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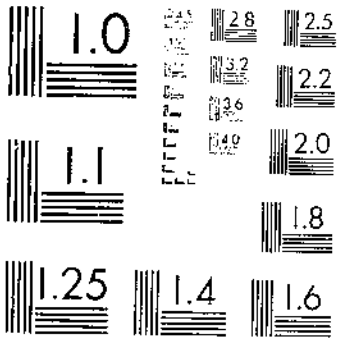

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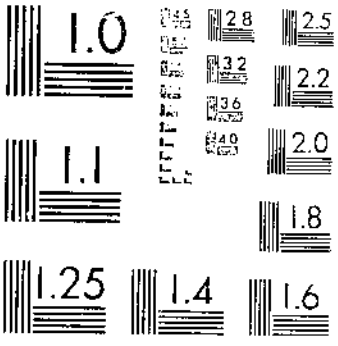

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TECHNICAL BULLETIN No. 404 MAY 1934

THE EXTERNAL ANATOMY OF THE RED DATE SCALE PHOENICOCOCCUS MARLATTI COCKERELL, AND ITS ALLIES

BY

F. S. STICKNEY

Associate Entomologist
Division of Fruit Insects
Bureau of Entomology

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By F. S. STICKNEY [1]

Associate entomologist, Division of Fruit Insects, Bureau of Entomology

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INTRODUCTION

The relationships of *Phoenicococcus marlatti* Cockerell, one of the two best-known scale-insect pests of the date palm, have been obscure. None of its relatives had been definitely determined, and little could be said beyond the fact that it did not belong within any one of a number of recognized groups. With the object of possibly discovering definite relatives of this insect, the writer undertook the study of a wide variety of material. Eleven species were found that gave strong evidence of being related to it, and they are of further interest because, so far as is known, they occur only on species of palms or of the genus *Pandanus*, which is considered by plant morphologists to be of the primitive stock from which palms arose.

[1] The writer wishes to thank O. F. Ferris, of Stanford University, in whose laboratory this work was done, for his constant interest and many helpful comments, as well as for the privilege of using his laboratory and material and the facilities of the Stanford collection of Coccidae. He gratefully acknowledges his indebtedness to E. E. Green, of Camberley, Surrey, England, who sent him much valuable material. He is also indebted for a number of useful species to E. O. Essig, of the University of California, to E. M. Ehrhorn and L. A. Whitney, both of Honolulu, to W. J. Hall, formerly Government entomologist of Egypt, and to Frederick Laing, of the British Museum. In addition, valuable material was available from the U.S. National Museum collection of Coccidae. R. E. Snodgrass, of the Bureau of Entomology, kindly responded to a request for his opinion on body segmentation.

None of the 11 apparent relatives of *Phoenicococcus marlatti* is known to occur in this country, but since they are widely scattered through the tropical and subtropical belts of the world and are subject to a considerable variety of climatic conditions, it seems likely that one or more of them might be able to establish themselves as pests either of the date palm or of some of the other palms so freely utilized as ornamentals in the United States.

These 11 species, with *Phoenicococcus marlatti*, form a group that apparently can be segregated from all other coccids. By way of acknowledging the distinctiveness of this group of species, and incidentally for convenience in referring to them, the tribe Phoenicococcini is erected for the reception of the genera in which the members of the group are separated. This new tribal name is based on the first (as far as known) species described, *Phoenicococcus marlatti* Cockerell, and is of further interest in that its basic meaning, "of the palm", refers nicely to these insects which, as has been mentioned, are restricted to palms or palmlike plants.

In the course of this investigation some other coccids were observed that had a number of structural features very similar to the corresponding parts of members of the Phoenicococcini. In fact, a few of these forms seemed to possess no characteristics fundamentally at wide variance with those present within this tribe. Furthermore, some diaspine species, in their general characteristics, are so strikingly like the Phoenicococcini that they are considered as definitely allied to the latter. It is therefore proposed tentatively to place the Phoenicococcini within the diaspine assemblage. If the coccids are considered as a superfamily—a recent way of regarding them—then the diaspines will have to be raised to family rank; and to maintain a proper balance in this scheme of classification, the new subfamily Phoenicococcinae within the family Diaspidae must be erected to receive the tribe.

The above-mentioned considerations seemed to justify making a detailed study of the external anatomy of *Phoenicococcus marlatti* and its 11 apparent relatives, and figuring and discussing those parts of some other coccids that appeared to throw light on their relationships to the Phoenicococcini.

ILLUSTRATIONS

Except in the case of *Phoenicococcus marlatti*, this study was made from dried specimens, all (including *P. marlatti*) prepared and mounted on slides, and for the most part in a rather flattened condition; also, in the preparation of most of the material it proved well nigh impossible to prevent a certain amount of wrinkling or other distortion. However, in many cases a satisfactory quantity of material was available from which to make comparisons and gain an idea of the actual condition of the parts. It should be borne in mind that some variation in size, form, position, or occurrence almost always exists in a structure, especially in one newly appearing or in process of disappearing. Nevertheless, it is believed that the determination of the typical situation as regards the various parts was in the main approximately accomplished. As far as possible, all figures were drawn from what were considered to be typical specimens, but no assurance is implied that the parts have been represented precisely true to the actualities.

Unless otherwise specified, all the divided drawings showing a complete half of the dorsal and ventral surfaces were made from young individuals. All structures within the limits of each individual drawing and all detached representations of corresponding structures in the same group of drawings were drawn to the same scale. For data on measurements and examples of variations occurring in structures, the reader is referred to the sections on comparative morphology and classification.

Within the limits of each figure all structures, except insignificant dermal markings and parts of the head-skeleton assemblage and rostrum, are either indicated, usually by a full representation, or discussed in the text. The head-skeleton assemblage and rostrum are figured rather incompletely in most instances and are left largely undiscussed, since they appear to be of the same general character in all species and give no evidence of being appreciably different from the corresponding parts treated in detail in another paper.[2] The designation and labeling of the parts in the separate drawing of a section of the head skeleton (fig. 12, *G*) is according to the system used in this other paper.

For the type species, *Phoenicococcus marlatti* and *Palmaricoccus attaleae*, full figures, showing a complete half of the dorsal and ventral surfaces, have been drawn of all post-embryonic stages except the prepupa of the latter, and, for the type species of the remaining genera of this group of apparent relatives of *P. marlatti*, of at least the first stage and the second and adult female stages. It is believed that the character of the structures of the stages omitted can be learned from the text and from an examination of corresponding figured parts of other species. The drawings for other coccids are limited largely to such parts as show comparisons of interest and possible significance between these coccids and those of the Phoenicococcini.

The segmentation of the body is based on an interpretation by R. E. Snodgrass, of the Bureau of Entomology, who gave as his opinion, after examining the adult male of *Phoenicococcus marlatti*, that the spiracles are borne by the anterior sections, and the legs by the posterior sections, of the thoracic segments; also that the metathoracic legs are so situated as to have crowded out in this region the first abdominal segment. Frequently two or more sections of the thorax are apparently fused or only partially indicated by sutures. Only one metathoracic segment is ever indicated on the dorsum, and it appears to be a continuation of the anterior section of the metathorax occurring on the venter; but it is considered here simply as the entire metathorax on this surface; also it was impossible to determine where the first abdominal segment ends and the posterior section of the metathorax begins. For convenience only the lateral margin is taken as the dividing line between different segments of the dorsum and the venter. Thus, two pairs of setae occurring fairly close together along the margin, one apparently just on the dorsal surface, the other just on the ventral surface, are considered as belonging to the segment or segments indicated by their locations. Difficulty is frequently encountered in determining the marginal line by which to separate the dorsum from the venter.

[2] STICKNEY, F. S. THE EXTERNAL ANATOMY OF THE PARLATORIA DATE SCALE, PARLATORIA BLANCHARDI TARG.-TOZZ., WITH STUDIES OF THE HEAD SKELETON AND ASSOCIATED PARTS. *In preparation.*

In order to make the body outline symmetrical, marginal structures, such as eyes, basal antennal segments, and bulges in the body derm, have been duplicated on both sides of divided drawings, but in no case have pores or setae been duplicated. The solid lines indicating the spiracular sclerites have been so drawn as to reveal their characteristics, though these sclerites, except when invaginated, are considered to be always just beneath the surface.

Many of the parts have been labeled, mainly to indicate apparent homologies through the various stages. The setae especially have been designated according to certain groupings. While no certainty is implied that the labeling always conforms strictly to the facts concerning homologies, it at least calls attention to the presence of the parts involved.

ABBREVIATIONS AND SYMBOLS USED ON ILLUSTRATIONS

a, b, c, d, e, f, g, h, i, homologous setae on posterior segment
1ab–9ab, first to ninth abdominal segments
8aba, 9aba, eighth or ninth abdominal segment of adult male
ai, apparent invagination
al, alimentary tube
ames, anterior section of mesothorax
amet, anterior section of metathorax
an, antenna
arp, anal-ring pore
ars, anal-ring seta
as, anus
av, anal valve
3b, third bar
ba, basal segment of antenna
bb, basal bar
bcla3, boundary clear area of third instar
bp, boundary of pocket
bpl, base of salivary plunger
bpen, base of penis
brs, basal rostral seta
brt, brush of tracheoles
bs, basal sclerite
bu, bulla
bw, body wall
bw3, body wall of third instar
bw4, body wall of fourth instar (adult female)
ca, clear area
cam, clear area of metathorax
cdp, caudodorsal pore
ch, sclerotic area of head
cha, channel
cla, claw
cm, connecting membrane with developing subsequent instar
cn, condyle
co, coxa
cp, caudal projection
cru, crumena (pouch to accommodate rostralis)
cst, clear spot of trochanter (probably sensory)
da, dark area, probably vestigial pores
db, distal bar
dba, dorsal band
df, differentiated area
dms, dorsomarginal seta
drs, distorostral seta
ds, distal sclerite
dsp, dorsosubmarginal pore
ee, eye
eo, external opening
eps, empty pore spot
fe, femur
fs, frontal seta
gsh, genital sheath
hs, head skeleton
ina, invagination apparently of alimentary tube
in9ab, mouth of invagination of ninth abdominal segment
inf, intersegmental furca
inr, invagination of rostrum, or rostral slit
ins, invaginated seta
it, inner thickening of seventh abdominal segment
la, line of apposition of dorsal and ventral surfaces
ld, ledge of seventh abdominal segment
le, leg
lmes, lateromesal seta
lp, large pore
ma, body margin
map, marginal protuberance
mav, mouth of anal valve
me, mesal line
mea, meatus
mep, mesal pore
mes, mesal seta
meso, mesothorax
meta, metathorax
1mhs–4mhs, first to fourth mesal head setae
mlp, mesal limit of papillae
mn, mandible
mns, mandibular sheath
mr, membranous area through which rostralis of adult is forced
mrs, mesal rostral seta
ms, mesal sclerite
mss, mesothoracic spiracle

mts, metathoracic spiracle
mv, margin of anal valve
mx, maxillae
mxt, maxillary tendon
oe, esophagus
os, outline of corresponding structure in subsequent stage
p, pore
pa, papilla
pen, penis
pgl, pygidial lobe
ph, pharynx
phs, pharyngial sheath
pl, plate or squamula
plw, pharyngial lateral wall
pmes, posterior section of mesothorax
pmet, posterior section of metathorax
pp, pore spot containing pore
pr, prothorax
psc, pleural sclerite
pt, partition
pte, pharyngial tendon
qp, quinquelocular pore
r, rostrum
rc, rectum
rop, adult rostralis puncture
ros, rostralis, or mouth-stylets tube
5s–11s, fifth to eleventh homologous head setae
sad, salivary duct
sap, salivary pump
sat, salivary tendon
sdc, salivary-duct chamber
se, seta
1se–14se, first to fourteenth homologous antennal setae
sep, seta (in part)
sip, dorsal, slightly invaginated, simple pore
slp, spinelike process (probably seta)
smp, small pore
sp, spiracle
S-sp, S-shaped pore
spa, spiracularia (spiracular sclerite)
srs, spinelike rostral seta
ss, submarginal seta
ssg, probably sensory spot of genital armature
ssl, sensory spot of legs
sta, slightly thickened area
t, trachea
ta, tarsus
tc, tracheal collar
tch, tracheal chamber
te, teeth of seventh abdominal segment
ti, tibia
tm, tracheole mass
tn, tendon
tr, trochanter
trp, trilocular pore
tpl, tendon of salivary plunger
va, vagina
vms, ventromarginal seta
vu, vulva
xs, extra seta (above greatest number in any preceding instar)
xx, may be absent

Dots	Internal or underneath parts
Fine lines	Sclerotic
Long dashes	Probable location of suture
Long dashes and dots	Mesal limits of papillae
Short dashes	Ridge
Short dashes and dots	Depression
Stippling	Membranous

HOST PLANTS AND GEOGRAPHICAL DISTRIBUTION

As far as is known, *Phoenicococcus marlatti* and each one of its apparent relatives is restricted to a single genus of palms or to *Pandanus* alone The records of their host plants are meager, however. Three of the species are listed as occurring simply "on palm", and another as occurring on "rottang", which probably refers to the genus *Calamus*, the prevailing creeper palm of the locality in which this species was collected, but possibly to *Daemonorops*, or perhaps even to some other genus.

Phoenicococcus marlatti has been taken from 3 species of *Phoenix*, *Palmaricoccus pritchardiae* from 2 species of *Pritchardia*, *Thysanococcus pandani* from 3 and possibly 4 species of *Pandanus*, and *Thysanococcus squamulatus* possibly from 2 species of *Calamus*. The records for the remaining 8 species give no indication of other than single host species for each.

The number of species now known are too few, and their host records too meager, to warrant any definite statements concerning the comparative interrelationships of insect and host.

This group of insects, in view of the fact that they number only 12, are unusually widely scattered through the tropical and subtropical

regions of the world, and no record has been found of their occurrence elsewhere. *Phoenicococcus marlatti* is found wherever date palms are commercially cultivated—in eastern Asia, North Africa, and the southwestern part of the United States—except in a few isolated oases. Besides from the date palm, *Phoenix dactylifera* L., it has been taken from *P. canariensis* (Hort.) and *P. reclinata* Jacq. in southern California, the location and history of these palms indicating that the insect spread to them from infested date palms established in the immediate vicinity. The following list gives the names of the 11 species associated with *Phoenicococcus marlatti*, their host plants, and the general geographical locations where they were found:

Palmaricoccus, new genus

attaleae, new species.—On *Attalea cohune* Mart., State of Colima, west coast of Mexico.
pritchardiae, new species.—On *Pritchardia hardyi* Rock, Molokai Island, Hawaii; on *P. rockiana* Bece., Punaluu, Oahu Island, Hawaii.
nesiotes Laing.—On "palm sp.", Lord Howe Island (between Australia and New Zealand); on "palm", Macheno, Hawaii.

Halimococcus Cockerell

lampas Cockerell.—On "palm", Natal, South Africa.
thebaicae Hall.—On doum palm, *Hyphaene thebaica* Mart., Egypt.
borassi Green.—On Palmyra palm, *Borassus flabellifer* L., Peradeniya, Ceylon.

Platycoccus, new genus

tylocephalus new species.—On "palm", Honolulu, Hawaii.

Thysanococcus, new genus

chinensis, new species.—On *Calamus* sp., Yenping, South China.
pandani, new species.—On *Pandanus* sp. and *P. tectorius* Soland., in both cases from Buitenzorg, Java; on *P. utilis* Bory and *P. penangensis* Ridley, in both cases from Singapore.
squamulatus, new species.—On *Calamus tetradactylus* Hance, Canton Christian College, Kwangtung, China; on "palm tree", Hong Kong, China.
calami, new species.—On *Calamus* sp. and on "rottang" (creeper palm of the tropical forest), in both cases from Buitenzorg, Java.

It is of interest to note that, of these 11 species, only *Palmaricoccus nesiotes* can be said to have been taken from well separated localities. Considering the wide distribution of such a few related species, it is probable that many others will eventually come to light. That other species have not now been recorded seems to be due chiefly to their restricted host range.

COMPARATIVE MORPHOLOGY

With a few exceptions the terms used in discussing the external anatomy of the insects included in this bulletin are in common usage among coccidologists, or words of well-known meaning have been applied in the belief that their implications, in the connections in which they are employed, will be readily grasped. The few exceptions are "bulla", "spiracularia", "crumena", "rostrum", and "rostralis", all taken from MacGillivray (*12*) [3] (but not all original with him) and used for their apparent advantage in expressing briefly and precisely the parts referred to.

[3] Italic numbers in parentheses refer to Literature Cited, p. 182.

EGG

The derm of the egg is a delicate membrane, which crumbles to a misshapen mass after the nymphs hatch and, in the puparial forms, is left within the puparium, where, in all observed cases, the eggshells are scattered about. In the available material the egg of all members of each genus possesses a single spine, two disconnected spines, or a single group of more or less closely bunched spines, in every case situated on the mesoventral surface or the mesocephalic margin of the head. The character of the spines can segregate satisfactorily only one genus (*Platycoccus*) from all the others.

FIRST STAGE [4]

WAX

The wax produced is normally white in color and cottony or filamentous in texture, though it may become matted down when old or if the individual is in a closely confined space, and it may take on a creamy or pale yellowish tinge. As observed in dried specimens, wax is absent or scarce and is located typically around the body margin, or it may more or less cover the body. In *Phoenicococcus* and *Palmaricoccus* it tends to be more in evidence than in the other genera. It never assumes any distinct formations. In the living individuals of *Phoenicococcus marlatti* it is generally fluffy when the insect is not confined, but otherwise it tends to become sufficiently dense practically to conceal the body.

SHAPE AND SIZE OF THE BODY

In outline the body is usually elongate elliptical. In cross section it is typically rather flat at first and may be noticeably so. Older specimens show a tendency toward a plane surface beneath and a very slight to a roundish convexity above, especially in the wholly puparial [5] stages.

The size of the body, based on the average specimen in each species, varies about as follows: Newly hatched, 0.22 mm long and 0.12 mm wide, to 0.36 mm long and 0.20 mm wide; fully developed, 0.29 mm long and 0.20 mm wide, to 0.82 mm long and 0.39 mm wide. In fully developed individuals the females may or may not be appreciably larger than the males, the greatest difference in size occurring where the latter are wholly puparial, but the females are never normally smaller than the males. Males wholly puparial may be but little larger than the newly hatched specimens, but the greatest disparity in size between young and old individuals occurs in a partially puparial form. The size of the body may be of diagnostic value. For example, the widest range in size of young individuals occurs between two species in one genus, and their difference in size remains sufficiently great for it to be used satisfactorily in separating them. On the other hand, the body may be very nearly of the same size in species of different genera.

[4] A structural differentiation of sex was not observed in any species.

[5] Strictly speaking, "puparium" refers to a larval skin within which the pupa develops. It has, however, been used in a loose sense to include the skin of any instar entirely enclosing subsequent instars. For lack of a better term, it is so used in this bulletin.

BODY DERM

In the term "body derm" are included segmentation, sclerotization, and such sculpturing as papillae, spines, spicules, and other characteristic dermal markings. The segmentation may be almost complete,[6] failing only on the ventral surface cephalad of the posterior section of the mesothorax, or it may be largely obscure except on the abdomen, where it is always at least partially in evidence.

The body may be considered as membranous in the younger individuals, except that in *Phoenicococcus* and *Palmaricoccus* certain sclerotic areas may be present in the vicinity of the head skeleton as well as caudad of the rostrum and on the posterior abdominal segment, or in addition the penultimate segment may be moderately sclerotic, this sclerotization frequently extending in a decreasing degree cephalad onto the next segment or two. There is a general sclerotization of the body as the instar matures, typically less marked on the venter than on the dorsum. Papillae and definitely recognized spines are absent. Spicules occur most freely on the ventral surface of the thoracic segments caudad of the rostrum in numerous more or less irregular rows. Spicules are considered to be merely a form of dermal thickening, and if numerous give a sclerotic appearance to the parts. They are always located away from the sutures and greatly help to determine segmentation.

The derm of the body margin is relatively smooth and undifferentiated in all genera except *Thysanococcus*, in which it is rather sharply defined and may appear to be serrated.

PORES

Three types of pores only are normally present—an 8-shaped tubular, a trilocular-disk, and a quinquelocular-disk type.

The tubular type possesses the following characteristics: A single external opening followed by a membranous tube, always longer and generally much longer than wide, ending distally in a fairly broad, more or less strongly sclerotic piece, which can be usually, though not always, easily differentiated into two parts, the basal and the distal bars; a centrally located partition which, from a lateral aspect, may or may not be in evidence through a part of the bars or through the bars and partly or almost wholly through the membranous tube connecting them with the external opening, this partition if present, being always delicate through the tube, especially toward the external opening and, owing in part to the single external opening, never producing the effect of splitting the pore entirely into two separate ones; and a typically slender, delicate, and usually much-elongated tube, the bulla, which always issues from the center of the distal bar. When the tubular pore is viewed on end, a figure 8 is seen across the inner surface of its distal bar, even when the partition is not in evidence from a lateral aspect. This 8-shaped effect is apparently produced by the partition, and it would therefore seem that vestiges or rudiments of the partition, as the case may be, are always present. It is discerned only if the pore is not altered in form, such as being in a collapsed condition or pressed out of shape and in position for the inner surface of its distal bar to be adequately viewed, and generally also the pore

[6] As considered in this bulletin, complete segmentation of the thorax requires the definition of its four sections on the ventral surface, and of both sections of the mesothorax and a single section of the metathorax on the dorsal surface; complete segmentation of the abdomen requires the definition of seven of its segments (excluding the first) on the ventral surface, and of eight of its segments on the dorsal surface.

must be sufficiently stained. Under the right conditions its 8-shaped character seems to be always present, though it may be nearly indistinct, more frequently so in small and delicate pores.

Tubular pores are scarce, from 1 to no more than 16 pairs being typically present. They are always scattered and most numerous on or near the body margin. The development of the partitions through them is of diagnostic value, for example, in separating *Phoenicococcus* and *Palmaricoccus* from the other genera.

The two disk types of pores are not fundamentally different in construction from these types occurring in other coccids. They are always associated with the spiracles only, a single pore alone, either with both pairs or with the mesothoracic pair, but not with the metathoracic pair only. Their sizes and shapes vary appreciably, but, along with the number of loculi, are typical for the species. The number of loculi present appears to be of little importance, since both types occur within a single genus as well as in different genera.

SPIRACLES

Both pairs of spiracles may open approximately on the surface, or the mesothoracic pair alone may open to the surface through an invaginated tube. The character of the latter and the position of its external opening is of generic value; its form, of specific value. The supporting spiracular sclerites, the spiraculariae, may or may not be subequal in size and structure. The structural condition of the spiraculariae may be distinctive for the species, but apparently not for the genus.

A differentiated spot in the body derm near the margin of apparently the posterior section of the metathorax is frequently observable, apparently always present in *Phoenicococcus* and *Palmaricoccus*. It is usually delicate and is termed here simply a "clear area." Its significance is not appreciated, but if the posterior section has not crowded out the first abdominal segment laterad of the leg, then it is in position to be a vestige of a spiracle on this segment.

