, 35, 37, 39, 41, 43, 44, 56
krishtali, Brevennia 49
Lacombia 2
Laingiococcus 2
nigeriensis, Brevennia 49
nudus, Heterococcus 1, 3, 6, *11*, 19, 22, 24, 26, 29, 33, 35, 37, 39, 41, 43, 44, 47, 53, 56
*nudus, Phenacoccus* 11
*nudus, Phenacoccus (Heterococcus)* 11
*occidentalis, Heterococcus* 11, 12
*oryzae, Ripersia* 49
Pseudorhodania 2
pulverarius, Brevennia 49
*pulverarius, Heterococcus* 11
Puto 55
raui, Heterococcus 3, 8, *14*, 19, 24, 29, 33, 35, 39, 43, 47, 56
rehi, Brevennia 1, *49*, 51, 53, 56
*rehi, Heterococcus* 49
*rehi, Ripersia* 49
*rehi, Tychea* 49
Ripersia 47
*sacchari niger, Ripersia* 49
*sacchari oryzae, Ripersia* 49
*sacchari, Ripersia* 49
Stachycoccus 2
tetrapora, Brevennia 49
*tetrapora, Ripersia (Brevennia)* 47
*tritici, Erium* 16
tritici, Heterococcus 3, 8, 9, 11, *16*, 17, 19, 33, 44
*tritici, Trionymus* 16
*tuttlei, Heterococcus* 1, 49, 51, 56
*variabilis, Heterococcus* 11




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