BODY SETAE

In distribution the body setae conform to a rather definite pattern. When well represented, they occur in recognized positions throughout, distinguished as rows (the maximum number being five) on the thoracic and all abdominal segments except the posterior abdominal one. With an appreciable number absent the homologies of all may not be confidently determined, but for the most part apparently can be from their positions. With one exception, they conform in size and form within limits depending upon their locations, the exception being a marginal row of comparatively large, rather spinelike setae in one species (fig. 37). Otherwise they are all comparatively small, and some of them may be almost minute, with the following exceptions: The first to fourth pairs on the mesoventral surface of the head cephalad of the head skeleton vary among themselves in size typically for the species, with always 1 or 2 pairs rather long; a single ventromesal pair each on the posterior sections of the mesothorax and the metathorax occur either small or rather long, depending upon the species; and 2 pairs on the posterior abdominal segment always occur as the longest setae of the body. The number and size of the setae are of diagnostic value in segregating some species and genera.

ANTENNA

The antenna is always either 6-segmented or of the annulated type, but both types do not occur in a single genus. If of the 6-segmented type, the basal segment is either distinctly more than twice as broad, or distinctly less than twice as broad, as any other segment. With a single exception, it is of one or the other size for all species in each genus. The apical segment of the 6-segmented type is always decidedly more elongate than, and may be twice as long as, any other segment, but it is never wider than the widest of the other segments beyond the basal one, and frequently is slenderer through most of its length than any of them. The intervening segments vary in size among the species of all the genera sufficiently to make them of no value in a generic diagnosis, and perhaps of but little value in a specific one.

The setae of the 6-segmented type are of both specific and generic value. Differences in their number on the basal segment can separate *Phoenicococcus* and *Palmaricoccus*, on the one hand, from *Halimococcus* and *Platycoccus*, and in turn can separate the last two genera from each other; whereas the number of setae on the apical segment apparently can separate only *Platycoccus* from the other three genera mentioned. The form and number of setae on the intervening segments, but apparently not of those on the basal and distal segments, can differentiate the species within each genus.

In the annulated type of antenna (fig. 52, *A*, *B*) the basal segments are not equally distinguishable, segments 2 to 4 being clearly defined but never segment 5; the annulations in one species are fewer in number and less strongly marked than in the others; some slight variations occur in number, size, and location of the setae according to the species, and apparently, at least in size and location, according to the individual. The annulated part appears to embrace the apical segment, and may also include some of the next segment.

A small, usually raised and blunt but sometimes spinelike, structure occurs persistently on the distal margin of the second segment in both types of antenna. This may be a modified pore or a sensory structure, but it is here designated simply as a "spinelike process." A pair of small, apparently invaginated structures are always present on the apical segment of the 6-segmented type, or the annulated part of the other type. In the tuberculate type of antenna in other stages apparently this same kind of structure also persistently occurs, characteristically in pairs, frequently appearing as evaginated setae. They are therefore considered in this stage as invaginated setae.

It was not possible to determine the precise positions of the setae of both types of antennae, owing to inability to judge the degree of twisting to which the segments had been subjected. But both types possess two characteristically long apical setae; in the 6-segmented type, one being typically longer and more apical in position than the other.

The presence in this small group of two such strikingly different types of antennae suggests that the phenomenon is of only minor significance.

ROSTRUM AND ROSTRALIS

The beak, or rostrum, is a subconical organ with a narrow central channel bordered by apparently three more or less connected sclerites. Three pairs of small rostral setae are usually in evidence, 1 pair being

either distinctly basal or apical and the other 2 pairs always apical in position. This distinction in position is of value in separating *Phoenicococcus* from the other genera.

The mandibles and maxillae are closely joined in the caudal portion of the head-skeleton assemblage, producing a tube termed here the "rostralis." The bases of the mandibles and maxillae remain fixed in position, but prior to penetration of the host tissue the greater part of the rostralis is found within a membranous and very elastic pouch, the crumena, which is suspended in the body cavity between the head skeleton and the rostrum. At this time the apical part of the rostralis lies along the central channel of the rostrum, which appears to serve as a guiding and supporting organ for the rostralis.

The rostralis is rather dense, stiff, and smooth in texture, but has a certain degree of flexibility, as demonstrated by its various loops or bends within the body cavity. It is always longer than the body, and may be more than three times as long in young individuals, its length depending to a certain extent upon the species but varying within limits in each. Within the crumena the rostralis has to double back, always producing a characteristic small rounded or ovoid loop, which is usually observed in the cephalic half of the body. An elongate caudal loop is also always formed by the rostralis and, in addition, 1 or 2 loops, varying in form largely according to the species, may be present.

LEGS

The legs are subequal in size and never decidedly stout, but some variation exists in the shape of the different segments, a character apparently of more specific than generic significance. The trochanter and femur, and also the tibia and tarsus, may be fused, but apparently if the first 2 parts are fused the other 2 always are. The setae on each leg are approximately alike in character, scarce, and may be absent on the femur and tibia. The number of setae on the coxa and their number and the size of one on or near the inner margin of the trochanter are characteristics of generic value. A minute seta, virtually on the thickened basal part of each coxa and trochanter, appears to be always present, though not always readily distinguished.

Bordering the thickened basal part of each trochanter are a few clear spots, probably pores or sensory structures. On the outer margin of each tarsus, nearly always in evidence, is a differentiated spot, sometimes practically flush with the surface and sometimes mildly raised, sufficiently so in 1 or 2 instances to resemble a short stout spine. This may be a pore or a sensory structure, but it is here designated as a "spinelike process." The segments of the legs are frequently twisted out of position and, as with the antennal setae, an accurate representation of their positions in the drawings is not vouched for.

ANAL SEGMENT

The region caudad of the seventh abdominal segment is apparently composed of a single segment, considered here as the anal segment, although, as will be indicated in the discussion of the last two male stages, it is evidently composed of at least the eighth and ninth abdominal segments. The caudal margin may or may not have 1

or 2 bulges on each side. These are merely slight, rounded, undifferentiated protuberances of the body derm, characteristic of all species of *Phoenicococcus* and *Palmaricoccus*, present in one species of *Halimococcus*, and absent in all other species.

For the most part the setae of the anal segment can be homologized in all species, the anus and the two long caudal pairs of setae being used as orienting points. The anus may be distinct or almost indistinct, and is always on or almost on the caudal margin. If distinct the anus may have a prominent anal ring or none at all. Anal-ring setae may or may not be present, but one or more setae apparently homologous with anal-ring setae are always in evidence. Thus the character of the anus and anal ring is seen to be variable within a small group of insects. Yet these parts may be of generic importance.

PUPARIUM

The female is always nonpuparial in this stage. The male is either nonpuparial, partially puparial in the sense that the subsequent instars are entirely covered by the intact dorsal shell with the ventral derm in a more or less ruptured condition, or wholly puparial in the sense that the subsequent instars are enclosed within a shell which is ruptured only caudally, where a characteristic flap, which may or may not remain attached to the shell, is always produced. Within a single genus one species may be wholly puparial and another species not puparial at all. Thus the puparial state is not necessarily of generic, but may be of specific, importance.

SECOND-STAGE FEMALE

WAX

In color, texture, and general quantity the wax is similar to that found in the first stage of the same species.

SHAPE AND SIZE OF THE BODY

In outline the body is elongate elliptical, pyriform, or subcircular, with the posterior end more or less constricted and protruding. In cross section the body is rather flat beneath, with varying degrees of convexity above, ranging from a very slight convexity, giving the appearance of a strikingly flat individual, to a pronounced dome-shaped convexity, giving the appearance of a globular individual. From a lateral aspect (fig. 1) in puparial forms the body is predominantly flat beneath with varying degrees of convexity anteriorly and above, within limits both for the individual and the species, but always with the posterior end drawn out into a projection. From a lateral aspect in the single nonpuparial form the body is essentially as in its first stage but with a greater convexity above.

The size of the body varies with the individual and the species, ranging, for fully developed specimens of particular species, typically from about 0.52 mm long and 0.35 mm wide, to 2.2 mm long and 0.80 mm wide. Newly molted specimens may be as small as 0.35 mm long and 0.14 mm wide. The general shape and size of the body are of little generic value except in the genus *Platycoccus*.

BODY DERM

The term "body derm" is used here to cover the same characteristics as in the first stage. Segmentation ranges from being practically complete, except for that of the prothorax and both sections of the mesothorax on the venter, to being virtually obscure, except for the anal valve and its usual definition in part ventromesally on the abdomen.

The body may be practically membranous throughout in younger individuals, or membranous except for some sclerotization of the posterior end. In fully developed individuals, if nonpuparial, the body remains in a membranous condition; if puparial, it becomes rather strongly sclerotic on the dorsum, and may become only lightly, and never more than moderately, sclerotic on the venter.

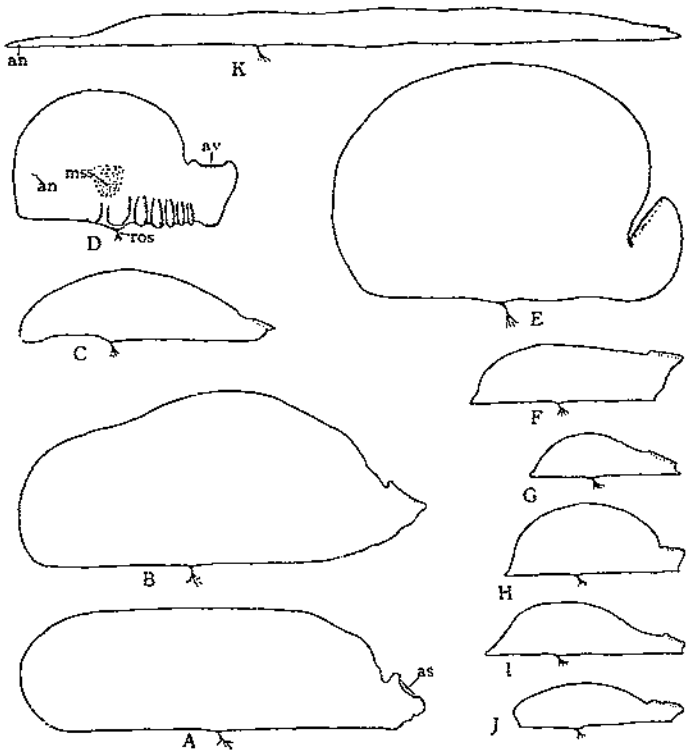

FIGURE 1.—Female puparia of species of the Phoenicococcini, lateral outlines (drawn to same scale): *A*, *Palmaricoccus altaleae*; *B*, *P. pritchardiae*; *C*, *P. nesiotes*; *D*, *Halimococcus lampas*; *E*, *H. thebaicae*; *F*, *H. borassi*; *G*, *Thysanococcus chinensis*; *H*, *T. pandani*; *I*, *T. squamulatus*; *J*, *T. calami*; *K*, *Platycoccus tylocephalus*. × 45.

Papillae are present or absent, numerous or scarce, localized or scattered over one or both surfaces or along the body margin, comparatively prominent or insignificant, and of various shapes, but predominantly spinelike. These papillary characteristics differentiate the species, but are of little generic importance. For instance, within a single genus the papillae may be highly developed or apparently absent. Papillae are most pronounced in young individuals, becoming increasingly obscure as sclerotization develops.

Definite spines are absent except on the dorsum of one species, where they assume a characteristic development. In all but 2 species of 1 genus distinctly reticulated surfaces are absent except on the anal valve, which may or may not possess distinct markings; if so, these markings are usually reticulate. Spicules are frequently plentiful ventromesally on the thorax caudad of the rostrum, and they may be present elsewhere on the ventral surface.

The derm of the body margin is either undifferentiated or the dorsal and ventral surfaces meet along a sharply defined line which may or may not possess a fringe apparently composed of minute specialized spicules or fine granulations. This fringe is of limited generic value, occurring, for example, in all the members of *Thysanococcus* but in no other species.

PORES

Apparently only two fundamental pore types may occur, the 8-shaped tubular and the quinquelocular-disk type. The structural conditions in both types are essentially as are found in the first stage, except that some pores of the 8-shaped tubular type assume a modified or "variating" form in one species only, distinguished from the ordinary kind as follows: With a single moderately sclerotic bar having flaring sides which seem frequently to fold up or collapse, a moderately sclerotic tube connecting the bar with the single external opening, a delicate partition extending nearly through the connecting tube, and a short, stout sclerotic bulla.

Tubular pores may be apparently absent, scarce, moderate in number, or abundant, localized or scattered, comparatively large or small; if absent, quinquelocular pores are always present in fair numbers, for the most part loosely scattered about the mesothoracic spiracles. Quinquelocular pores are always present, associated either with the mesothoracic or with both pairs of spiracles, or with neither pair. If not associated with either pair, quinquelocular pores always occur in a row along the margin, but they may be present along the margin and also associated with the mesothoracic spiracles in the same species. Around the spiracles quinquelocular pores vary considerably in number, but much less so along the margin. The position of the quinquelocular pores is of both generic and specific value; their sizes and numbers are largely of specific value only.

Tubular pores are in general smaller, more delicate, and more numerous in *Phoenicococcus*, *Palmaricoccus*, and *Platycoccus* than in the first stages of the respective species of these genera. Also the partitions are less in evidence through their membranous tubes in the first two above-mentioned genera. In *Platycoccus* and the other 2 genera the development of the partition assumes similar importance in the 2 stages. Disk pores are normally more numerous, and may be considerably so in all species of the tribe except one, than in their respective first stages.

SPIRACLES

The mesothoracic spiracles may open approximately on the surface, in shallow depressions, in rather deep roundish pockets, or in elongate granulate invaginations, the last two positions being of distinct generic value. The metathoracic spiracles are found in the first three positions. The spiraculariae are elongate or stout, distinct or indis-

tinct in outline, subequal in size and structure or not, their appearance being of some specific but of little generic value. Clear areas occurring laterad of the metathoracic legs in the first stage are apparently absent in this and all other stages.

BODY SETAE

The body setae show greater range in number and less range in size than in the first stage, but the homologies of many setae in the two stages are evident. The number and distribution of setae is of generic value in segregating *Phoenicococcus* and *Palmaricoccus*, in which they are most fully represented, from the remaining genera, and in separating the remaining genera from each other.

ANTENNA

The antenna is always tuberculate. The number and character of its setae are of generic value in segregating *Phoenicococcus* and *Palmaricoccus*, and in turn *Thysanococcus*, from the other genera.

ROSTRUM AND ROSTRALIS

The rostrum and rostral setae appear to be essentially as in the first stage of the same species, except for the position of the rostrum in relation to the neighboring tissue. In all puparial forms it is invaginated, whereas in the nonpuparial form it is little invaginated, if at all.

The rostralis, as with all other structures, including the head skeleton, is developed anew in this stage, and makes the same sort of movements preparatory to penetrating the tissue of the host as in the first stage. It ranges from being not quite twice as long to more than three times as long as in the first stage of the same species. It varies within limits for both the individual and the species. The development of all structures anew holds true for all stages, except possibly the third-stage female.

ANAL SEGMENT

The anal segment is composed of apparently the single segment caudad of the seventh abdominal one, as in the first stage. An anal valve may or may not be present; if so, it constitutes the whole anal segment and is always on the dorsal surface, with the anus more or less removed from the caudal margin. If the anal valve is absent, the anus is distinctly on the ventral surface near the caudal margin of the body. The anal valve is always sharply defined and depressed below the surrounding surface.

The details of the parts through which it apparently operates in one species (fig. 13, *B*) may be considered as representative for the tribe. An inner thickening on the surrounding segment serves as a buttress against which the hinge, or cephalic part, of the valve impinges, with the hinge resting upon a ledge or projecting under shelf of the surrounding segment and braced against an inner thickening of the latter. Several teeth of the surrounding segment can be seen forced into the hinge and buttressed by a ridge of the latter to hold the valve firmly in place. The valve can open outwardly only, since a ledge of the surrounding segment extends entirely around the opening. The laterocaudal margin of the valve is somewhat thickened.

The anal valve only rarely has pores, and these are always small and of the tubular type. Several pairs of setae always occur in various positions on the valve. These setae are of specific but of little generic value.

The anal ring may or may not be present in the species possessing the anal valve; if present, it is insignificant, but appears to be of some generic though of no specific value. The anal ring is prominent and anal-ring setae are present in the species having no anal valve, and the anal ring is of distinct value in separating this species from all the others.

PUPARIUM

The presence of the anal valve indicates that the instar is puparial. All species are either wholly puparial or not puparial at all in this stage. The nonpuparial condition is of generic importance.

THIRD-STAGE FEMALE

The structures of the third-stage female are vestigial, and there are apparently none that occur in the preceding instar except the two pairs of spiracles, which are well developed in this stage. The body derm appears to be complete, however, being either delicate or firm, though typically rather brittle, and is usually ruptured to some extent in being removed from the puparium, in which it fits rather tightly. In some species this instar separates from the puparium readily, in others with difficulty. This stage has not been indentified in the monotypic genera *Phoenicococcus* and *Platycoccus*, which are nonpuparial and puparial, respectively, and is apparently lacking in 1 species each from *Palmaricoccus* and *Thysanococcus*, but it is present in all 3 species of *Halimococcus*.

No other intermediate stages were observed in the female.

ADULT FEMALE

WAX

Wax produced in the nonpuparial form is of the same character as that in the first-stage and in the second-stage female. No wax was observed as produced by this stage in the puparial forms, although the number of pores present in each indicates that wax can be produced. The apparent absence of wax in the puparial forms seems to be due to their confinement in puparia.

SHAPE AND SIZE OF THE BODY

In the nonpuparial form the body at first is normally moderately elliptical in outline and moderately convex above in cross section, becoming rounder in outline and slightly more convex above in cross section in older individuals. In all other species the body assumes approximately the shape of the puparium containing it, except that the posterior end is less inclined to curve upward as observed from a lateral aspect, and none of its segments is expanded as is sometimes the case to a moderate degree early in the second stage and to a less degree in the later puparium.

In the nonpuparial form the body is appreciably larger than that of the second-stage female; a typical newly molted specimen being

0.52 mm long and 0.35 mm wide, and, when fully developed, 1.3 mm long and 0.98 mm wide. Thus the growth is seen to have more than doubled, and a typical fully developed adult is about double the size of a fully developed second-stage female, which is approximately 0.64 mm long and 0.42 mm wide. In the puparial forms the body is always smaller, but it may be very little smaller or considerably smaller, than the puparium containing it. The measurements for the adults in the smallest and largest puparia, the dimensions of which have already been given, were 0.48 mm long and 0.32 mm wide, and 1.3 mm long and 0.56 mm wide, respectively.

BODY DERM

The term "body derm" is used here in the same sense as in the first stage and in the second-stage female. Segmentation is always obscure on the dorsum except on the posterior abdominal segments, but is usually in evidence, at least in part, on the venter caudad of the rostrum.

The body is practically membranous at first except frequently for some sclerotization in the anal region, and it remains approximately this way in all puparial forms. In the nonpuparial form there is a great development of papillae, which cover all the ventromarginal and submarginal surfaces, giving the body a rather sclerotic appearance. But there is a definite sclerotization in the narrow sense of the word only when the instar is near maturity, the derm becoming heavy on the dorsal and lateral surfaces but remaining in a membranous condition, at least mesally, on the ventral surface.

In the puparial forms papillae are little more than localized around the spiracles and may be almost, if not entirely, absent here. Definite spines are absent, but spicules may or may not be numerous mesally on the ventral surface. The body margin is not indicated by any dermal markings; nor are there any other noticeable dermal markings than those already mentioned, except for frequent variously appearing striations in the vicinity of the vulva.

PORES

Two types of pores only are present in the nonpuparial form, the 8-shaped tubular and the quinquelocular disk type. With one exception, only one type of pore, the 8-shaped tubular, is found in the puparial forms. This one exception has quinquelocular pores on the sixth abdominal segment in a location similar to that of the circumgenital pores occurring in typical diaspids. The 8-shaped pores are apparently all of the ordinary kind in both puparial and nonpuparial forms. Thus the variating kind occurring in the second-stage female of one species apparently reverts to type in this stage of this species. The 8-shaped pores are smaller and more delicate than in the second-stage female, and the partition through the tubes may extend hardly more than through the bars in two species of *Palmaricoccus*. But in distribution the 8-shaped pores assume the same general significance as in the previously discussed stages in separating *Phoenicococcus* and *Palmaricoccus* from the other genera. In the remaining genera the 8-shaped pores are characteristically localized laterad of the head skeleton or in the midventral region, although a few may occur on the pygidium.

SPIRACLES

In all cases the spiracles open practically on the surface. The spiracular iae may or may not be subequal, but they always stand out clearly.

BODY SETAE

In structure the setae are approximately as in the second-stage female, except for a tendency to a greater specialization on the anal segment of some species. Their general distribution is homologous with that in the second-stage female, but their number is usually greater in varying degrees than in the latter.

ANTENNA

The antenna may or may not be essentially as in the second-stage female of the same species; the chief differences are the absence of a prominent central sunken area and a membranous base, in its form and size, and in the development of its setae.

ROSTRUM

The rostrum and rostral setae are essentially as in the second-stage female of the same species. The rostralis ranges from being slightly longer than to about twice as long as in the second-stage female of the same species.

ANAL SEGMENT

The anal segment embraces all of the apparently single segment caudad of the seventh abdominal one, as in earlier stages, but a sclerotization of its dorsal surface may be extended to include the seventh, and apparently even some of the sixth abdominal segment, giving the anal segment the effect of embracing more segments than it actually does. In the nonpuparial form the anal segment is not sclerotic and is well up on the ventral surface; in all other species it is partly on both surfaces, with the greater part on the dorsum. Its dorsal surface may or may not be partially or wholly sclerotic; when sclerotic it takes on the appearance of a pygidium and is so considered here.

Delicate processes, or squamulae, in general character closely resembling those of typical diaspids, may be present. These squamulae are confined to the laterocaudad margin of the pygidium and frequently appear to possess pores. Tubular pores opening on the surface may or may not be present on the anal segment, but there are always from 4 to 6 pairs of setae here. Some of these setae may be comparatively enlarged. In the puparial forms the anus is always well up on the dorsal surface, most frequently near the center of the anal segment. An anal ring and anal-ring setae may or may not be present.

SECOND-STAGE MALE

WAX

Data on wax are available only for *Phoenicococcus marlatti*. It is produced in somewhat larger quantity and laid down in denser fashion than in the female stages of this species, but is essentially of the same general texture and color.

SHAPE AND SIZE OF THE BODY

The body is predominantly elongate elliptical in outline, with the sides approaching the parallel condition in some cases. In cross section the body ranges from being noticeably flat on both surfaces to being no more than moderately convex above. Instars from round puparia for the most part assume a body outline similar to the latter, and it is natural to suppose that in cross section they should do likewise; but this is not the case, apparently owing to the collapse of the delicate dorsal derm in this stage during preparation of the material.

The size of the body varies appreciably, for both the individual and the species. The newly molted body may be of practically the same size as its first-stage one, or it may be considerably smaller, in both nonpuparial and puparial forms. In the nonpuparial forms some growth takes place; in the puparial forms there is little or no growth, except apparently in length in the instars of two wholly puparial forms, in which the posterior end is observed to project somewhat through the valvular opening of the puparium.

In the nonpuparial forms the range in size of typical newly molted specimens is greatest between species in a single genus, being from 0.29 mm long and 0.17 mm wide to 0.36 mm long and 0.20 mm wide. In the wholly puparial forms it is greatest between typical specimens of species in different genera, being from 0.29 mm long and 0.09 mm wide to 0.40 mm long and 0.18 mm wide. In the partially puparial forms the range is less, being typically from 0.44 mm long and 0.25 mm wide to about 0.47 mm long and 0.22 mm wide. In the nonpuparial forms the increase in growth of the individual is greatest within a single genus, being typically from 0.29 mm long and 0.17 mm wide to 0.46 mm long and 0.21 mm wide. The size of the body may be considered as of little generic importance.

BODY DERM

The term "body derm" is used here in the same sense as in previously discussed stages. Segmentation ranges from being practically complete, except on the venter cephalad of the mesothoracic spiracles, to being no more than a demarcation of the sclerotic posterior end of some forms.

The body may be practically membranous throughout, or membranous except for some sclerotization of the posterior end. In 2 puparial forms the posterior 3 or 4 abdominal segments are strongly sclerotic, appearing as a single piece which is sharply defined and projects from the puparium. As the instar approaches maturity the sclerotization increases in the nonpuparial forms, but it is not so heavy as frequently on the dorsum of the second-stage female.

Papillae may be absent or scarce, or they may be abundant along the body margin and submargin and around the spiracles. The extremes of papillae being absent or abundant occur within one genus, but the forms involved are puparial and nonpuparial, respectively. The nonpuparial forms always have at least some papillae, which may be scarce and localized. The partially puparial forms are apparently without definite papillae. The wholly puparial forms may or may not possess any; if so, they are always localized and comparatively insignificant. The presence or absence of papillae is of little generic but may be of definite specific value.

Spines are absent, but spicules may be numerous ventromesally on the thorax and abdomen, or in contrast may be practically absent from the body. No reticulated areas or other prominent body markings are present, except that in one species many fine, short, irregular lines are typically intermixed with a row of tubular pores along the ventromarginal and submarginal surfaces. The derm of the body margin is undifferentiated or, if papillae occur in this region, they may be distinguished by their character.

PORES

Five pore types may occur—an ordinary 8-shaped tubular, an asymmetrical or undivided tubular, a quinquelocular-disk, a trilocular-disk, and a quadrilocular-disk type. The last two types are present only occasionally, a pore of either type in one species replacing a quinquelocular pore normally associated with each metathoracic spiracle. The 8-shaped tubular and the quinquelocular and trilocular disk types are of the same general character, exclusive of certain variations in size and shape, as corresponding types occurring in the first stage. The quadrilocular-disk type differs in essentials from the other disk types only in the number of its loculi. The asymmetrical tubular type is characterized by having apparently a single sclerotic bar with no more than a mild central depression, a distinct bulla issuing from the inner lateral margin of the bar, and a single membranous tube connecting the bar with the external opening.

All pores, or the disk type only, may be absent from the body, or either tubular type may be scarce or abundant. Both tubular types, or either type alone, may occur in the same species. Tubular pores may be less or considerably more abundant than in the second-stage female of the same species or even in all species of the same genus. In *Phoenicococcus* and *Palmaricoccus* the distribution and structural conditions (excluding size) of the tubular pores are essentially of the same character as in the second-stage female of the same species. Thus, these genera can also be segregated from the other genera in this stage, as in the previously discussed stages, by the character of their tubular pores. When present the disk type of pore is always associated with either pair, or with both pairs, of spiracles, and pores of this type are no more numerous, or, much more frequently, distinctly less numerous than the spiracular pores in the second-stage female of the same species.

SPIRACLES

Both pairs of spiracles always open approximately on the surface. The spiraculariae are usually subequal and elongate, and may or may not be strongly sclerotic.

BODY SETAE

The comparison presented between the body setae of the first stage and those of the second-stage female can be similarly applied between the first stage and this stage. The body setae may be less numerous, more numerous, or in about the same numbers in both sexes of the second stage of the same species, even in the same genus (*Palmaricoccus*).

ANTENNA

The antenna is always tuberculate. It is segmented and prominent in the nonpuparial forms, but is hardly more than a slightly thickened spot in all except one of the wholly puparial forms. In this one exception it may or may not be a mere thickened spot, but it is never more than a simple rounded tubercle. In the partially puparial forms the contrast between the development of the antenna in the two sexes of this stage is slight or insignificant. The puparial condition seems to exert a definite influence on the development of the antenna.

ROSTRUM AND ROSTRALIS

The rostrum and rostral setae are similar to these parts in the first stage and the second-stage female of the same species. The rostralis is always longer than the body, but may be very little longer or more than five times as long; the closest agreement and the greatest disparity between the length of the rostralis and that of the body occur in two wholly puparial forms but in different genera. The rostralis is always shorter than in the second-stage female of the same species, ranging from less than one fourth to more than one half as long. It may be moderately shorter than, but not one half as short or more than twice as long as, that of the first stage of the same species. When a corresponding comparison is made of the length of the rostralis in the second-stage male, the second-stage female, and the adult female of each species, a general tendency is revealed for the rostralis to vary in length proportionately among these stages; but the rostralis of the first stage fits in less satisfactorily with this proportionate variation in length. The length of the rostralis for any stage appears to be of little generic, but may be of definite specific, value.

LEGS

Vestigial legs may be obscure or distinct, even to showing evidences of segmentation and in the possession of setae. All three pairs of legs are not always equally developed.

ANAL SEGMENT

The anal segment embraces apparently the single segment caudad of the seventh abdominal segment, as in previously discussed stages. In *Phoenicococcus* there is a close resemblance between the general character of the anal segment in this stage and that in the second-stage female. In all the other species there is a closer similarity between the anal segment in this stage and that of *Phoenicococcus* in this stage than there is between the anal segment of any of them in this stage and that of their respective second-stage females, owing to the presence of an anal valve in all the second-stage females. The presence or absence of an anal ring and anal-ring setae agrees with the situation in the first stage of the same species.

THIRD-STAGE MALE

There is no reason to believe that the third-stage male is ever absent, although specimens of some species were missing in the writer's material. All specimens available indicate that the body is

moderately elliptical in outline and, in general, with evenly rounded anterior and posterior ends. In cross section it is moderately convex above. The body is slightly smaller than that of the fully developed second-stage male of the same species. The distribution of body setae is apparently homologous with that in the previously discussed stages.

The anal segment embraces the entire apparently single segment caudad of the seventh abdominal one, as it does in the previously discussed stages. On the meson of the ventral surface of the anal segment is a sclerotic area with an inwardly projecting piece (fig. 7), which apparently, from the way the caudal segment of the developing subsequent instar is folded around it, is the connection in this region between this instar and the subsequent instar. The increased body length of the fourth instar makes something like this necessary. For a similar reason the two basal segments of each appendage of the fourth instar are developed more or less outside these parts of the third instar, in a telescoped fashion. Other structural matters dealing with the third-stage male are discussed in the section on classification.

FOURTH-STAGE MALE

The body differs in shape from that of the preceding instar in being slightly longer and narrower in outline, possibly somewhat flatter above in cross section, and in having a characteristic caudal projection. In segmentation, sclerotization, and number and distribution of setae the body proper is essentially as in the preceding stage of the same species, except that the caudal projection is clearly defined as a separate segment, with an intervening segment between it and the seventh abdominal one. The caudal projection then apparently constitutes the ninth abdominal one and bears the anus. If this is so, the anal segment in previous stages is actually composed of at least the eighth and ninth abdominal segments. The determination of the particular segment to which the setae of the composite anal segment belong is believed possible from their location in relation to each other and to the anus, and from the usually larger size of one in a pair on each side along the ventrocaudal margin of all the male stages up to and including this stage.

The increased length of the body and its appendages in the adult male makes it necessary for some parts to develop apparently outside the corresponding parts in the fourth instar. This crowding out is most noticeable at the posterior end where the long caudal projection of the adult male extends to the sixth abdominal segment, or beyond, in the fourth instar (figs. 8 and 16), pulling with it the eighth abdominal segment of the adult, which is folded back over the segment or segments immediately cephalad of the latter. The base of the caudal projection of the adult may also be bent over. For a further discussion of the structural parts of the fourth-stage male the reader is referred to the section on classification.

ADULT MALE

SHAPE AND SIZE OF THE BODY

The shape of the body is predominantly elongate elliptical. In some forms the sides approach the parallel condition; in others a mild bulging of the thoracic segments in particular is noticeable along

the margin. The posterior end is always drawn out into a smooth rapierlike projection.

There is a considerable variation in the size of the body, the range in the available material, both for the individual and for the species, being approximately from 0.37 mm long and 0.12 mm wide, to 0.59 mm long and 0.19 mm wide, measuring in all cases to the tip of the posterior projection.

BODY DERM

The term "body derm" is given the same significance here as previously. Segmentation ranges from being complete to more or less obscure over the greater part of the ventral surface; also the anterior section of the mesothorax on the dorsum may not be defined. The body is membranous except for some sclerotization of the posterior end. Papillae and spines are absent, spicules insignificant or practically absent. The body margin lacks configurations and is not well defined.

WINGS AND THORACIC WING FRAMEWORK

This group of insects is characteristically without well-developed wings and the thoracic wing framework is practically absent. There is no sign of even vestigial wings except in one species.

SPIRACLES

The spiracles open approximately on the surface. The spiraculariae are prominent and inclined to be stout and appreciably sclerotic.

BODY SETAE

In number and distribution the setae are essentially as in the two preceding instars of the same species, but in size they are longer in general and some of them appreciably larger and longer on the head and posterior end than the corresponding ones in the two preceding instars.

ANTENNA

The antenna occurs characteristically with two stout basal segments and a distal club. The club varies considerably in form and in the number of its segments for each species, ranging from being noticeably stout to rather slender, and having from 3 to 8 segments. The setae on the club vary greatly in form, size, and number among the various species, but are relatively stable in these characteristics for the individuals.

The character of the antenna may be of some generic value, but more frequently it is of specific value.

EYES

Either one or two pairs of simple eyes are present, the extra pair always being somewhat smaller and situated on the ventral surface well removed from the other pair, which is on or near the body margin. The number of pairs of eyes is not distinctive for any one genus.

HEAD SKELETON AND ROSTRUM

Only possibily the merest vestiges of the head skeleton and none of the rostrum are ever present except in one species, where both of these structures can be recognized but are in a decidedly vestigial condition. It is in this species that vestigial wings occur.

LEGS

The legs are well developed and in general of stouter proportions than in the first stage; also the metathoracic pair are typically stouter than the others. The number and character of the leg setae vary greatly and may be of both specific and generic value. Pronounced sensory areas on the legs are present in *Phoenicococcus* and are of value in separating this genus from all the others.

ANAL SEGMENT

The anal segment embraces the ninth, but not the eighth, abdominal segment, as in the preceding stage. The posterior projection is a sheath having a deep central, but open, channel for holding, guiding, and generally supporting the penis. It is termed here the "genital sheath," and appears to be of but little generic or specific importance. The anus varies in prominence and location, but these features seem to be of no generic and of little specific value. The number of setae on the anal segment is not distinctive for any one genus, but seems to be of use in separating *Halimococcus* and *Platycoccus* from the other genera.

CLASSIFICATION

The Phoenicococcini possess the characteristics listed below which can distinguish the group, in that one or more of these characteristics do not hold for some corresponding stage or stages in any other coccid species.

Absent in all stages.—Characteristic secretionary formations or resinous secretions, gall formations, cerarii, dorsal ostioles, ventral cicatrices, brachial plates, dorsal spines, cribriform plates, more or less sessile unilocular pores, bilocular-disk pores, multilocular pores with more than five openings, clearly distinguished partitions entirely through tubes of tubular pores including external openings (the latter appearing 8-shaped) or a separation of tubes of tubular pores into two parts, sclerotic areas near inner end of a tubular pore separated by a membranous area, inner ends of any pores with a characteristic and apparently normal twisted 8-shaped effect, 8-shaped pores noninvaginated or so slightly as to be as broad as the invaginations are deep, anal-ring pores, any other than tubular pores on the two posterior abdominal segments, abdominal spiracles, distinct setaceous areas, generally distributed spiniferous areas (a spiny area present, localized on dorsal surface of second-stage female in one species), a segmented beak or rostrum, an invaginated anus, anal cleft, anal plates, anal lobes, anal tubercles (undifferentiated caudal bulges of body derm present in first stage of some species), pygidial lobes, abdomen with clearly emarginated caudal end.

Absent in all stages except adult female.—Pygidium, pygidial plates or squamulae, pores on anal segment appreciably projecting beyond body margin (last two characteristics present in adult female of one species only).

Absent in all stages except second-stage male.—Any other than these three pore types—a tubular type with 8-shaped effect at inner end of pore, a trilocular type, and a quinquelocular type.

Absent in adult male.—Any other than a single smooth rapierlike posterior projection, thoracic wing framework and well-developed wings, compound eyes or more than two pairs of simple eyes, ocelli.

In first stage setal shafts not forked or with serrated margins or lateral projections, with two pairs of characteristically long, closely associated caudal setae, much longer than any other body setae and with inner pair considerably the longer, but only moderately larger at base than the outer pair, antenna with six segments only, or of the annulated type possessing either 13 or 14 setae, anus distinctly on ventral surface or on, or practically on, caudal margin. In second and adult female stages eyes and legs absent, antenna tuberculate, possessing no more than a 1-segmented sclerotic piece and an insignificant membranous base, rostrum well developed. In adult female having anus on dorsal surface, with no more than six pairs of tubular pores altogether on the three posterior abdominal segments, or on pygidium if present. In second-stage male eyes apparently absent, antenna no more than tuberculate, legs quite vestigial or absent.

This rather long list of items gives in detail the limitations of the tribe, but its members can be segregated from all other coccids by the following characteristics: Absent in all stages, abdominal spiracles, cerarii, dorsal ostioles, more or less sessile 8-shaped pores, tubular pores with their external openings double or 8-shaped, multilocular pores with more than five openings, anal-ring pores, anal cleft, anal plates, anal lobes, pygidial lobes; the absence of a pygidium in all stages except the adult female; absent in adult male, compound eyes, thoracic wing framework; except in second-stage male, the presence of the asymmetrical type of tubular pore; present in first stage, anus on ventral surface or on, or practically on, caudal margin of body only, two closely associated pairs, no more and no less, of comparatively long caudal setae, the inner pair always being distinctly longer than the outer pair.

The grouping of the members of the Phoenicococcini as given here is only a tentative arrangement. For practical purposes they can be separated satisfactorily into several genera, but when data on additional material are available this classification may not hold. Also the writer lacks an adequate understanding of the significance to be attached to practically all the characteristics exhibited by these insects, and hence those used in segregating the respective stages of the various species. After all, there are only 12 species involved, peculiar in that they evidently do not fall within any established group or have any definitely recognized affinities. Until an adequate study of sufficient material in the group has been made, and probably also until more is known concerning the true significance of comparable structural features in other coccids, no sound classification of them is possible, nor is a statement justified as to the phylogenetic ranking of the genera or the species within the genera.

The 12 species placed in the tribe Phoenicococcini are segregated into 5 genera, 3 of which are newly established here. The more important reasons for this segregation follow.

Phoenicococcus Cockerell, as typified by its single species, can be distinguished from all other species in the tribe in that the second-stage female lacks an anal valve and the position of the anus in relation to other parts of the body in this stage and in the adult female is strikingly different from that in the corresponding stages of the other species.

The three species assigned to *Palmaricoccus*, new genus, can be distinguished from the remaining eight species in that all 8-shaped tubular pores have partitions almost through their membranous tubes; the egg has only a single spine; the first stage has a larger number of setae on the abdomen, the first two antennal segments, and each trochanter, and has a prominent anal ring; the second-stage female

has more setae on the head, abdomen, and antenna; the adult female has the 8-shaped tubular pores scattered over at least the ventral surface of the body, and the antenna also has a larger number of setae.

Platycoccus, new genus, as typified by its single species, can be distinguished from all other species of the tribe in that the egg has two disconnected spines, the second-stage female has the head prolonged as a distinct projection, the puparium is markedly flat, and the tubular pores are comparatively numerous along the body margin, particularly laterad of the head skeleton.

The three species assigned to *Halimococcus* Cockerell can be distinguished from the four remaining species of the tribe in that the first stage has the external openings of the tubular pores approximately flush with the surface, the mesothoracic spiracles are within small invaginations which open to the surface away from the body margin, and it has the 6-segmented type of antenna; the second-stage female lacks a fringe around the body margin, has few tubular pores, not enough to form a long row, has five or more times the number of quinquelocular pores associated with the mesothoracic spiracles, which open into roundish pockets, and the antenna has two minute setae only.

The four species assigned to *Thysanococcus*, new genus, can be distinguished from all other species in the tribe in that the first stage has the external openings of the tubular pores on small sclerotic projections, the mesothoracic spiracles within prominent granulate invaginations which open to the exterior approximately on the body margin, and the annulated type of antenna; the second-stage female has the body margin more or less fringed, the mesothoracic spiracles within elongate granulate invaginations, and the antenna always with one or two rather prominent fleshy setae, but no more.

Of the 11 species included here as relatives of the date palm scale (*Phoenicococcus marlatti*), 4 have been previously described and 7 are recorded as new. As far as is known, no synonyms have occurred in the literature for any of the previously described species except *P. marlatti*, which has appeared under the names *Sphaerococcus draperi* (*4, p. 12; 14, p. 70*) and *S. marlatti* (*3, p. 11; 7, pp. 14–15; 8, p. 37; 9, p. 34; 11, p. 248; 14, p. 104; 16, p. 221*). Morrison (*13, p. 671*) has stated that this species "has no close relationship whatever with *Sphaerococcus*", and after an examination of some *Sphaerococcus* material, the writer also vouches for the fact that *P. marlatti* does not belong there.

Subfamily PHOENICOCOCCINAE, new subfamily

This subfamily is created for the reception of the single tribe Phoenicococcini, new tribe, which in turn is created for the reception of the five genera with which this bulletin is particularly concerned. The characterization of the tribe as given below will, for the present, serve for the subfamily as well.

Tribe PHOENICOCOCCINI, new tribe

TRIBAL CHARACTERISTICS

Egg

Derm membranous, very delicate; no recognizable structures present except 1 or 2 single spines or a single group of 3 to 12 spines, all mesally situated on or near the cephalic margin; all spines distinctly sclerotic; the single spines rela-

tively broad and short, almost tuberculate in form but always acutely pointed; spines in the group more characteristically spinelike in form, comparatively stout, and varying in size, position, and degree of crowding in each group, not only for the species, but mostly in a lesser degree for the individual as well; body derm around bases of single spines not sclerotic, but that around the bases of groups moderately sclerotic, and the sclerotization somewhat changeable in outline.

First Stage

Wax frequently little or not at all in evidence, or may entirely cover body, especially in nonpuparial forms; filamentous or matted in appearance and whitish in color. Body elongate elliptical, with or without bulges along caudal margin; in cross section younger specimens more or less flat, but in older ones may or may not be distinctly roundish; its segmentation may be nearly complete or only partially indicated, if the latter, mostly so on abdominal segments; may be membranous throughout or posterior abdominal segments, especially the caudal or penultimate segment or both, may be sclerotic, and there may also be some sclerotization around head skeleton and rostrum; may or may not be firm in contour and margins more or less serrate in appearance. Only three types of pores normally present, an ordinary 8-shaped tubular, a trilocular-disk, and a quinquelocular-disk type; 8-shaped tubular type and either the trilocular or quinquelocular disk types always present, but not all three types in same species. Tubular pores situated on body marginally, submarginally, or dorsomesally, never decidedly ventromesally, much more often occurring on or near margin, with no more than 2 pairs to 1 segment, and ranging in number from 1 to about 16 pairs; may be small or large, slender or stout, delicate or pronounced in appearance, and vary distinctly in size for any one species; in such a case smaller pores more frequently submarginal or mesal in position, larger ones more marginally situated. For any one species all trilocular or quinquelocular pores closely associated with mesothoracic spiracles alone or with both pairs of spiracles, but not with metathoracic spiracles alone; no more than 1 such pore associated with any one spiracle; may or may not be comparatively large, may or may not have indented margins, may or may not be invaginated. The mesothoracic, but not the metathoracic, spiracles may or may not be invaginated; spiraculariae elongate or stout, strongly sclerotic or only moderately so, subequal or not. A clear area laterad of each metathoracic coxa may or may not be in evidence. The majority of body setae usually short, insignificant in appearance, and distributed in general over all segments, mostly in recognized positions with the larger number in rows on or near the body margin; from 1 to 4 pairs on ventral surface of head always larger and longer than the other head setae, 1 ventromesal pair each on mesothorax and metathorax may or may not be comparatively prominent, a row entirely around body margin noticeably long and spinelike may be present, 2 pairs on or near caudoventral margin of anal segment, much longer and usually much larger than any other body setae, always present, with the more mesal pair almost or quite half the length of body or more, and the outer pair from about one fifth to three fourths the length of the mesal pair; typically from 9 to 12 pairs on head, 3 to 4 pairs on prothorax, 4 to 7 pairs on mesothorax, 3 to 8 pairs on metathorax, none to 5 pairs each on first to seventh abdominal segments, inclusive, and 5 to 7 pairs on posterior abdominal segment; in all, 33 to 69 pairs present. Antenna either of the 6-segmented or of the annulated type; if the former, the basal segment may or may not be twice as broad as any other, and distal segment considerably longer and may be more than twice the length of any other segment; basal segment of 6-segmented type, with from 2 to 4 slender setae, second segment, none, 1, or 2 slender setae; third, none to 4, 1 of which may be fleshy; fourth, none or 1 fleshy seta; fifth, 2 or 3 slender setae and 1 fleshy seta; and sixth segment, 2 to 4 slender setae, 2 of which are always apical in position and noticeably long, and 5 fleshy setae; if of the annulated type, from 2 to 4 basal segments more or less delimited, and with either 13 or 14 setae scattered over the antenna; distal margin of second segment of both types with a more or less spinelike process, or possibly a pore, almost always in evidence, and sixth segment, or annulated part, as the case may be, always with a pair of minute structures, apparently invaginated setae. If this stage is nonpuparial, rostrum not invaginated; if wholly puparial, rostrum appreciably invaginated, producing an apparent opening quite noticeable when rostrum is withdrawn during molting; rostrum with apparently none or 1 to 3 distinct pairs of setae, 2 of which are always distad in position; rostralis always with 1 characteristic small cephalic loop and 1 to 3 other loops of various sizes, shapes, and positions, when uncoiled within body. Legs may be slender or rather stout; trochanter and femur, also tibia and tarsus,

may be fused; fleshy leg setae absent; typically from 3 to 6 and either 2 or 3 setae on coxa and trochanter, respectively, 1 seta on each of these segments being always minute and situated near basal articulation of segment, none to 3 setae on femur, none or 1 on tibia, if present always on inner margin, 3 on tarsus, 1 being on inner margin and the other 2 on outer distal margin, besides a more or less spinelike process nearly always in evidence on outer margin of tarsus, and 1 pair of setae on inner margin of basal part of claw. Anus always approximately on caudal margin; anal ring and anal-ring setae may or may not be present. Male instar nonpuparial, partially puparial, or wholly puparial.

Second-Stage Female

Characteristics of wax essentially as in first stage of same species. Body outline either moderately or elongate elliptical, pyriform, or subcircular with posterior end constricted; in cross section younger specimens moderately convex above or markedly flat; if nonpuparial, changes comparatively little in shape; if puparial, becomes much more convex above and may become almost globular in appearance over its greater part or may remain decidedly flat; general outline continued evenly around both ends, or either anterior or posterior end projecting, but without bulges along caudal margin; its segmentation may range from being nearly complete for all segments to being practically obscure throughout, except for anal segment; younger specimens membranous throughout or posterior end may be moderately or strongly sclerotic; if nonpuparial, it remains membranous throughout; if puparial, it becomes sclerotic on dorsum but remains membranous, or at least no more than moderately sclerotic, on venter; body margin rounded and well defined or not, or may appear as a sharply delimited line either simple in character or fringed with what appear to be fine spicules or granulations; papillae present or absent, if present, may be insignificant or prominent in appearance, scarce or abundant, localized or generally distributed, typically more numerous marginally and submarginally. Only two fundamental pore types present, the 8-shaped tubular, either ordinary or variating in structure, and the quinquelocular-disk type; both types present, or apparently the quinquelocular type alone, in a single instar. Tubular pores may be of the ordinary kind only, as in the first stage, or both the variating kind and the ordinary kind may be present; tubular pores may be scarce, moderate in number, or abundant, ranging in number from 1 or 2 to about 800. Quinquelocular pores may be associated with both pairs of spiracles or with mesothoracic, but not with metathoracic spiracles alone; they may or may not be invaginated, if so, apparently always open on body surface; when present, from 1 or 2 to nearly 60 associated with each of 4 spiracles. Quinquelocular pores may occur singly or in about 6 to 17 groups, each with from 1 to 5 pores, in a marginal or submarginal row extending almost around body margin; noninvaginated; when present, typically from 19 to 31 pores on each side. Both pairs of spiracles may be situated on surface or in shallow depressions or deep pockets, or the mesothoracic, but not the metathoracic, pair alone may be in shallow depressions or in distinct pockets or in elongate invaginations from body margins; when in deep pockets, accompanied by quinquelocular pores of at least two distinct sizes, the larger ones opening on surface, the smaller ones situated well within the pockets; spiraculariae elongate or stout, prominent or obscure, subequal or not. The distribution of body setae is of the same general character as, but they vary much less in size and considerably more in number than, in first stage, ranging in number typically as follows: Head, none to 14 pairs; prothorax, none to 7 pairs; mesothorax, 1 to 10 pairs; metathorax, 2 to 9 pairs; first abdominal segment, none to 3 pairs; second to seventh abdominal segments, inclusive, none to 7 pairs each; anal segment, 3 to 7 pairs; in all, 8 to 77 pairs present. Antenna with or without membranous base; sclerotic part may be rounded or irregularly fashioned, and may or may not have a central sunken area; always with at least two small invaginated setae, and may possess from none to as many as five fleshy setae of varying lengths. If this instar is nonpuparial, rostrum not invaginated; if puparial, rostrum appreciably invaginated, producing an apparent opening into body cavity that becomes a distinct slit when, on molting, rostrum is withdrawn entirely within body; rostral setae of same general character as in first stage of same species; rostralis always with a characteristic small cephalic loop and three additional loops of varying forms, when uncoiled within body; if body derm is membranous on venter, rostralis of adult is forced through undifferentiated tissue in varying locations near caudal end of rostral slit; if body derm is sclerotic on venter, rostralis of adult is forced through either one of a pair of membranous areas on each side of rostral slit, or

through a single mesal membranous area caudad of rostrum. Anal valve present or absent; if absent, this instar not puparial and anus distinctly on ventral surface; if present, this instar puparial and anus well up on dorsal surface; sharply defined and sunken below the surrounding laterocaudal surface; except basally, its covering tissue frequently appears reticulated or imbricated; only rarely with pores, these tubular, with no more than two pairs present, minute or almost obscure and situated along caudal margin; anus may be fairly large or minute; anal ring and anal-ring setae may or may not be present.

Third-Stage Female

Not observed in nonpuparial form. May or may not be present in puparial forms; if so, body with comparatively few recognizable structures. When present, body fits snugly within puparium. Body derm may be delicate or firm and distinct; without recognizable papillae, pores, setae, antennae, head skeleton, rostrum, or any other structures occurring in preceding stages, except the two pairs of spiracles which apparently are always well developed. Many thin roundish spots may be present in body derm, evidently to accommodate tubular pores of preceding instar; each either empty or with a pore, in material removed from a puparium. Sclerotic tubercles may be present on body derm, varying in number and size for both individual and species. On development of adult, head skeleton and rostrum of puparium simply drop down or swing around into an inverted position.

Adult Female

When observed, texture, color, and quantity of waxy matter essentially as in second-stage female of same species. Body either moderately or elongate elliptical or pyriform, with anterior or posterior end either projecting or not, but with no distinct bulges along caudal margin; shape of nonpuparial form at first similar to that of second-stage female, but in older specimens rounder in outline and more convex above in cross section; shape of partially and wholly puparial forms, in both younger and older specimens, similar to that of second-stage female of same species; segmentation obscure, except occasionally on ventral surface of thorax caudad of rostrum and of abdomen and on dorsum of posterior end of partially and wholly puparial forms; young individuals may be lightly sclerotic throughout and older ones heavily sclerotic on dorsum, or both young and old individuals may be practically membranous throughout, or membranous except for sclerotization of posterior end; body margin rounded and indistinctly defined, never with a fringe; papillae present or absent, if species nonpuparial in female, more or less densely covering marginal regions and prominent, if puparial, scarce and localized and not so prominent. Only two pore types present, the ordinary 8-shaped tubular and the quinquelocular-disk type; both types may be present, or only the tubular one, but not the quinquelocular type alone; tubular pores scarce, moderate in number or numerous, scattered over venter or over both surfaces or localized on venter largely along margin and submargin, or largely in a pair of indistinctly defined clusters situated mesally on thorax only or on both thorax and abdomen; anal segment may or may not possess up to about six small pairs; in all, typically from 8 to 360 tubular pores present; if species is nonpuparial in female, quinquelocular pores always associated with both mesothoracic and metathoracic spiracles, typically to the number of 6 to 30 and 1 to 15, respectively, with each pair, and present nowhere else; if puparial in female, no quinquelocular pores associated with either pair of spiracles, but rarely in an irregular band having typically from 20 to 26 pores, on sixth abdominal segment. Both pairs of spiracles open approximately on surface; spiracularine elongate or stout, clearly sclerotic, and may or may not be subequal. Distribution and size of body setae of same general character and usually as numerous as, and may be distinctly more so than, in second-stage female; typically from none to 20 pairs on head, 4 to 40 pairs on thorax, and 11 to 50 pairs on abdomen; in all, 17 to 110 pairs present. Antenna with or without a prominent central sunken area and membranous base; with from 1 to 5 fleshy setae and a small pair of partially or wholly invaginated setae, or with a pair of partially invaginated setae only. Rostrum, rostral setae, and rostralis of same general character (not considering size) as in second-stage female of same species. A pygidium may or may not be present; if absent, anus may be distinctly on dorsal or distinctly on ventral surface; pygidial area apparently may be restricted to anal segment or extend cephalad onto seventh, and even sixth, abdominal segment; anal segment with from 2 to 6 pairs of tubular pores, always located along caudal margin, and with from 2 to 6 pairs of setae of varying sizes and positions; pygidial plates or squamulae, in the sense of delicate processes

projecting from the caudal margin, rarely present; no such plates or squamulae anywhere else on body; anus may be minute or comparatively large; anal ring and anal-ring setae may or may not be in evidence.

Second-Stage Male

Waxy secretions, when observed, of same general texture as in other stages, but inclined to be denser and cover body better. Body moderately or elongate elliptical, with anterior and posterior ends more or less evenly rounded; segmentation may be nearly complete or obscure except partially on venter of thorax and abdomen; very lightly sclerotic in general, or membranous except for sclerotization on posterior abdominal segments; margin indistinctly or clearly defined, but never fringed; papillae present or absent, if present, scarce or fairly abundant but localized along margin and submargin or on posterior end. Three pore types normally present, the ordinary 8-shaped tubular, an asymmetrical tubular, and the quinquelocular-disk type, which in one species may occasionally be replaced by either the trilocular or the quadrilocular disk type; if preceding instar is wholly puparial, all types of pores apparently may or may not be absent, if nonpuparial or partially puparial, all pores never absent; apparently the 8-shaped tubular type only, both tubular types only, or the 8-shaped tubular and a disk type, or the asymmetrical tubular and a disk type, but not a disk type only, may be present in any one species; 8-shaped tubular pores delicate or pronounced in appearance, scarce or numerous, localized or scattered over both surfaces, and, when present, ranging in number from 6 to 350; asymmetrical tubular pores moderately prominent and localized in distribution, typically 1 to 2 and 2 to 6 occurring on anterior and posterior ends, respectively, or in a ventromarginal and submarginal row containing about 50 well-distributed but irregularly placed pores extending almost entirely around body; when present, typically from 1 to 8 disk pores associated with each mesothoracic and from 1 to 3 with each metathoracic spiracle, or a single pore with each one of either pair of spiracles alone. Spiracles open approximately on surface; spiraculariae elongate, and may be decidedly so, lightly or strongly sclerotic, subequal. Distribution, size, and number of body setae may or may not be approximately as in second-stage female of same species; their range in number of pairs typically as follows: Head, 5 to 15; thorax, 4 to 25; abdomen, 8 to 43; in all, 23 to 80 pairs present. Antenna may be more vestigial, less vestigial, or essentially as in second-stage female of same species. Rostrum and rostral setae apparently similar to these parts in second-stage female of same species, but rostralis may be reduced to one shallow loop besides the characteristic small cephalic one. Legs vestigial, but showing a varying degree of development; may be entirely obscure or, in contrast, may show evidences of segmentation and possess minute setae. Anus on or near caudal margin; prominent or minute; with or without anal ring and anal-ring setae.

Third-Stage Male

Body moderately elliptical in outline, with the anterior and posterior ends evenly rounded in general; in cross section moderately convex above; segmentation may be almost complete and distinct; membranous throughout; papillae and pores absent. Vestigial wings may or may not be present; if so, the two subsequent instars also with vestigial wings; if absent, the two subsequent instars without any evidence of wings. Spiracles open approximately on surface; spiraculariae may not be sharply defined or only very moderately sclerotic, apparently subequal. Body setae essentially of same character, but may be less or greater in number than in preceding stage of same species, but at least always with several pairs on posterior abdominal segment; their distribution of the same general character as in first stage and female stages; mostly small, delicate, and with unusually short shafts, but frequently with a prominent pair on caudal margin of posterior abdominal segment. Antenna and legs externally developed; without recognizable pores or setae; more or less distinctly segmented, indicated by indentations and sclerotic areas; typically short, stout, and tapering toward their apices. Outlines of head skeleton and rostrum complete and distinct, but the parts in a vestigial condition. Eyes and rostralis absent. Anus on or near caudodorsal margin; distinct. Connection with developing ninth abdominal segment of subsequent instar usually distinctly in evidence on or near caudoventral margin of posterior abdominal segment.

Fourth-Stage Male

Body moderately or elongate elliptical; anterior end evenly rounded in general but posterior end always with a short stout projection, the ninth abdominal segment; segmentation and sclerotization essentially as in preceding stage; papillae and pores absent. Spiracles, spiraculariae, and body setae similar to these parts in preceding stage of same species, except spiraculariae usually slightly better defined and more sclerotic. Antenna and legs more developed than in preceding stage, more elongate, and their segmentation and sclerotization more pronounced; without recognizable pores or setae; legs may or may not be sharply elbowed. Outlines of head skeleton and rostrum may or may not be complete; in all cases observed in a more vestigial condition than in preceding stage of same species; invagination to alimentary tube apparently always present. Eyes and rostralis absent. Anus always well up on dorsal surface, usually distinct. Connection with developing ninth abdominal segment of subsequent instar generally obscure.

Adult Male

Bod longate elliptical in outline, with posterior end always projecting as a smooth, more or less sclerotic, rapierlike structure; in cross section flatter than fourth-stage male; segmentation may be complete or only partially so; membranous in general; may or may not appear delicate. Thoracic wing framework absent, or, at most, possibly indicated in one species by a depression along cephalic and caudal borders of mesothorax; wings absent, or in one species in a vestigial condition. Spiracles open approximately on surface; spiraculariae elongate or stout, mostly strongly sclerotic, and subequal. In distribution and size body setae essentially of same general character as in first stage of same species; in the available complete records varying in number as follows: Head, 9 to 11 pairs; prothorax, 4 to 6 pairs; mesothorax, 2 to 8 pairs; metathorax, 2 to 6 pairs; first to eighth abdominal segments, inclusive, none to 5 pairs each; ninth abdominal segment, either 3 or 4 pairs; in all, 31 to 66 pairs present. Antenna with 2 stout basal segments and a distal club composed of from 3 to 8 segments; club may be stout or elongate; basal segment with 2 or 3 slender setae; second segment with 3 to 5 slender setae; club segments with a varying number of slender, fleshy, or spinelike setae, in all ranging from about 14 to 60 in number; a pair of very small invaginated setae apparently may or may not be present on distal segment of club. Either 1 or 2 pairs of eyes present, 1 pair slightly smaller than the other and distinctly on ventral surface. Head skeleton absent except for possibly an extreme vestige or so, and rostrum absent, or head skeleton and rostrum may both be present though with parts very vestigial; rostralis absent; an invagination to alimentary tube present, but may be too delicate to discern easily. Legs inclined to be stout; mesothoracic pair, especially tibia and tarsus, frequently stouter than these parts of the other legs; setae comparatively scarce or abundant, usually more numerous on the metathoracic legs; setae slender, fleshy, or spinelike; all three pairs with a minute seta each near basal articulations of coxae and trochanters, and apparently may or may not possess a small spinelike process on outer margin of each tarsus, the latter always with a pair of prominent setae on its outer distal margin and claw always with a prominent pair on inner margin of its base, with both pairs generally having expanded tips; areas that look like sensory areas may or may not be present. Anus large or small, distinct or delicate, and variable in position according to species.

The genera included in this tribe may be distinguished by the following keys:

Keys to Genera of Phoenicococcini

Egg

a. With a single spine..... Phoenicococcus Cockerell.
Palmaricoccus, new genus.

aa. With more than one spine.
b. With two disconnected spines..... Platycoccus, new genus.
bb. With a single group of four or more spines.. Halimococcus Cockerell.
Thysanococcus, new genus.

First Stage

a. Normally with 3 pairs of setae on anal ring, all distinctly smaller than neighboring setae; with 8 pairs of setae, including anal-ring setae, on posterior abdominal segment; rostralis with two more or less long caudal loops when uncoiled within body..... Phoenicococcus Cockerell.

aa. No setae actually on anal ring; setae considered to be homologous with anal-ring setae present, but not all distinctly smaller than neighboring setae; with not more than six pairs of setae on posterior abdominal segment; rostralis with no more than 1 long caudal loop, but sometimes with 1 or 2 roundish caudal loops also, when uncoiled within body.

b. Pores with distinct partitions almost through tubes; at least 5 pairs of setae each on second to fifth abdominal segments, inclusive; basal segment of antenna with 4 setae, and next segment with at least 2 setae, besides a possible spinelike one; all trochanters with 2 setae each, excluding a minute basal one; anus and anal ring relatively prominent; a more or less distinct bulge or two on each side of body along caudal margin..... Palmaricoccus, new genus.

bb. Pores partitioned only very slightly or not at all through any part of tubes; no more than 4 pairs of setae each on second to fifth abdominal segments, inclusive; basal segment of antenna with no more than 3 setae and next segment with no more than 1 seta, excluding possible spinelike one; all trochanters with only 1 seta each, excluding a minute basal one; anus small, distinct or apparently obscure; anal ring obscure or absent; a bulge along caudal margin of body slight or absent.

c. Mesothoracic spiracles open almost directly to exterior; ventromesal thoracic setae short; antenna of the 6-segmented type, relatively elongate; first and fifth antennal segments with 3 setae each, sixth segment with 7 setae..... Platycoccus, new genus.

cc. Mesothoracic spiracles open to exterior through an invaginated tube; ventromesal thoracic setae relatively long; antenna either of the 6-segmented or of the annulated type, if of the 6-segmented type, not relatively elongate; first antennal segment with only 2 setae, fifth with only 1, but sixth with 9 setae

d. External openings of 8-shaped pores practically flush with surface; external openings of mesothoracic spiracular invaginations distinctly away from margin on ventral surface; antenna of the 6-segmented type; 4 or 5 setae, excluding minute basal ones, on each coxa; the inner marginal seta on each trochanter relatively short; anus delicate, more or less difficult to see..... Halimococcus Cockerell.

dd. External openings of 8-shaped pores on sclerotic elevations; external openings of mesothoracic spiracular invaginations distinctly on body margin; antenna of the annulated type; only 2 or 3 setae, excluding minute basal ones, on each coxa; the inner marginal seta on each trochanter relatively long; anus small but distinct..... Thysanococcus, new genus.

SECOND-STAGE FEMALE

a. Not puparial; body does not become thickened and hardened; anal valve absent; anus distinctly on ventral surface; anal ring pronounced; with typically at least one pair, and frequently two pairs, of small but distinct anal-ring setae..... Phoenicococcus Cockerell.

aa. Becomes puparium; body more or less thickened and hardened in puparial state; prominent well-defined anal valve present; anus distinctly on dorsal surface; anal ring insignificant or absent; usually none, but one minute, almost obscure pair of anal-ring setae may be present.

b. 8-shaped pores numerous and distributed in general and irregularly over both surfaces of body or, if not so, comparatively prominent, with their partitions extending more or less through membranous tubes; and in no case with pores possessing a single bar only, having flaring or folded-up sides; with typically 11 pairs of setae on head and 5 or more pairs each on second to fifth abdominal segments, inclusive; with 4 or 5 comparatively large fleshy antennal setae. Palmaricoccus, new genus.

bb. 8-shaped pores not distributed in general and irregularly over either surface of body, comparatively small and with partitions apparently extending not at all or but little into membranous tubes or, if not so, each possessing a single bar only, with flaring or folded-up sides and a tube approximately as sclerotic as the bar; no more than 8 pairs of setae, usually less, on head, and no more than 3 pairs of

setae each on second to fifth abdominal segments, inclusive; with no more than 2 comparatively large fleshy antennal setae or, if these are absent, then antenna with 2 small or minute setae only.

c. Head distinctly prolonged as a rounded projection; body noticeably flat, with derm of dorsal and ventral surfaces in contiguity an appreciable distance within margin, at least in older individuals; with all tubular pores small and delicate and comparatively numerous (more than 400) along margin or submargin of both sides of both surfaces, particularly cephalolaterad of head skeleton; mesothoracic spiracles, with their accompanying quinquelocular pores, in no more than slight depressions..... **Platycoccus**, new genus.

cc. Head not prolonged; body at least moderately thick; derm of dorsal and ventral surfaces not in contiguity an appreciable distance within margin in individuals of any stage of development; tubular pores either distinctly small, delicate, and comparatively few in number, or at least not numerous (not over 60) along margin or submargin of both sides of both surfaces, or comparatively prominent; if prominent, their tubes approximately as strongly sclerotic as their bars, which possess flaring or folded-up sides; mesothoracic spiracles with at least one or more of their accompanying quinquelocular pores, if present, in distinct pockets, or in deep invaginations from the body margin.

d. Body margin without a fringe; with 10 or more quinquelocular pores associated with each mesothoracic spiracle occurring in at least two distinctly different sizes—small, noninvaginated ones within distinct pockets which open to exterior well within margin on ventral surface, and large, invaginated ones situated outside the pockets; with no quinquelocular pores on body other than those associated with the spiracles; antenna with two minute partially invaginated setae only..... **Halimococcus** Cockerell.

dd. Body margin with a fringe which sharply separates ventral and dorsal surfaces; with only 1 or 2 subequal quinquelocular pores associated with each mesothoracic spiracle, which with the associated pores are within deep granulate invaginations opening to exterior on body margin; other quinquelocular pores sometimes present along body margin; antenna with at least 1 or 2 comparatively large fleshy noninvaginated setae..... **Thysanococcus**, new genus.

ADULT FEMALE

a. Entire body margin and ventrosubmargin covered with numerous prominent papillae; each of 2 pairs of spiracles with a group of quinquelocular pores; anus situated far cephalad on ventral surface; a pair of distinct anal-ring setae normally present..... **Phoenicococcus** Cockerell.

aa. Body margin and submargin of both surfaces devoid of papillae; no quinquelocular pores associated with any spiracle; anus distinctly on dorsal surface; anal-ring setae usually absent, if present, inconspicuous or practically obscure.

b. With 8-shaped pores scattered over both surfaces or at least over venter; each antenna with 4 or 5 prominent fleshy setae. **Palmaricoccus**, new genus.

bb. With 8-shaped pores, except when on posterior abdominal segment, localized in midventral region of body from laterocephalic border of head skeleton to and including fourth abdominal segment, their distribution in any one species distinctly more localized than this; each antenna with no more than two fleshy setae.

c. Head distinctly prolonged as a rounded projection. **Platycoccus**, new genus.

cc. Head not prolonged at all.

d. With all 8-shaped pores localized mesad of spiracles, with no deep fold or suture extending from rostrum toward each mesothoracic spiracle; with no plates or squamulae on anal segment; each antenna limited to two minute partially invaginated setae; anus minute and difficult to see; anal ring absent..... **Halimococcus** Cockerell.

dd. Except for those on anal segment, 8-shaped pores localized directly mesad of spiracles and with a distinct fold or suture extending from rostrum towards each mesothoracic spiracle, or, except for those on anal segment, 8-shaped pores located on the first three segments caudad of metathoracic spiracles; 2 to 6 pairs of small 8-shaped pores along caudal margin of anal segment, which also may possess plates or squamulae; each antenna with either 1 or 2 prominent fleshy setae; anus at least distinct; anal ring present though small.
Thysanococcus, new genus.

SECOND-STAGE MALE

a. With prominent anal ring; with normally three pairs of anal-ring setae.
Phoenicococcus Cockerell.

aa. Anal ring reduced in size; anal-ring setae absent.
b. Tubular pores rather numerous (at least 100 present), scattered over at least one surface of body and never asymmetrical in type, that is, with bulla issuing from one side of bar.
c. Typically one or more pairs of spiracular pores present; a row of mesal setae each on dorsal and ventral surfaces of abdomen.
Palmaricoccus, new genus.
cc. Spiracular pores absent; a row of mesal setae absent on both surfaces of abdomen ..... **Platycoccus**, new genus.
bb. Tubular pores apparently absent or few in number (8 or less) or, if comparatively numerous, 100 or more occurring in a distinct row along ventral margin or submargin of body, the majority of the asymmetrical type.
d. Tubular pores apparently absent or very few in number and restricted to head and the two posterior abdominal segments or to margin of abdomen ..... **Halimococcus** Cockerell.
dd. Tubular pores comparatively numerous, restricted to a row extending practically around body.
Thysanococcus, new genus.

ADULT MALE

a. No more than 15 setae on club of antenna; 6 setae only, all slender, on each metathoracic tibia and tarsus together, and two or more prominent clear areas, probably sensory in function, on tibia and tarsus together of each leg ..... **Phoenicococcus** Cockerell.

aa. Thirty or more setae on club of antenna; at least 12 setae, either none or only some of them slender in form, on each metathoracic tibia and tarsus together, and apparently no sensory areas on tibia and tarsus of any leg.
b. With one pair of eyes only.
c. Four pairs of setae on anal segment; at least 3 setae on basal, and at least 2 setae on second antennal segment.
Palmaricoccus, new genus.
cc. Three pairs of setae only on anal segment, only 2 setae on basal, and no setae on second antennal segment.
Platycoccus, new genus.
bb. With two pairs of eyes.
d. Only 3 pairs of setae on anal segment; club of antenna stout, with no more than four segments, all of which lack spicules; metathoracic tibia with no more than 10 setae, none of which are long and spinelike ..... **Halimococcus** Cockerell.
dd. Four pairs of setae on anal segment; club of antenna elongate, with eight segments, all possessing numerous spicules; metathoracic tibia with about 25 setae, practically all of which are long and spinelike ..... **Thysanococcus**, new genus.

Genus PHOENICOCOCCUS Cockerell

FIRST STAGE

Body more or less elongate elliptical, with 1 or 2 small characteristic bulges on each side along caudal margin of posterior end; distinctly flat in living individuals; segmentation well defined except possibly on ventral surface of prothorax and anterior section of mesothorax; more or less membranous cephalad, but abdominal segments progressively more sclerotic posteriorward, especially so toward maturity

of instar. 8-shaped pores comparatively prominent, subequal, with partitions extending nearly, if not quite, through tubes; bars closely joined, though readily distinguished apart; bullae distinct but delicate, external openings flush with surface; typically 10 pairs present, limited to marginal, submarginal, and dorsomesal regions of body. A single quinquelocular pore normally associated with each of 4 spiracles. No invaginated tubes between tracheae and external openings of spiracles; spiracullariae elongate, strongly sclerotic, subequal. Clear area present laterad of each metathoracic coxa. Typically 12 pairs of setae on head, including a frontal pair on ventral surface between arms of head skeleton, 4 pairs on prothorax, 7 pairs each on mesothorax and metathorax, 2 pairs on first abdominal, 5 pairs each on second to seventh abdominal, and 7 pairs on posterior abdominal segment including those on anal ring. Antenna of the 6-segmented type; basal segment more than twice as broad as any other; apical segment moderately elongate. Antennal setae occurring typically as follows: 4 slender setae on basal segment; 2 slender setae and a spinelike process on distal margin of second segment; 3 slender setae on third segment; 1 fleshy seta on fourth segment; 2 slender and 1 fleshy setae on fifth segment; 4 slender and 5 fleshy setae on apical segment. Rostrum with apparently 3 pairs of small setae, 2 pairs distinctly apical and 1 pair distinctly basal in position; rostralis with 2 long caudal loops and 1 long cephalic loop, besides the characteristic small cephalic loop, when uncoiled within body. Legs moderately slender; neither trochanter and femur nor tibia and tarsus fused. Leg setae occurring typically as follows: 6, including minute basal one, on procoxa; 5, including minute basal one, on each of other coxae; 3 on trochanter, including minute basal one and a comparatively long one on inner margin; none on femur or tibia; 3 and a spinelike process on tarsus; 2 on claw. Anus on ventrocaudal margin; anal ring pronounced and typically with 3 pairs of small setae. Male instar not puparial.

Second-Stage Female

Body moderately elliptical, with a slight broad bulge on each side of mesothorax; general outline continued evenly around posterior end; segmentation distinct except on ventral surface of head, prothorax, and mesothorax; slightly sclerotic throughout even in younger specimens. With rather acutely pointed papillae, more readily observed in younger individuals, along margin of both surfaces and submargin of ventral surface. Tubular pores restricted to the ordinary 8-shaped kind; in structure essentially as in first stage of this genus; scattered on head but much the larger number along margin of both surfaces and submargin of ventral surface. Quinquelocular pores associated with both pairs of spiracles only, noninvaginated, subequal; typically 1 to 4 associated with each of four spiracles. Spiracles and associated pores open practically on surface; spiracullariae elongate, strongly sclerotic, subequal. Body setae varying in size, occurrence, and less so in position; typically 14 pairs on head, 6 pairs on prothorax, 3 pairs on anterior section of mesothorax, 7 pairs on posterior section of mesothorax, 9 pairs on metathorax, 2 pairs on first abdominal segment, and either 4 or 5 pairs on each remaining abdominal segment, excluding those on anal ring. Antenna irregular in form; with a slightly elevated membranous base and a sclerotic distal part having a central sunken area from which issue 5 fleshy setae. Rostrum with 3 distinct pairs of setae, 1 pair basad and other 2 pairs distad in position; rostralis with 2 long caudal loops, 1 long cephalic loop, and the characteristic small cephalic loop, when uncoiled within body. Anal valve absent; anus comparatively prominent and well up on ventral surface; anal ring pronounced, with typically from none to 2 pairs of setae. Instar not puparial.

Adult Female

Body normally moderately elliptical at first, becoming rounder as full development is approached; general outline continued evenly around posterior end; segmentation obscure except on ventromesal region of thorax and abdomen; in younger specimens, derm slightly sclerotic, in older ones, dorsal and lateral surfaces strongly sclerotic, ventral surface lightly sclerotic. Entire margin and submargin of ventral surface and cephalic and caudal regions of dorsal surface thickly studded with papillae, giving surface a sclerotic appearance; papillae small or prominent, blunt, spinelike or platelike; apical margins of papillae may be irregularly toothed or serrated. 8-shaped pores present, distinct, though small; partitions through bars and tubes practically complete; bars can be distinguished apart; bullae delicate; external openings flush with surface. 8-shaped pores comparatively numerous, scattered over both surfaces, but less abundant on

dorsum; smallest situated ventromesally, next in size dorsomesally, largest marginally on both surfaces and submarginally on ventral surface; some variation in number and position. Quinquelocular pores associated with both pairs of spiracles, and absent elsewhere; subequal, noninvaginated, irregularly scattered; varying appreciably in number, a range of from 6 to 30 and 1 to 15 around the mesothoracic and metathoracic spiracles, respectively, having been observed. Spiracles and associated quinquelocular pores flush with surface; spiracullariae elongate, strongly sclerotic, subequal. Body setae varying in size, position, and occurrence; none prominent; typically about 20 pairs on head, 40 pairs on thorax, and 50 pairs on abdomen. Antenna irregular in form; with a slightly elevated membranous base and a strongly sclerotic distal piece having a central sunken area from which issue 5 fleshy setae. Rostrum with 3 distinct pairs of setae, 1 distinctly basad and other 2 distinctly apical in position; rostralis typically with 2 long caudal loops, 1 long cephalic loop, and characteristic small cephalic loop, when uncoiled within body. Anal segment well up on ventral surface; not sclerotic; anus moderately prominent; distinct anal ring present, typically possessing one pair of setae.

Second-Stage Male

Body moderately to elongate elliptical, and about equally rounded at both ends; segmentation well defined except on ventral surface of head, prothorax, and mesothorax; more or less membranous throughout. Papillae present, small, mostly spinelike and scarce. With ordinary 8-shaped tubular pores only; more slender than, but in structural details essentially as, in second-stage female; in distribution essentially as in second-stage female except less numerous marginally on thorax but more numerous mesally on both surfaces of thorax and abdomen. Typically none or one quinquelocular pore associated with each mesothoracic, but no pores associated with metathoracic spiracles; no other quinquelocular or any other type of pore present. Spiracles and quinquelocular pores flush with surface; spiracullariae distinctly elongate, strongly sclerotic, subequal. Body setae except in a few minor respects as in second-stage female. Antenna irregular in form; with elevated membranous base and sclerotic distal part without a sunken area; with apparently a minute, slender seta on membranous base and five fleshy setae and a pair of small setae on distal part. Rostrum and rostralis essentially as in second-stage female, except that three larger loops are smaller. Vestigial legs usually in evidence. Anus on or near ventrocaudal margin; pronounced anal ring, usually possessing 1 to 3 pairs of very small setae.

Adult Male

Body elongate elliptical, with posterior end occurring as a curving, slightly stout rapierlike projection; segmentation of all segments distinct; ventromesal surface of head with a roundish mildly sclerotic area; eighth abdominal and anal segments characteristically mildly sclerotic except near intersegmental sutures; body membranous elsewhere. Vestiges of thoracic wing framework and wings absent. Spiracullariae elongate, largest diameter around spiracles, tapering toward inner ends, strongly sclerotic, subequal. Typically 12 pairs of setae on head, 6 pairs on prothorax, 7 pairs on mesothorax, 6 pairs on metathorax, 2 pairs on first abdominal, 3 pairs each on second and third abdominal, 4 pairs each on fourth and fifth abdominal, 5 pairs each on sixth and seventh abdominal, and 4 pairs each on eighth abdominal and anal segments. Antenna with 2 stout basal segments, the second one not twice as long as broad and with a club apparently composed of 5 segments; apex of distal segment of club blunt and capped by a characteristic rounded knob; with slender setae on each of 2 basal segments, 2 slender setae on each of next 2 segments, 1 fleshy seta on each of following 2 segments, and 4 fleshy and 4 slender setae on apical segment. A single pair of eyes, marginal in position. Head skeleton practically absent, though delicate differentiated areas may be evident, possibly extreme vestiges of parts of head skeleton; invagination leading to alimentary tube distinct. Rostrum absent. Legs subequal except tibia and tarsus of each metathoracic pair stouter than those of the other legs; 4 or 5 small slender setae, besides the minute basal one, on each coxa; 1 short and 1 long slender seta, besides the minute basal one, on each trochanter; no setae on prothoracic femur and tibia; no setae on mesothoracic femur and 1 small slender seta on mesothoracic tibia; 2 small slender setae each on metathoracic femur and tibia; 4 and 2 small slender setae on each tarsus and claw, respectively; distinct roundish or subovul differentiated areas, apparently sensory structures, on metathoracic tibia and on tarsus of all three pairs of legs. Anus distinct, well caudad of cephalic border of ninth abdominal segment.

Type of genus, *Phoenicococcus marlatti* Cockerell.

PHOENICOCOCCUS MARLATTI Cockerell (*1, pp. 262–263; 13*)

Material collected by the writer on the date palm (*Phoenix dactylifera*) in southern California. At all times of the year the majority of the insects are found below the fiber, on the white tissue.

EGG

(FIG. 5, *E*)

Ovoviviparous. Spine moderately sclerotic.

FIRST STAGE

(Figs. 2 and 5, *C* and *D*)

Body.—Distinctly sclerotic areas on venter cephalolaterad of head skeleton and caudomesad of rostrum. Usually a distinct furca on meson between mesothorax and metathorax, and a pair of delicate furcae near meson between the two sections of metathorax. Clear area laterad of each metathoracic coxa, delicate; varying in form and size, but apparently always present. Twenty newly hatched individuals, average: Length 0.33 mm, width 0.15 mm; the smallest 0.30 mm long, 0.13 mm wide; the largest 0.35 mm long, 0.16 mm wide. Ten fully developed individuals, average: Length 0.38 mm, width 0.19 mm; the smallest 0.35 mm long, 0.18 mm wide; the largest 0.42 mm long, 0.21 mm wide.

Pores.—Typically 10 pairs of 8-shaped pores present, as follows: 2 more or less marginal pairs on head; 1 marginal pair laterad of each pair of spiracles and on second, fifth, and eighth abdominal segments, and 1 dorsomesal pair each on posterior section of mesothorax, metathorax, and second abdominal segment. 8-shaped pores increase slightly in size posteriorward; all fairly stable in occurrence and position except the dorsomesal pairs, in which, of 40 individuals examined, 16 possessed the 3 pairs, 19 lacked a pore on one or both sides of metathorax, 1 on both sides of metathorax and also on second abdominal segment, 1 on one side of mesothorax, and 3 on one side of both mesothorax and metathorax. A single quinquelocular pore associated with each of 4 spiracles; this pore present on one or both sides of mesothorax in 38, and of metathorax in 29, of above-mentioned 40 individuals.

Spiracles.—Each spiracularia with two slight constrictions.

Body setae.—Somewhat less fixed in position on head and thorax than on abdomen. In number and position typically as follows: Head with 4 ventromesal pairs, of which first 3 caudal pairs are distinctly larger than all other head setae, 1 frontal pair on ventral surface between arms of head skeleton, 3 pairs in near vicinity of eyes, and 4 dorsomesal pairs; prothorax, 3 marginal pairs and 1 dorsomesal pair; anterior section of mesothorax, 1 ventromesal pair; posterior section of mesothorax, 3 marginal pairs, 1 lateromesal of dorsum, 1 dorsomesal, and 1 comparatively prominent ventromesal pair; dorsum of metathorax and anterior section of metathorax combined, 3 marginal pairs, 1 lateromesal of dorsum, 1 dorsomesal pair; first abdominal and posterior section of metathorax combined, 2 marginal pairs, 1 dorsomesal, and 1 fairly prominent ventromesal pair; second to seventh abdominal segments, inclusive, each, 2 marginal, 1 ventrosubmarginal, 1 dorsomesal, and 1 ventromesal pair; posterior abdominal segment, 7 pairs, including 4 marginal and 3 pairs on anal ring; in all, 69 pairs present. In one specimen, outer and inner long caudal pairs 58 and 195 microns long, respectively; inner pair extremely delicate toward their apices.

Antenna.—All segments and their setae nearly stable in form and size; setae stable in number but somewhat variable in position; fleshy setae of apical segment close against latter, some of them difficult to distinguish.

Rostralis.—In two typical specimens, 1.41 and 1.46 mm long, respectively, or four times or more the length of body.

Legs.—All setae and tibial spinelike processes practically stable in form and occurrence and, except apparently for coxal setae, practically stable in position.

Anal ring.—Cephalic margin not sharply defined; the 3 pairs of setae comparatively small, the caudal pair being minute and not always distinguished.

Exuviation.—In both sexes the break occurs cephalad of the antennae and extends along lateral margins to about as far as metathoracic legs; the ventral skin then turns back on the caudal region like a door.

Living specimens.—Pale pink at first; flattened; eventually becoming covered with a loose mass of white filaments; pale and shiny before molting.

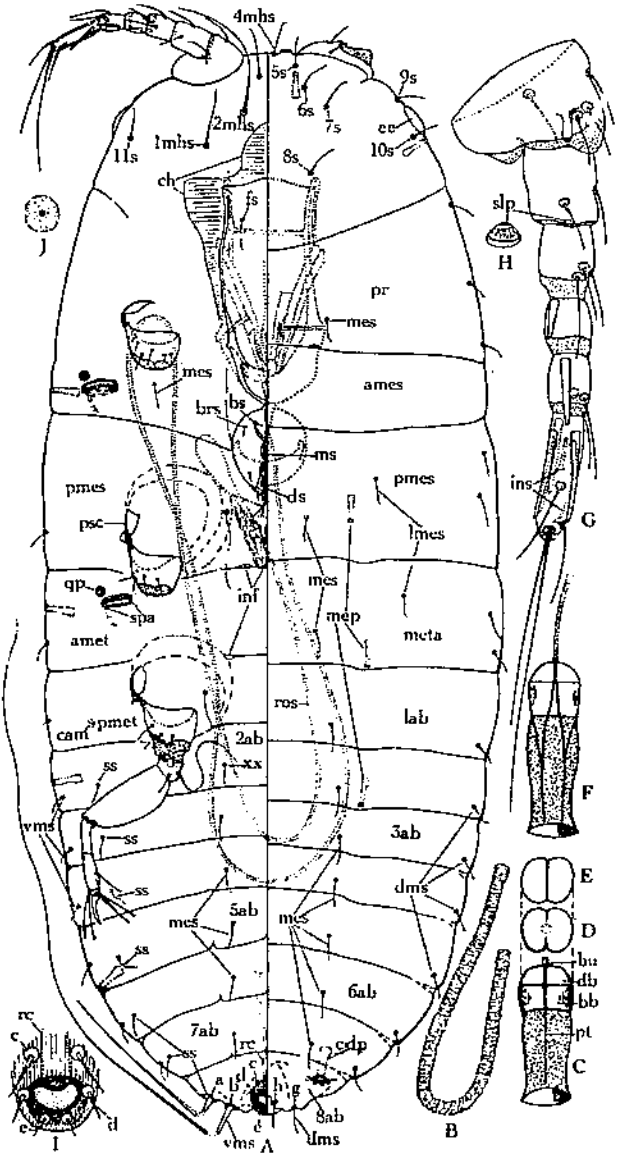

FIGURE 2.—*Phoenicococcus marlatti*, first-stage nymph: *A*, Body, dorsal and ventral, × 400; *B*, crumena, before entrance of rostralis, and consequent expansion, × 400; *C, D, E, F*, 8-shaped pore, through center, cross sections through inner margin of distal bar and tube, and appearance beyond center, respectively, × 3,000; *G*, antenna, ventral, × 1,000; *H*, spinelike structure on distal margin of second antennal segment, × 3,000; *I*, anal ring, × 1,200; *J*, clear area on venter laterad of each metathoracic coxa, × 2,000.

SECOND-STAGE FEMALE

(Fig. 3)

Body.—Thoracic furcae present, essentially as in first stage. Papillae mostly quite small, typically subtriangular, but ranging from very minute to comparatively broad and flat around spiracles; typically numerous along cephalic and caudal margins and in vicinity of spiracles, sparsely scattered elsewhere; variable in abundance and extent, more plentiful around mesothoracic than around metathoracic spiracles, may be almost absent around latter. Toward maturity of instar the entire body margin becomes comparatively thick and smooth, obscuring papillae. A rather large newly molted individual 0.39 mm long and 0.23 mm wide; a rather small one 0.35 mm long and 0.20 mm wide. A rather large, fully developed individual 0.78 mm long and 0.48 mm wide; a rather small one 0.51 mm long and 0.36 mm wide.

Pores.—The number and position of 8-shaped pores varying, more so on head and thorax than on abdomen. The 8-shaped pores occurring typically as follows: 12 scattered pairs on head; 7 or 8 marginal pairs, and an equal number of ventrosubmarginal pairs, on prothorax and mesothorax together; 2 pairs on or near margin of each of remaining segments down to and including fifth abdominal one; 1 marginal pair each on sixth, seventh, and posterior abdominal segments; 1 to 3 mesal pairs each on dorsum and venter of thorax; in all, 46 pairs present. The number of quinquelocular pores noticeably unstable; for example, one individual possessed 10 and 11, 7 and 6 associated with mesothoracic and metathoracic spiracles, respectively, whereas another individual possessed only a single pore to each of 4 spiracles; usually 2 or 4 and 1 or 2 associated with each mesothoracic and metathoracic spiracle, respectively.

Spiracles.—Each pair typically surrounded by a varying number of curving rows of irregularly formed papillae, mostly broad and shallow, especially the more lateral ones nearest spiracles; mesal ends of spiraculariae usually broadened.

Body setae.—Those on head and thorax somewhat variable in position, those on abdomen less so. Their number and position typically as follows: 14 pairs scattered on head, frontal pair absent; 4 marginal, 1 being considered as a lateromesal pair of dorsum, 1 dorsomesal and 1 ventromesal pair on prothorax; 1 lateromesal of dorsum, 1 dorsomesal and 1 ventromesal pair on anterior section of mesothorax; 4 marginal, 1 lateromesal of dorsum, 1 dorsomesal and 1 ventromesal pair on posterior section of mesothorax; 3 marginal, 1 lateromesal of dorsum, 1 dorsomesal, 2 ventrosubmarginal and 2 ventromesal pairs on metathorax; 1 dorsomarginal and 1 dorsomesal pair on first abdominal segment, and, in addition, 1 ventromarginal, 1 ventrosubmarginal, and 1 ventromesal pair on each of second to seventh abdominal segments, inclusive, except for usual absence of ventromesal pair on second abdominal segment; 6 pairs on posterior abdominal segment; in all, 76 pairs present.

Antenna.—Membranous base not well differentiated from body derm; sunken area of distal part with an irregular rim; a minute seta usually observed on membranous base; five fleshy setae varying in position and size arising from sunken area of distal part; apparently a minute pair of wholly invaginated setae on side of sclerotic distal part.

Rostralis.—Length in three typical specimens, 2.30, 2.44, and 2.49 mm, respectively.

Anal ring.—Sclerotization less extensive than in first stage. Typically with either 1 or 2 pairs of setae; sometimes with a single seta or even none. The ventromesal pair of setae on posterior abdominal segment considered homologous with the cephalic pair on anal ring of first stage.

Exuviation.—Splits immediately caudad of antennae and along margin to near posterior end; ventral skin rolls back to here.

Living specimens.—Pale pink; dull in tone at first, but becoming shiny as the molting period approaches; oval; mass of wax usually denser than in first stage. Some specimens in well-protected places outside fiber of host plant producing a fluffy mass of filaments piled high above body; these filaments nearly always eventually blown away, leaving naked body of insect.

THIRD-STAGE FEMALE

Not identified.

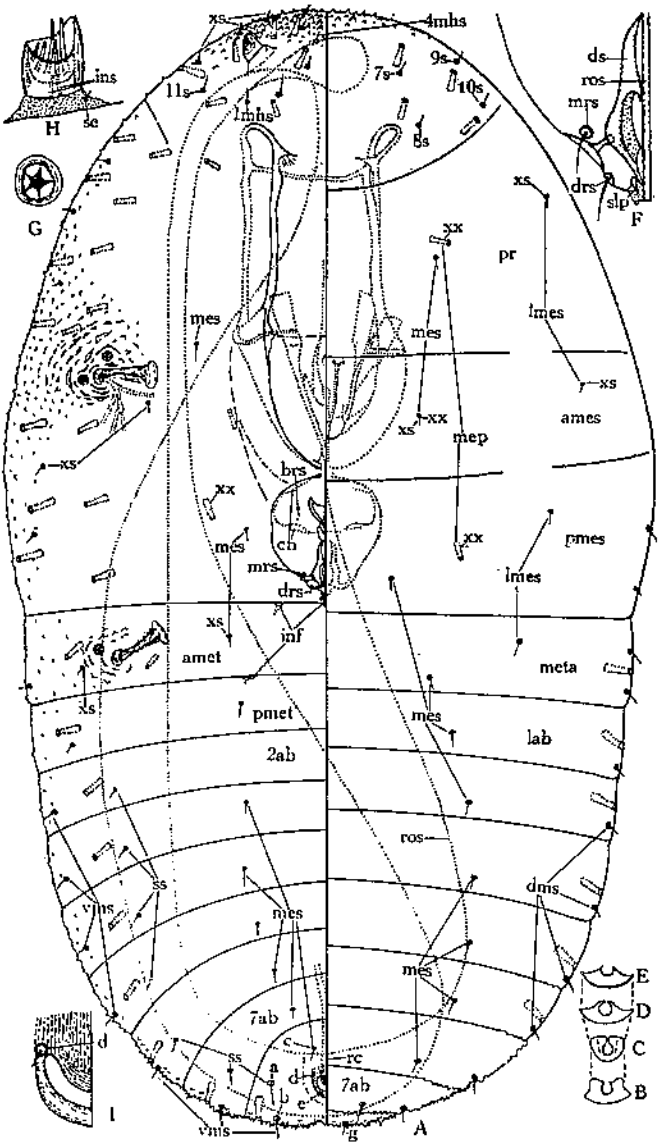

FIGURE 3.—*Phoenicococcus marlatti*, second-stage female: *A*, Body, dorsal and ventral, × 400; *B*, *C*, *D*, *E*, cross sections through the distal, mesal, and apical part of basal, and basal part of basal sclerites of rostrum, respectively, × 600; *F*, venter of distal part of rostrum, × 1,000; *G*, a quinqueiocular pore associated with a spiracle, × 2,000; *H*, antenna, × 1,000; *I*, anal ring, × 1,200.

ADULT FEMALE

(Figs. 4 and 5, *A* and *B*)

Body.—At first normally moderately elliptical in outline, flat beneath and moderately convex above in cross section; toward maturity becoming rounder in outline and slightly more convex above in cross section; after egg depletion becoming more or less concave beneath with a tendency to less convexity above; in the closely confined spaces in which it is so abundantly found, the body assuming approximately whatever shape is demanded of it; segmentation distinct on mesoventral region of thorax and abdomen, indicated only by dermal structures elsewhere; clear areas of varying form, most noticeable in older specimens, on mesoventral surface of abdomen, apparently indicating segmentation. Papillae larger, more crowded anteriorly and posteriorly than laterally; their profusion and extent varying; sometimes practically absent near metathoracic spiracles and scarce laterally. With 3 more or less distinct furcae between mesothorax and metathorax and between two sections of metathorax. Average length of 10 newly molted specimens 0.52 mm, width 0.35 mm; a rather large one 0.72 mm long and 0.46 mm wide; a rather small specimen 0.50 mm long and 0.34 mm wide; a fully developed, moderately large, and somewhat flattened specimen 1.3 mm long and 0.98 mm wide; size of fully developed specimens varying considerably.

Pores.—In structure 8-shaped pores essentially as in first stage and in second-stage female, but considerably more numerous on all segments; on one side of a typical specimen 156 counted on venter, 48 on dorsum. Number of quinquelocular pores varying greatly; one specimen with a large number had 24 and 30, 14 and 15, and one with a small number had 6 and 7, and 1 each, associated with mesothoracic and metathoracic spiracles, respectively; mesothoracic pores usually more scattered than metathoracic ones.

Spiracles.—Essentially as in second-stage female.

Body setae.—All relatively small; mesal setae generally smallest; one or more than in second-stage female on all segments of venter except anal segment; setae homologous with those of preceding instars relatively stable in occurrence and position, extra setae unstable in both respects. Number and position of body setae typically as follows: 9 marginal or submarginal, 2 dorsomesal, and 9 ventromesal pairs on head; 3 marginal, 1 lateromesal of dorsum, 1 dorsomesal, 2 ventrosubmarginal, and 3 ventromesal pairs on prothorax; 4 marginal, 2 lateromesal of dorsum, 2 dorsomesal, 3 ventrosubmarginal, and 3 ventromesal pairs on mesothorax; 5 marginal, 1 lateromesal of dorsum, 1 dorsomesal, 4 ventrosubmarginal, and 4 ventromesal pairs on metathorax; 1 dorsomesal pair on first abdominal segment; 2 marginal, 1 dorsomesal, 1 or 2 ventrosubmarginal, and 2, 3, or 4 ventromesal pairs on each of second to seventh abdominal segments, inclusive; in all, from 96 to 110 pairs present.

Antenna.—Essentially as in second-stage female but surrounded by numerous flat papillae of irregular outline.

Rostralis.—In one typical specimen, 4.92 mm long.

Anal segment.—Comparatively reduced in size; with 1 or 2 pairs of 8-shaped pores; with 4 pairs of small subequal setae; anal ring rather narrow and variable in form along its cephalic border; sometimes one or both anal-ring setae absent.

Living specimens.—Dorsum dull pinkish red at first, becoming shiny dark reddish or wine red toward full development; venter dull pinkish red at first, and well covered with a thin mat of waxy filaments. In exposed locations at first oval, with dorsum distinctly convex; toward full development dorsum becoming much swollen and rounding considerably onto ventral surface on all sides; mostly naked as usually observed, but occasionally, when protected from wind, some white filaments present piled high above dorsum, as in second-stage female. Behind fiber of host becoming flattened in general toward full development, frequently asymmetrical in form as a result of crowding; a discolored matted mass of waxy filaments nearly always enveloping the body. On forcing back a leaf base of the host to expose the insects, this mat of filaments typically pulled away above, disclosing most noticeably the bright reddish to dark wine-red dorsa of adult female bodies, with only a rim of wax around margins of latter observable; hence, the name "red date scale" that has been used in referring to this insect. After egg deposition the body becomes dull in tone, brown, and leathery in appearance.

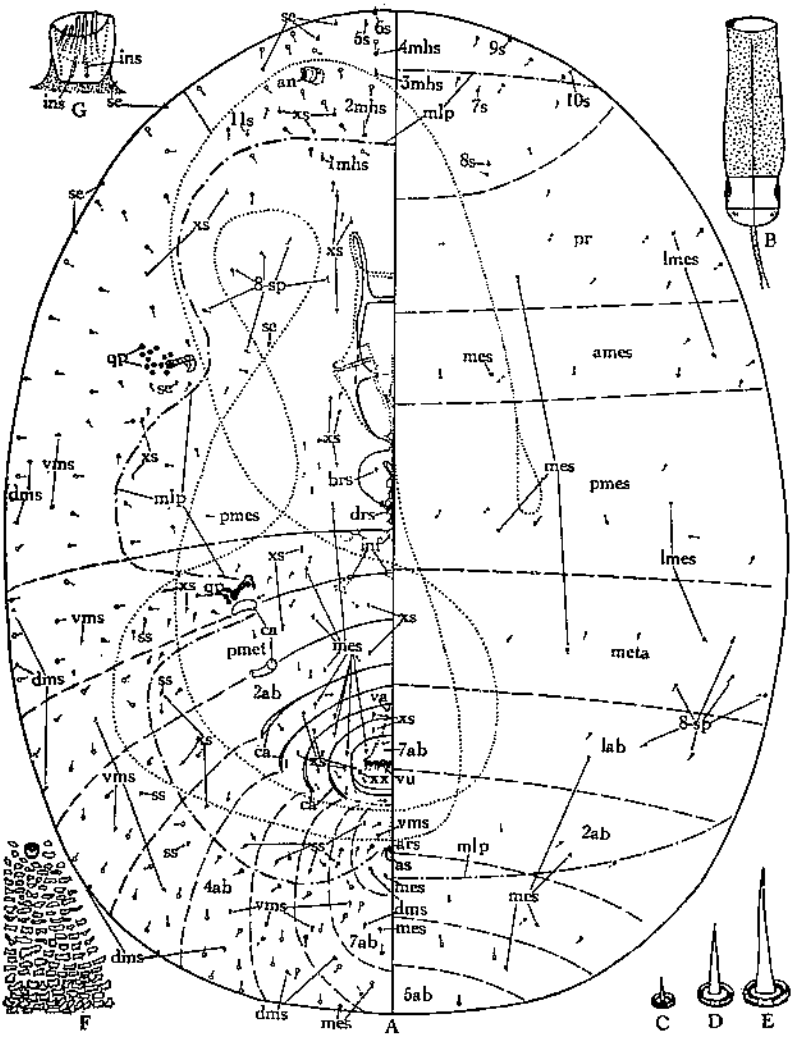

FIGURE 4.—*Phoenicococcus marlatti*, adult female: *A*, Body (partially developed), dorsal and ventral, × 165; *B*, ventromesal abdominal pore, × 3,000; *C*, basal antennal seta, × 2,000; *D*, ventromesal abdominal seta, × 2,000; *E*, ventromarginal seta, × 2,000; *F*, section of ventrocaudal surface of abdomen to show papillae (setae and pores omitted), × 165; *G*, antenna, × 750.

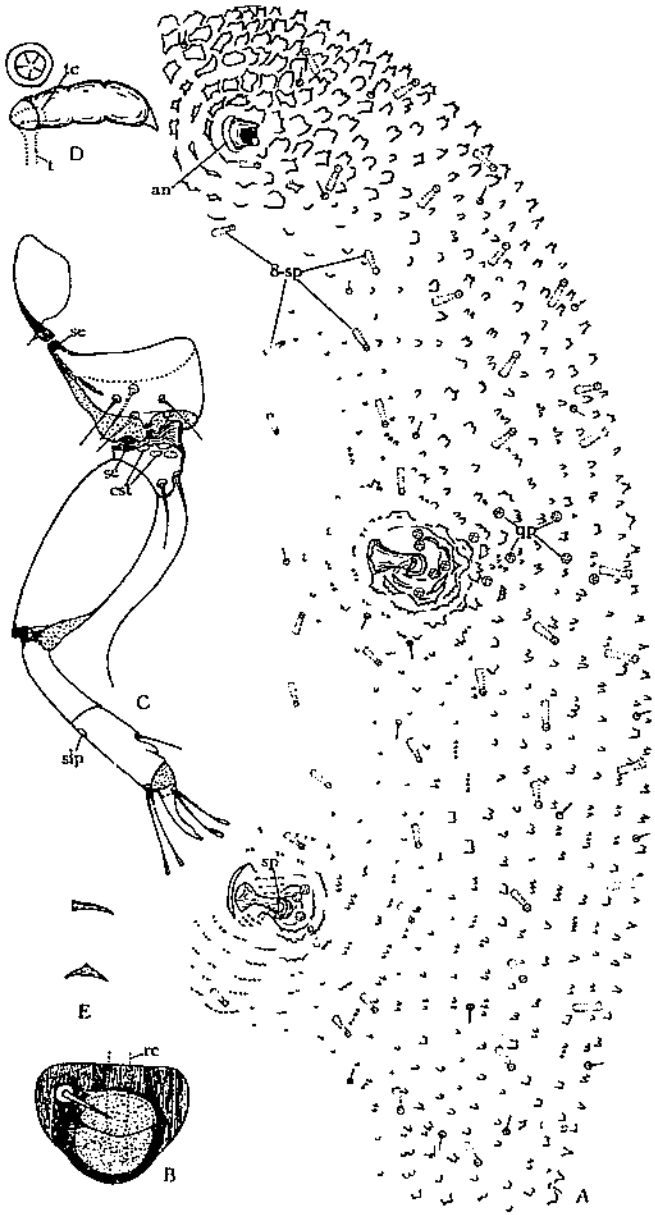

FIGURE 5.—*Phoenicococcus marlatti*: *A*, Adult female, ventrocephalic surface, × 350; *B*, same, anal ring, × 1,200; *C*, first-stage nymph, venter of metathoracic leg, × 1,000; *D*, same, mesothoracic spiracle, × 2,000; *E*, egg spine, lateral aspects, × 1,500.

SECOND-STAGE MALE

(Fig. 6)

Body.—Papillae practically restricted to a narrow fringe along caudal margin. Thoracic furcae present, essentially as in first instar. A rather large newly molted specimen 0.35 mm long and 0.19 mm wide; a rather small one 0.32 mm long and 0.16 mm wide; a typical fully developed specimen 0.41 mm long and 0.20 mm wide.

Pores.—A typical specimen possessed the following 8-shaped pores: 8 scattered pairs on both surfaces of head; 1 marginal pair on first abdominal segment; 2 marginal pairs each on prothorax, each section of mesothorax, and second to eighth abdominal segments, inclusive; 3 marginal pairs on metathorax; 1 ventromesal pair each on prothorax, anterior section of mesothorax, and second to fifth abdominal segments, inclusive; 1 ventrosubmarginal and 1 ventromesal pair on posterior section of mesothorax; 1 ventrosubmarginal and 2 ventromesal pairs on anterior section of metathorax; 1 dorsomesal pair on each segment of thorax and first to sixth abdominal segments, inclusive; 1 lateromesal pair of dorsum each on mesothorax and metathorax; in all, 55 pairs present. 8-shaped pores slightly smaller toward meson, perhaps somewhat more so on dorsum. Of 30 specimens, 9 had a quinquelocular pore associated with each mesothoracic spiracle, 9 lacked such a pore on one side and 12 on both sides of mesothorax.

Body setae.—Essentially as in second-stage female except for presence of frontal pair on head and 2 pairs of dorsomarginal setae instead of 1 on anal segment, and slightly larger size of second ventromesal pair on head and 1 of marginal pairs on anal segment; in all, 78 pairs present.

Antenna.—Comparatively elongate; membranous base just a raised portion of body derm; sclerotic distal part sharply narrowed apically, producing almost the effect of another segment; with 5 fleshy setae of varying sizes and 1 pair of small, apparently wholly evaginated, fleshy setae issuing from lower distal part.

Rostralis.—In three typical specimens, 1.3, 1.5, and 1.6 mm long.

Legs.—The three pairs nearly always distinct; 2 or 3 segments and as many minute setae can usually be distinguished.

Anal ring.—Pronounced; of 15 individuals, 3 possessing 3 pairs of setae, as in first instar, all 12 others lacking 1 to 3 setae from the middle and caudal pairs; in contrast to second-stage female, the cephalic pair considered as actually present on anal ring.

Exuviation.—Break occurring cephalad of antennae, the derm of both dorsal and ventral surfaces being pushed back to posterior end.

Living specimens.—Pale pink; dull in tone at first, shiny toward maturity; wax more dense than in second-stage female, producing a veritable cocoon.

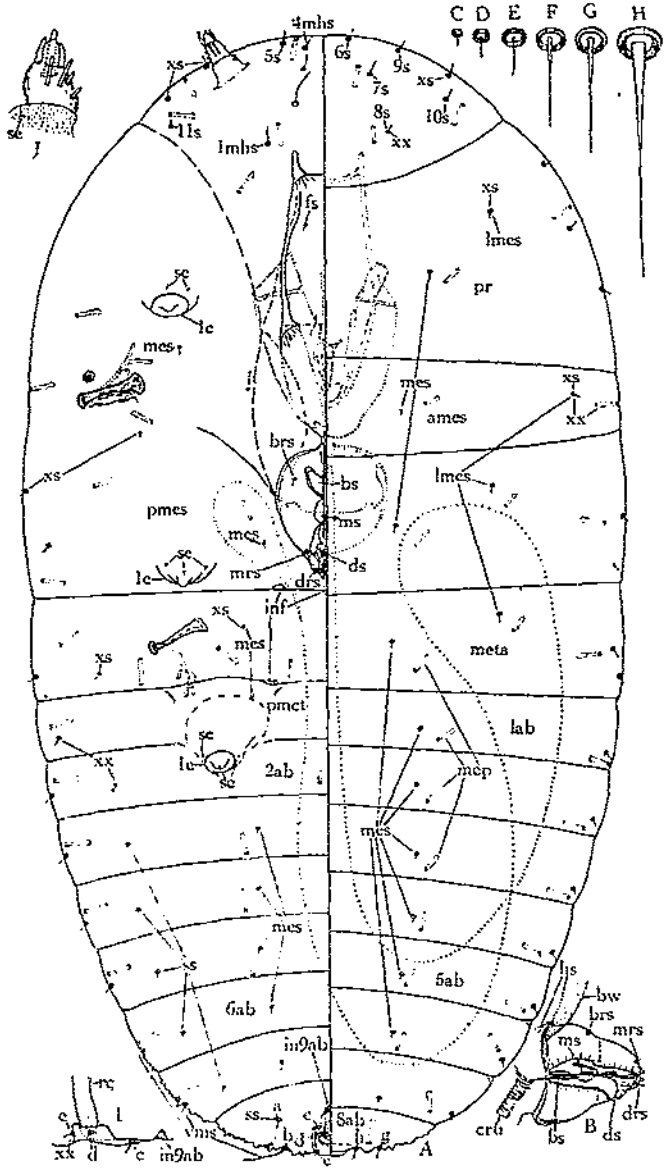

FIGURE 6.—*Phoenicococcus marlatti*, second-stage male: *A*, Body, dorsal and ventral, × 400; *B*, rostrum, lateral aspect, × 400; *C*, *D*, *E*, *F*, *G*, *H*, representing setae from various parts of body to illustrate approximately their comparative sizes, × 2,000; *C*, all leg setae; *D*, two caudal pairs of anal-ring setae; *E*, ventromesal cephalic pair of anal-ring and all rostral setae; *F*, all head setae except second ventromesal pair, all marginal and submarginal setae of both dorsal and ventral surfaces of thorax and abdomen except indicated ones mentioned above on anal segment, and all dorsomesal setae; *G*, second pair of ventromesal head setae and ventrosubmarginal pair of setae of anal segment; *H*, ventromarginal pair of setae on anal segment; *I*, anal ring, lateral aspect, × 1,000; *J*, antenna, × 1,000.

THIRD-STAGE MALE (PREPUPA)

(Fig. 7)

Body.—Moderately elliptical; segmentation of all segments more or less defined; varying in size, the average of 10 specimens being 0.37 mm long and 0.18 mm wide.

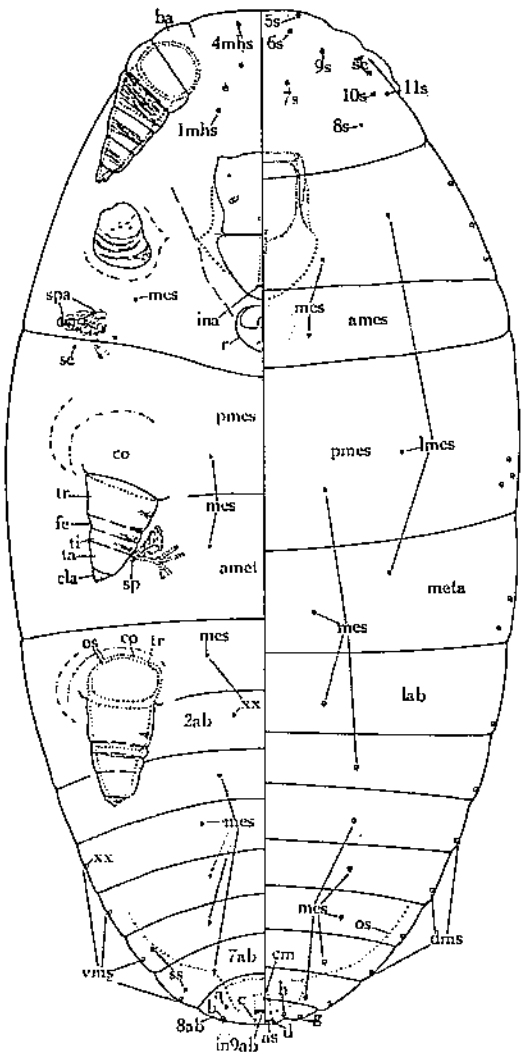

FIGURE 7.—*Phoenicococcus marlatti*, third-stage male (prepupa): Body, dorsal and ventral, × 360.

Spiraculariae.—Elongate, with inner ends expanded, lightly sclerotic, subequal.

Body setae.—Subequal, shafts short except second ventromesal pair on head, 1 marginal pair on anal segment slightly larger, and 2 mesocaudal pairs on anal segment smaller than the average seta. Body setae occur typically as follows: 12 pairs on head, frontal pair either indistinct or absent; 3 marginal pairs, 1 lateromesal of dorsum, 1 dorsomesal, and apparently 1 ventromesal pair on prothorax; 1 dorsomesal pair on anterior section of mesothorax; 2 or 3 marginal pairs, 1 lateromesal of dorsum, 1 dorsomesal and 1 ventromesal pair on posterior section of mesothorax and on anterior section of metathorax; 1 ventromesal pair on posterior section of metathorax; 1 marginal and 1 dorsomesal pair on each of first to third abdominal segments, inclusive; 1 ventromesal pair on each of second to seventh abdominal segments, inclusive; and, in addition, 1 ventrosubmarginal pair each on posterior section of mesothorax and sixth and seventh abdominal segments; 6 pairs on anal segment; in all, 63 or 64 pairs present.

Antenna.—Stocky; with indications of five segments, partially and lightly sclerotic.

Legs.—Stocky; with indications of all segments; all segments, except possibly coxae, partially and lightly sclerotic.

Anal segment.—Anus distinct, on or quite near caudal margin. Apparent external opening of a membranous tube connecting with ninth abdominal segment of subsequent instar distinct.

Exuviation.—Break occurring along dorsomesal line from anterior margin to posterior section of mesothorax.

FOURTH-STAGE MALE (PUPA)

(Fig. 8)

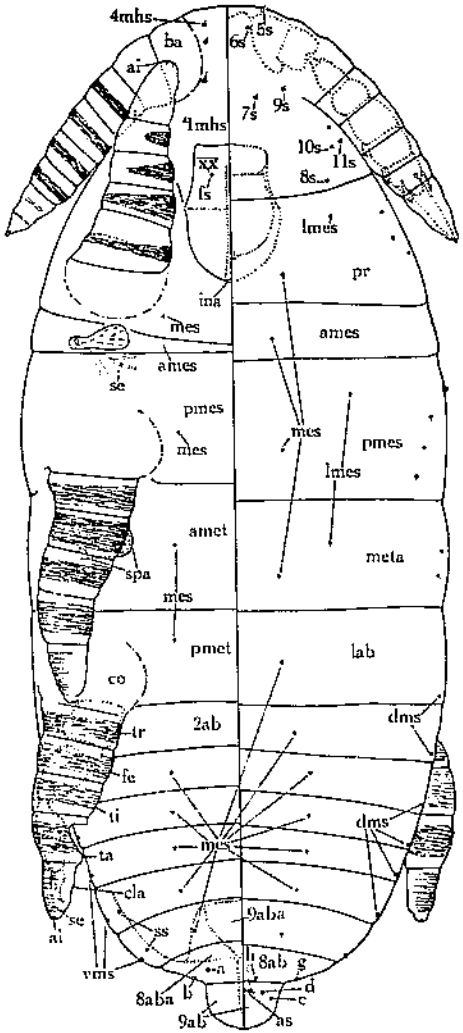

FIGURE 8.—*Phoenicococcus marlatti*, fourth-stage male (pupa): Body, dorsal and ventral, × 300.

Body.—Elongate elliptical, with posterior projection noticeably blunt and rounded; segmentation practically complete throughout; varying in size, the average of 10 specimens being 0.38 mm long and 0.16 mm wide.

Spiraculariae.—Moderately stout, owing to considerable expansion of inner or mesal ends.

Body setae.—Essentially as in preceding instar, except frontal pair on head present and distinct, and ventromesal pair of second abdominal segment usually absent.

Antenna.—Stocky, but less so than in preceding instar; with indications of at least seven segments, some of which are partially and clearly sclerotic.

Legs.—Essentially as in preceding instar except more elongate, sclerotization of the five distal segments more pronounced, and segmentation more clearly defined; relatively straight.

Anal segment.—Anus distinct; situated well caudad of cephalic margin of ninth abdominal segment.

Exuviation.—Essentially as in preceding instar.

ADULT MALE

(Fig. 9)

Body.—Indentation of sutures along margin pronounced; varying in size, a rather large specimen 0.59 mm long and 0.19 mm wide, a rather small specimen 0.37 mm long and 0.12 mm wide.

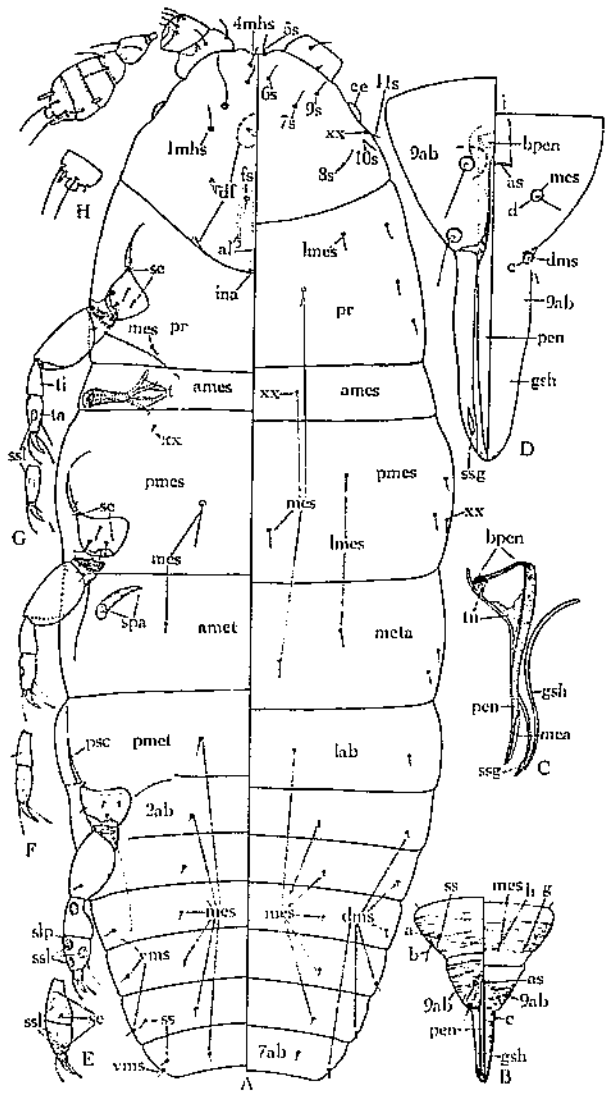

FIGURE 9.—*Phoenicococcus marlatti*, adult male: *A*, Body, dorsal and ventral, × 360; *B*, posterior end, dorsal and ventral, × 360; *C*, lateral aspect of genital structures, × 360; *D*, posterior end, dorsal and ventral, × 1,000; *E*, *F*, *G*, dorsal surfaces of the metathoracic, mesothoracic, and prothoracic tibiae, tarsi, and claws, respectively, × 360; *H*, dorsum of apical segment of antenna, × 360.

Body setae.—In distribution and number essentially as in 2 preceding instars except for addition of 2 pairs on ventral surface of anal segment; in structure, shafts distinctly longer than in 2 preceding instars; second ventromesal pair on head and ventromesal pair on posterior section of mesothorax comparatively large; in all, 66 pairs present.

Antenna—The 4 distal segments of club compactly united, 1 swollen in appearance, almost oval; distal segment of club capped by a characteristic knob; all slender setae, except 4 distal ones, and all fleshy setae comparatively short.

Legs.—Not large; typically with 3 sensory areas on each metathoracic tibia and 2, 3, and 6 on tarsus of each prothoracic, mesothoracic, and metathoracic leg, respectively.

Living specimens.—Appearing to naked eye but little larger, but distinctly redder, than first-stage individuals.

Genus PALMARICOCCUS, new genus

First Stage

Body moderately to elongate elliptical; 1 or 2 small bulges on each side along caudal margin of abdomen; segmentation well defined except on ventral surface of head, prothorax, and anterior section of mesothorax; posterior abdominal segment or two sclerotic, remainder of body more or less membranous, although there may be sclerotization laterocephalad of head skeleton. In any one species 8-shaped pores either all of nearly same size and comparatively large, or some comparatively large and others sharply reduced in size; partitions through tubes extending nearly to external openings; bars closely joined but can be distinguished apart; bullae distinct but delicate; external openings flush with surface; typically 12 to 16 pairs present along marginal, submarginal, and dorsomesal regions of body. A single quinquelocular or trilocular pore associated with each mesothoracic, but not with metathoracic spiracles. No invaginated tubes between tracheae and external openings of spiracles; spiracularlae may be elongate and strongly sclerotic or suboval and lightly sclerotic; a subequal clear area present laterad of each metathoracic leg, delicate, variable in form, but usually distinct. Typically either 11 or 12 pairs of setae on head, frontal pair on ventral surface between arms of head skeleton present or absent, 4 pairs on prothorax, 7 pairs on mesothorax, either 7 or 8 pairs on metathorax, 2 pairs on first abdominal segment, 5 pairs each on second to seventh abdominal segments, inclusive, and 6 pairs on posterior abdominal segment. Antenna of the 6-segmented type; basal segment more than twice as broad as any other, apical segment moderately elongate. Antennal setae occurring typically as follows: 4 slender setae on basal segment, 2 slender setae and a spinelike process on second segment; either 3 or 4 slender setae on third segment; either 1 fleshy seta or none on fourth segment; 3 slender setae and 1 fleshy seta on fifth segment; 4 slender and 5 fleshy setae on apical segment. Rostrum with apparently 3 pairs of small apical setae; rostralis either with 1 single long caudal loop or, in addition, with 1 or 2 irregular roundish caudal loops, when uncoiled within body. Legs moderately slender or slightly stout; neither trochanter and femur nor tibia and tarsus fused. Leg setae occurring typically as follows: 6 setae, including minute basal one, on each procoxa and 5, including minute basal one, on each of remaining coxae; 3 setae, including minute basal one and a comparatively long one, on trochanter; either 1 or 2 setae on femur, either 1 or none on tibia, 3 setae and a spinelike process on tarsus, and 2 setae on claw. Anus on caudal margin; anal ring distinct, but no setae definitely on anal ring. Male instar may or may not be puparial.

Second-Stage Female

Body moderately elliptical to pyriform; general outline not continued evenly around posterior end, which slightly projects; segmentation of head and thorax obscure, that of abdomen distinct toward posterior end, in young specimens membranous except seventh abdominal segment. Papillae present; prominent and numerous along margin and submargin, and may or may not be scattered plentifully over both surfaces of body. 8-shaped pores always present; of ordinary kind only; varying considerably in size, rather limited in number or numerous, or scattered over body; partitions extending to a greater or less degree through tubes; bars may or may not be difficult to distinguish apart; bullae distinct; external openings not on projections. All quinquelocular pores subequal, noninvaginated, typically 1 to 55 associated with each spiracle, no others on body. Spiracles and quinquelocular pores open on surface or in shallow depressions of surface derm; region about spiracles may or may not be noticeably thickened and rugose; spiracularlae elongate, strongly sclerotic, subequal. Typically either 10 or 11 pairs of setae on head and 2 to 7 pairs on each remaining body segment. Antenna with or without an elevated membranous base, but

always with a sclerotic distal part; the latter may or may not have a central sunken area but always has 4 or 5 fleshy setae and a pair of small setae which may or may not be wholly invaginated. Rostrum with 3 pairs of setae, 1 pair basad and 2 pairs distad in position; rostralis with 1 elongate loop, 2 roundish loops, and the small cephalic loop, when uncoiled within body. A membranous area through which rostralis of adult is forced may or may not be distinct. Anal valve always present; with characteristic markings; lacking pores, but with 3 to 6 pairs of setae; anus centrally or cephalically located on anal valve; anal ring small or indistinct, apparently lacking setae. Becomes puparium; derm of latter may or may not be heavily sclerotic.

Adult Female

Body moderately to elongate elliptical or pyriform, posterior end distinctly projecting beyond general margin. In both young and old specimens derm membranous except on dorsocaudal part of anal segment, which may be lightly sclerotic; segmentation obscure except on venter of abdomen and on both surfaces of posterior abdominal segments. Papillae present, but not distributed in general over body; at most restricted to immediate vicinity of spiracles and ventromesal region of thorax, on which they are inconspicuous, spinelike, or platelike with serrated apical margins, and occur characteristically in irregular rows. 8-shaped pores distinct though small; partitions apparently may or may not extend through tubes; bars can be distinguished apart with difficulty; bullae delicate; external openings may or may not be surrounded by distinctly sclerotic rims; pores scattered over venter or over both surfaces; may be numerous or few in number. No pores associated with spiracles, but quinquelocular pores may be present on sixth abdominal segment. Spiracles flush with surface; spiracullariae elongate, strongly sclerotic, subequal. Body setae small or moderate in size except on anal segment; typically 7 to 12 pairs on head, 19 to 24 pairs on thorax, and 35 to 48 pairs on abdomen. Antenna limited to a single sclerotic piece without a prominent central sunken area, though a very small depression apparently may be present in one species; with 4 or 5 fleshy setae and a pair of small slender setae, which may be wholly or only partially invaginated. Rostrum with apparently 3 minute pairs of setae; rostralis with 1 elongate loop, and the characteristic small cephalic loop, or, in addition, with 2 large roundish loops, when uncoiled within body. Anal segment on both surfaces of posterior end either practically membranous or partially and lightly sclerotic on its caudal portion; with from 2 to 6 pairs of 8-shaped tubular pores on or near caudal margin; with 6 pairs of setae, 3 pairs along ventrocaudal margin being relatively prominent. Anus well up on dorsal surface; moderately prominent; apparently with or without a small anal ring; anal-ring setae apparently absent.

Second-Stage Male

Body moderately to elongate elliptical; sides may be nearly parallel or midthoracic region may bulge; segmentation obscure except on abdomen or rather distinct throughout except on ventral surface of head, prothorax, and mesothorax; membranous except for possible faint sclerotization of posterior abdominal segment, or lightly sclerotic but increasingly so posteriorward on the 3 or 4 posterior abdominal segments. Papillae practically absent except around spiracles, or abundant marginally and submarginally on both surfaces of body, where they are small and spinelike. 8-shaped pores restricted to ordinary kind; may be only moderately plentiful or comparatively numerous; scattered on both surfaces; partitions extending through bars and more or less through tubes, but may be difficult to distinguish in latter; bullae delicate; external openings apparently flush with surface, but may be surrounded by sclerotic rims. Typically from none to 8 quinquelocular pores associated with each mesothoracic and none to 3 with each metathoracic spiracle; in the latter position a single trilocular or quadrilocular pore may replace a quinquelocular pore normally present; no other quinquelocular or any other pore type present elsewhere on body. Spiracullariae distinctly elongate, strongly sclerotic, subequal. No less than 8 pairs of setae on head; no less than 6 pairs on anal segment, 1 of which is distinctly larger and pair next to it slightly larger than the other body setae, and no less than 3 pairs on each of other body segments, except possibly anterior section of mesothorax and first abdominal segment. Antenna prominent, with 4 or 5 large fleshy setae, or greatly reduced in size, with hardly more than vestiges of setae; if the latter, puparial in form. Rostrum with 3 pairs of minute setae, all more or less apical in position; rostralis with a broad shallow bend and the characteristic small cephalic loop, or with 1 elongate loop, 2 broad rather deep

loops, and the characteristic small cephalic loop, when uncoiled within body. Vestigial legs may or may not be in evidence. Anus prominent; situated on or near caudal margin, which may or may not slightly project here; distinct anal ring; anal-ring setae apparently absent.

Adult Male [7]

Body elongate elliptical, with posterior end occurring as a moderately slender rapierlike projection; segmentation defined in all segments except anterior section of mesothorax; membranous except posterior abdominal segment and, in addition, possibly a mild sclerotization of a portion of penultimate segment. Vestiges of thoracic wing framework absent, or at most indicated by cephalic and caudal borders of dorsum of mesothorax being unusually well defined, with pronounced depressions. Vestigial wings may or may not be present. Spiraculariae stout or inclined to be elongate, strongly sclerotic, subequal. Body setae approximately as in *Phoenicococcus marlatti* except 2 to 4 pairs each may be absent from head, thorax, and abdomen. Antenna with 2 stout basal segments; second segment not longer than broad; club stout or elongate, composed of 5 to 7 segments; each of 2 basal segments with 2 to 5 slender setae and none or 1 fleshy seta; each of club segments with from 1 to 4 slender and from none to 8 fleshy setae; antennal setae may be comparatively small or prominent. Single pair of eyes, marginal in position. Head skeleton with the merest vestige remaining, or with vestigial parts distinct. Rostrum either absent or vestigial. Legs large, subequal, or metathoracic tibia and tarsus distinctly stouter than the other tibiae and tarsi; with slender and fleshy setae of various sizes on all segments, or slender setae only on each trochanter and femur; with typically 7 to 9 setae on each coxa and 3 on each trochanter, including minute basal seta on each, 3 to 9 on each femur, 3 to 16 on each tibia, 5 to 16 on each tarsus, and 2 on each claw; apparently no definite sensory areas present on any segments. Anus distinct; may be near or on cephalic border of anal segment.

Type of genus, *Palmaricoccus attaleae*, new species.

Keys to Species of Palmaricoccus

First Stage

a. Only 12 8-shaped tubular pores normally present, with dorsomesal ones absent; spiracular pores trilocular; no seta on fourth antennal segment. attaleae, new species.

aa. From 14 to 16 8-shaped tubular pores normally present, including at least 4 pairs of dorsomesal ones; spiracular pores quinquelocular; a prominent fleshy seta on fourth antennal segment.

b. Body comparatively large, typically about 0.36 mm long and 0.16 mm wide; 14 8-shaped tubular pores normally present, dorsomesal ones only slightly smaller than marginal ones; a single pore associated with each of 4 spiracles; mesothoracic spiracular pores about 5 microns in diameter; 1 pair of frontal setae present; 1 seta midventrally located on femur and 1 seta on inner distal margin of tibia; rostralis comparatively long and possessing 1 long caudal loop and 2 or more large roundish loops, when uncoiled within body, besides the characteristic small cephalic loop ..... pritchardiae, new species.

bb. Body comparatively small, typically about 0.22 mm long and 0.13 mm wide; 16 8-shaped pores normally present, with dorsomesal and dorsosubmarginal ones distinctly smaller than marginal pores; no pores associated with metathorac spiracles; mesothoracic spiracular pores about 3 microns wide; frontal setae absent; no seta midventrally situated on femur and no setae at all on tibia; rostralis not long, with 1 long caudal loop and the characteristic small cephalic loop only, when uncoiled within body ..... nesiotes Laing.

Second-Stage Female

a. With 8-shaped pores distributed in general over body, dorsomesal pores being only slightly smaller than the others; distinct platelike thickenings of irregular form about all 4 spiracular external openings; with 4 fleshy antennal setae, reduced in size and arising from a sunken area; anal valve with only 3 pairs of setae, all comparatively large, rather stout, and subequal; anus located centrally on anal valve ..... attaleae, new species.

[7] Data lacking for one species, and not complete for another.

aa. Majority of 8-shaped pores on or near body margin, the mesal ones on both surfaces considerably smaller than the marginal pores; no distinctly plate-like thickenings around any spiracular opening; all fleshy antennal setae prominent and not arising from a sunken base; anal valve with 6 pairs of setae, 4 of these small or ordinary in size, the remaining 2 pairs, laterad in position, slightly larger, but not stout; anus distinctly cephalad as regards its position on anal valve.

b. A newly molted specimen typically about 0.64 mm long and 0.33 mm wide; caudal margin of posterior end evenly rounded but not projecting; papillae extending from margin considerably mesad on ventral surface; 8-shaped pores numerous (more than 700 on body); typically 30 or more quinquelocular pores associated with each of 4 spiracles, though sometimes as few as 12 or as many as 55 or more may be present around any spiracle; 7 pairs of setae each on fourth, fifth, and sixth abdominal segments; antenna with 5 prominent fleshy setae.
pritchardiae, new species.

bb. A newly molted specimen typically 0.37 mm long and 0.19 mm wide, thus not much more than half as large as **pritchardiae**; caudal margin of posterior end with a wavy outline and characteristically projecting; papillae rather sharply restricted to marginal and submarginal regions of ventral surface; considerably less than half as many 8-shaped pores (no more than 250 on body, and usually less) as in **pritchardiae**; typically only 4 to 6 quinquelocular pores associated with each mesothoracic and 1 with each metathoracic spiracle; only 6 pairs of setae each on fourth, fifth, and sixth abdominal segments; antenna with only 4 fleshy setae---------- nesiotes Laing.

ADULT FEMALE

a. With 8-shaped pores scattered promiscuously over both surfaces of body; with an irregular row of quinquelocular pores on sixth abdominal segment; fleshy antennal setae shorter, or at least no longer, than antenna itself; all six pairs of setae on anal segment distinctly larger than the other body setae---------- attaleae, new species.

aa. With 8-shaped pores scattered promiscuously, but practically confined to ventral surface; no quinquelocular pores on body; 4 of antennal setae at least twice the length of antenna itself; with only 3 pairs of setae on anal segment distinctly larger than the other body setae.

b. Body suboval to pyriform, typically 1.1 mm long and 0.74 mm wide; typically with no less than 300 8-shaped pores on body; 4 of antennal setae at least 3 times length of antenna itself.
pritchardiae, new species.

bb. Body elongate elliptical, typically 0.67 mm long and 0.30 mm wide; typically with no more than 60 8-shaped pores on body; none of antennal setae more than about twice length of antenna itself.
nesiotes Laing.

SECOND-STAGE MALE

a. Remains within first-stage body, which is puparial; papillae absent; 8-shaped pores minute, rather difficult to distinguish; antennae hardly more than slightly sclerotic thickenings; all antennal setae distinctly vestigial---------- attaleae, new species.

aa. Bursts from first-stage body, which is not puparial; numerous distinct papillae around body margin; 8-shaped pores not minute, readily observable; antennae not only projecting well above the surface as distinct tubercles, but apparently segmented and each with 4 or 5 prominent fleshy setae.

b. Body typically 0.40 mm long and 0.23 mm wide; typically with 4 to 8 quinquelocular pores associated with each mesothoracic and 1 to 3 with each metathoracic spiracle; a pair of frontal setae present between arms of head skeleton---------- pritchardiae, new species.

bb. Body typically 0.29 mm long and 0.17 mm wide; typically with 1 to 3 quinquelocular pores associated with each mesothoracic, and usually none but occasionally 1 quinquelocular pore associated with each metathoracic spiracle; frontal setae absent---------- nesiotes Laing.

ADULT MALE

:a. Wings entirely lacking; club of antenna stout, 5-segmented, distal segment sharply reduced in breadth; segments of each metathoracic leg with typically the following number of slender and fleshy setae, respectively, excluding minute basal ones on coxae and trochanters: Coxa 5 and 1, trochanter 2 and none, femur 4 and 1, tibia 5 and 2, tarsus 4 and 5. attaleae, new species.

:aa. Vestigial wings present and distinct; club of antenna 7-segmented, distal segment not appreciably reduced in breadth; segments of each metathoracic leg with typically the following number of slender and fleshy setae, respectively, excluding minute basal ones on coxae and trochanters: Coxa 4 and 4, trochanter 1 and 2, femur 4 and 5, tibia 8 and 8, tarsus 4 and 12. nesiotes Laing.

PALMARICOCCUS ATTALEAE, new species

Material collected by G. F. Ferris in 1925 near Manzanillo, State of Colima, west coast of Mexico, on the old fruit of the "coquito palm" (*Attalea cohune*) lying on the ground beneath the trees.

EGG

(Fig. 10, *F*)

Oviparous. Spine strongly sclerotic.

FIRST STAGE

(Fig. 10, *A–E*)

Body.—Elongate elliptical. Sclerotic areas near head skeleton usually obscure or absent. A distinct furca on meson between mesothoracic and metathoracic segments. The 2 posterior abdominal segments relatively strongly sclerotic. Typical newly hatched specimen 0.27 mm long and 0.12 mm wide; fully developed female moderately sclerotic, typically 0.50 mm long and 0.27 mm wide. Male instar becomes puparium; strongly sclerotic; typically 0.39 mm long and 0.20 mm wide.

Pores.—Typically with 12 pairs of 8-shaped pores as follows: 2 marginal pairs on head; a single marginal pair each on prothorax, anterior sections of both mesothorax and metathorax, and first, third, sixth, seventh, and posterior abdominal segments; submarginally, a pair each on venter of third and fifth abdominal segments. 8-shaped pores slightly larger posteriorward. A single trilocular pore associated with each of four spiracles.

Spiracles.—Spiraculariae suboval, lightly sclerotic, subequal; with granulate areas on each side of spiracular external openings.

Body setae.—In distribution essentially as in *Phoenicococcus marlatti*, usually with the addition of a minute pair on venter of anterior section of metathorax mesad of spiracles, and one less pair on posterior abdominal segment; in all, 69 pairs present. In one specimen, outer and inner long caudal pairs 53 and 203 microns long, respectively.

Antenna.—With 4 setae on third segment, none on fourth, and 3 slender setae on fifth segment; otherwise essentially as in *Phoenicococcus marlatti*.

Rostralis.—Length in two typical specimens, 0.63 and 0.72 mm, respectively.

Legs.—Essentially as in *Phoenicococcus marlatti* except for presence of two setae on femur.

Anal ring.—Reduced in size but apparently present. No setae on anal ring, but two pairs near it on ventral surface considered homologous with the middle and cephalic pairs on anal ring in *Phoenicococcus marlatti*.

Exuviation.—In male, break occurring ventrally on suture between sixth and seventh abdominal segments and extending along this suture onto dorsal surface until usually but a small connection remains; frequently in mounted specimens the caudal end entirely separated from puparium. In female, derm swollen from growth of subsequent instar bursting in an irregular manner.

Dried material.—Frequently found in crevices; body mostly bright brown; apparently naked.

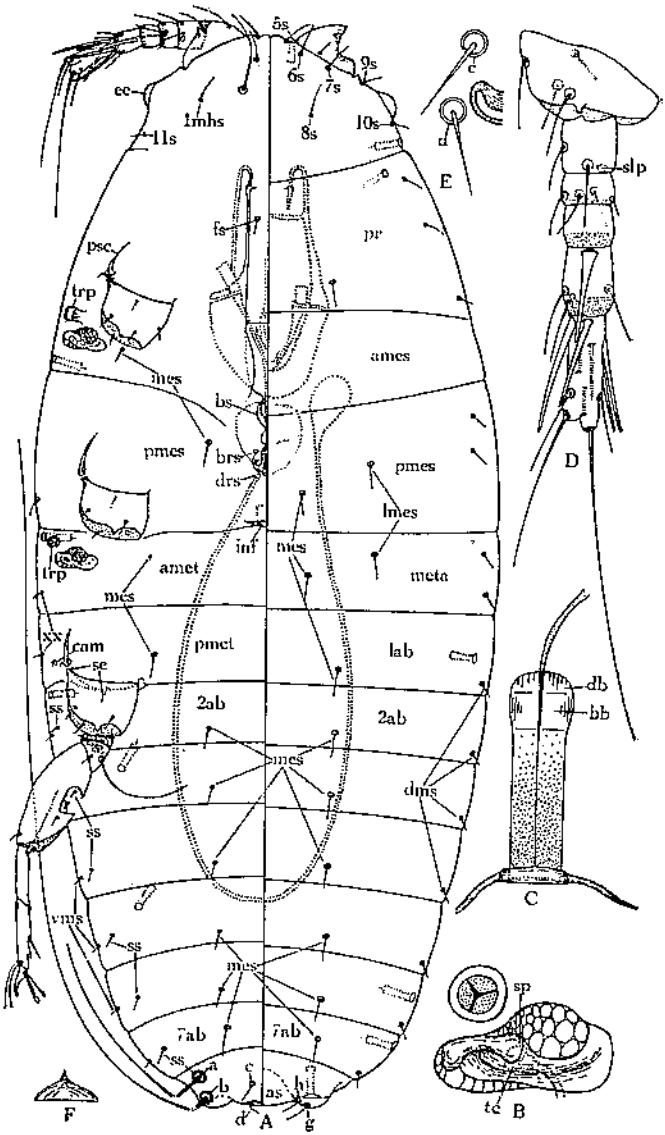

FIGURE 10.—*Palmaricoccus attaleae*: *A*, First-stage nymph, body, dorsal and ventral, × 500; *B*, same, mesothoracic spiracle, × 2,000; *C*, same, dorsocaudal pore, × 3,000; *D*, same, antenna, ventral surface, × 1,000; *E*, same, anal-ring and neighboring setae, × 2,000; *F*, egg spine, × 1,500.

SECOND-STAGE FEMALE

(Figs. 11, 12, *F*, and 13, *A–D*)

Body.—Elliptical in younger specimens, pyriform in older ones; segmentation obscure except for the 4 or 5 posterior abdominal segments; in younger specimens derm membranous except on seventh and to some extent on sixth abdominal segments, seventh being strongly sclerotic; sclerotization spreading cephalad, but in decreasing degree, to and including dorsum of fourth abdominal segment before general thickening of entire body wall takes place. Prominent, stout, spinelike, frequently curved papillae, scattered thickly along lateral and cephalic margins of ventral surface, so abundant that, in younger specimens, the derm beneath is obscured; away from these margins papillae becoming smaller, blunter, and fewer in number; fully developed individuals uniformly heavily sclerotic, obscuring the papillae. In older specimens a pair of comparatively large roundish thin areas in body wall laterad of head skeleton penetrated on either side by rostralis of adult. A newly molted specimen 0.36 mm long and 0.25 mm wide; a typical puparium 1.60 mm long and 0.97 mm wide.

Pores.—8-shaped pores moderately numerous and scattered over both surfaces except on the 3 or 4 posterior abdominal segments; all small and somewhat elongate, smallest mesad on dorsal surface; partitions extending apparently about half way through tubes; bars readily distinguished apart; on one side of one typical specimen were 82 ventral and 38 dorsal pores, thus roughly twice as many on ventral as on dorsal surface. From 3 to 15 quinquelocular pores associated with each of four spiracles; situated within shallow depressions leading to spiracles or on raised sclerotic pieces studding the depressions.

Spiracles.—Both pairs in shallow depressions; distinct, irregularly formed, overlapping sclerotic thickenings or plates cover the sides and surrounding regions of the depressions, giving a rough or rugose appearance to the parts; spiraculariae distinct, slightly enlarged at inner ends.

Body setae.—Typically 11 scattered pairs on head; 3 marginal, 1 dorsomesal, and 1 ventromesal pair on prothorax; 3 marginal, 1 dorsomesal, 1 lateromesal of dorsum, and 1 ventromesal pair each on mesothorax and metathorax, and 1 additional marginal pair on metathorax; 1 marginal and 1 dorsomesal pair on first abdominal segment; 1 dorsomarginal, 1 dorsomesal, 1 ventromarginal, 1 ventrosubmarginal, and 1 ventromesal pair on each of second to seventh abdominal segments, inclusive; 3 pairs on anal valve; in all, 64 pairs present.

Antenna.—A raised membranous base practically absent; otherwise essentially as in *Phoenicococcus marlatti* except for presence of only 4 fleshy setae and apparently 1 minute slender seta on lateral surface of distal sclerotic part of antenna.

Rostralis.—In one typical specimen, 1.8 mm long.

Anal valve.—Except basally, covering tissue reticulate in appearance; markings obscured in older specimens; with three pairs of comparatively large, stout setae. Anus centrally located; anal ring apparently present, small and without setae.

Dried material.—Puparium reddish to blackish brown around margins and bright brown mesally; leathery in appearance; almost wholly exposed owing to shallow crevices on the old fruit; naked except for occasional slight fringe of whitish waxy matter around body margin; somewhat variable in size and form; moderately flattened; lateral surface bulging or rounded, with no sharp line separating it from the ventral surface; posterior end pointed dorsocaudad.

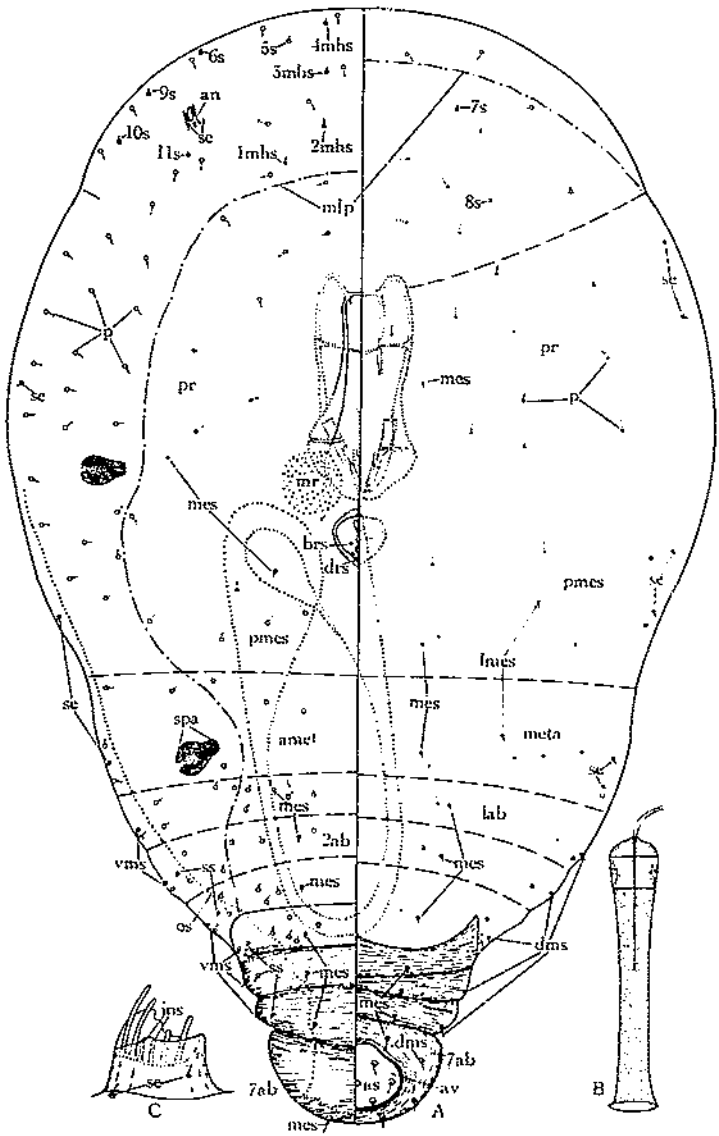

FIGURE 11.—*Palmaricoccus attaleae*, second-stage female: *A*, Body (partially developed), dorsal and ventral, × 160; *B*, 8-shaped pore, × 3,000; *C*, antenna, × 2,000.

THIRD-STAGE FEMALE

(Fig. 12, *A–E*)

Body.—Pyriform; fitting snugly against inner walls of preceding instar; segmentation not distinguishable except for slight indentations along margins of posterior abdominal segments, possibly marking the limits of the latter; membranous but distinct; derm comparatively rigid and rather easily separated from preceding instar; posterior abdominal segments plainly ridged in wavy lines; caudal margin frazzled in all available specimens; no definite structures discernible on dorsal surface; within posterior end apparently a delicate membrane connecting this instar with the developing subsequent instar.

Pores.—Moderate number of clear spots scattered over ventral surface; usually in center of each an 8-shaped structure, the inner end of a pore of preceding instar; clear spots apparently thin areas in body wall to accommodate inwardly projecting second-instar pores; this view strengthened on noting occasionally an entire pore lying flat within a clear spot which is formed to suit the pore; not infrequently a clear spot is empty, presumably indicating that a pore has been pulled away in removing it from puparium; the latter showed empty clear spots, too, with uneven margins, apparently indicating that pores have been pulled away.

Spiracles.—Each pair peculiar to this instar; spiraculariae elongate, moderately sclerotic, subequal; each with a sclerotic collar around external opening of spiracle, behind which is a short, somewhat expanded chamber, at the farther end of which issues a dense brush of tracheoles characteristically extending cephalad and ending in an enlarged irregular mass of tissue.

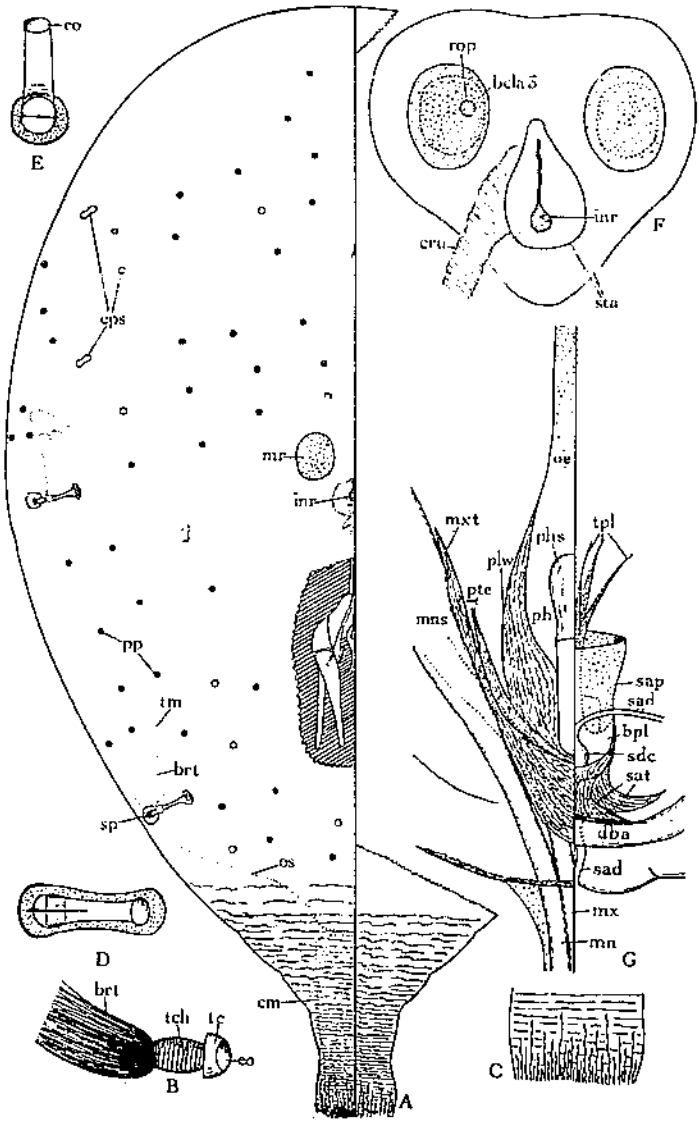

FIGURE 12.—*Palmaricoccus attaleae: A*, Third-stage female, body, dorsal and ventral, × 150; *B*, same, tracheal collar, expanded tracheal chamber, and brush of trachecles, × 500; *C*, same, caudal margin of posterior end, showing frazzled condition, × 300; *D*, same, full-length pore lying in clear spot, × 1,500; *E*, same, inner end of pore only lying in clear spot, × 1,500; *F*, second-stage female, midventral region, × 300; *G*, adult female, details of part of head-skeleton assemblage, × 1,000.

ADULT FEMALE

(Figs. 12, *G*, 13, *E*, and 14)

Body.—Moderately elliptical to pyriform; segmentation obscure except on both surfaces of the five posterior segments; membranous throughout, including anal segment. A typical rather large specimen 1.07 mm long and 0.82 mm wide; a rather small one 0.85 mm long and 0.55 mm wide.

Pores.—8-shaped pores all noticeably small; distributed approximately as in second-stage female, except scarcer on venter of head and for their occurrence on anal segment; partitions extending apparently hardly more than through bars; bars can be distinguished apart; external openings not surrounded by distinctly sclerotic rims; on one side of one typical specimen, 110 and 108 pores counted on venter and dorsum, respectively, thus about equally numerous on both surfaces. Around sixth abdominal segment an irregular band of subequal quinquelocular pores ranging in number typically from 20 to 26; slightly more numerous on ventral than on dorsal surface.

Spiracles.—With several small curving rows of faint shallow papillae around spiracular openings; with dense brush of tracheoles issuing from inner end of tracheal chamber.

Body setae.—In number and distribution essentially as in second-stage female, though occasionally an extra seta on each segment; all small except on anal segment; typically 8 pairs apparently on head, 19 pairs on thorax, 2 pairs on first abdominal segment, 5 pairs each on second to sixth abdominal segments, inclusive, and 6 pairs each on seventh and anal segments; in all, 66 pairs present.

Antenna.—With 4 fleshy setae of varying sizes and a pair of minute setae, not quite wholly invaginated, apparently issuing from a small apical depression.

Rostralis.—With one large elongate caudal loop and the characteristic small cephalic loop, when uncoiled within body; in one typical specimen, 2.0 mm long.

Anal segment.—Reduced in size; typically 2 pairs of 8-shaped pores on caudal margin; with 6 pairs of setae, all noticeably larger than the other body setae, 3 long slender pairs being on dorsum and 3 stout pairs of varying sizes being on venter. Anal ring apparently present but inconspicuous.

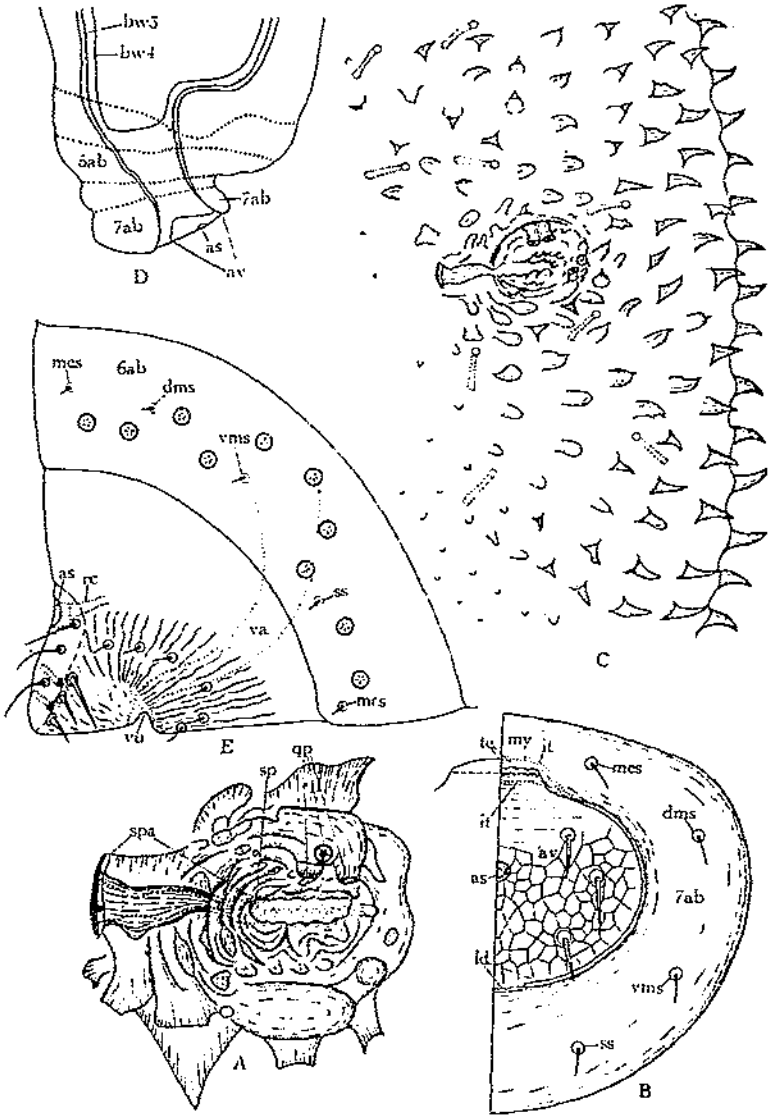

FIGURE 13.—*Palmaricoccus attaleae*: *A*, Second-stage female, mesothoracic spiracle, × 900; *B*, same, dorsal aspect of posterior end, × 450; *C*, same, mesothoracic spiracular region, × 450; *D*, same, lateral aspect of posterior end, × 150; *E*, adult female, lateral aspect, posterior end, × 850.

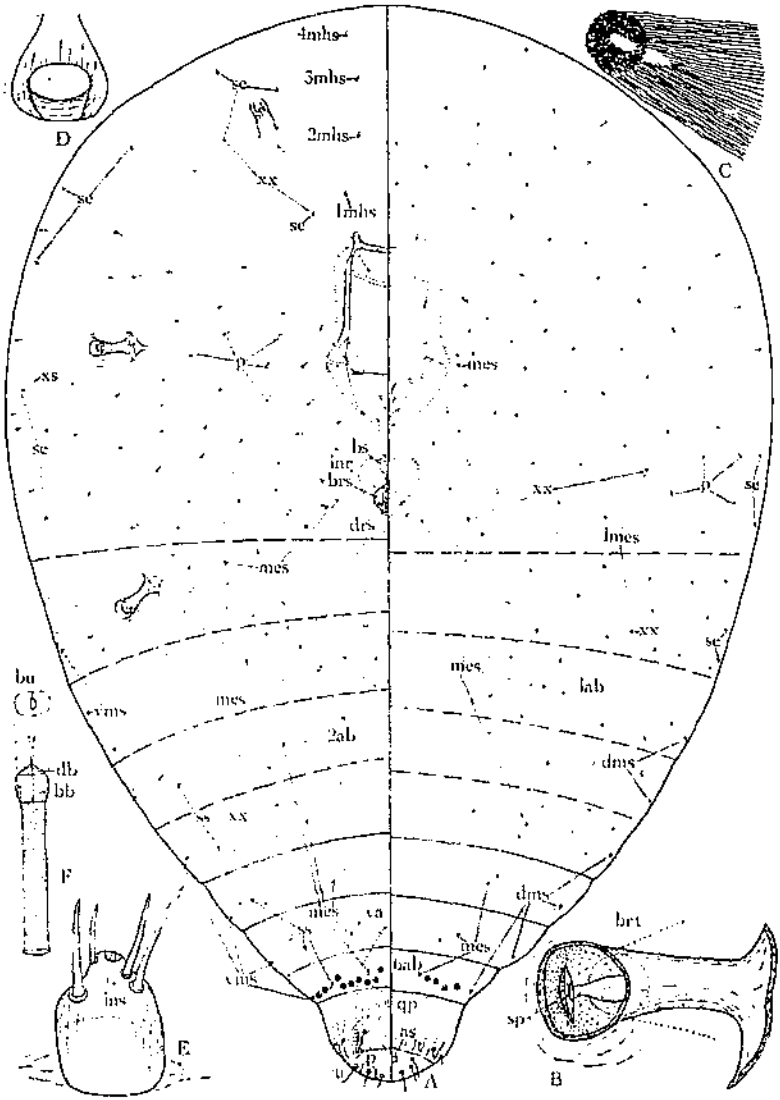

FIGURE 14.—*Palmaricoccus allaleus*, adult female: *A*, Body, dorsal and ventral, × 150; *B*, mesothoracic spiracle, × 900; *C*, brush of tracheoles, × 900; *D*, anal ring, × 1,200; *E*, antenna, × 1,000; *F*, 8-shaped pore, × 3,000.

SECOND-STAGE MALE

(Figs. 15 and 17, *D*)

Body.—Elongate elliptical, with anterior end rounded and posterior end truncated; segmentation obscure except on abdomen; membranous throughout. Papillae absent. A typical specimen 0.40 mm long and 0.18 mm wide.

Pores.—8-shaped pores scattered within limits on both surfaces; not numerous; minute; partition extending almost through tube; bars distinguished apart with difficulty; external opening slightly expanded and not surrounded with sclerotic rims; on one side of one typical specimen, 3 dorsal and 5 ventral 8-shaped pores on head, 6 dorsal and 19 ventral ones on prothorax and mesothorax combined, 2 dorsal and 6 ventral ones on metathorax, 2 dorsal ones on first abdominal segment, 1 dorsal one each on second, third, and fourth abdominal segments, 4, 2, and 1 ventral pores on these segments, respectively, and 1 dorsomesal pore on seventh abdominal segment; in all, 54 8-shaped pores present on one side. No pores associated with mesothoracic spiracle, but typically one quinquelocular pore associated with each metathoracic spiracle; this pore may be absent from one side or in its place there may be a trilocular or a quadrilocular pore.

Body setae.—Essentially as in first instar except for following setae absent: 4 pairs on head, the lateromesal pairs of dorsum on mesothorax and metathorax, all marginal and submarginal ones on venter of mesothorax posteriorward to and including sixth abdominal segment, 1 marginal or submarginal pair on venter of seventh abdominal segment, the ventromesal pair on anterior section of metathorax; in all, 47 pairs present.

Antenna.—Lightly sclerotic and only slightly raised above surface; with 4 minute, stout, spinelike structures, all probably setae, and 2 more or less clear spots which may be vestiges of setae.

Rostralis.—With a broad shallow caudal bend and the characteristic small cephalic loop, when uncoiled within body; in one specimen, 0.43 mm long.

Legs.—All three pairs in evidence but extremely vestigial.

Anus.—On caudal margin, which does not project here; narrow and only moderately sclerotic anal ring.

Exuviation.—Old derm pushed back posteriorward into a shapeless mass.

THIRD-STAGE MALE

No specimens in condition for distinguishing the parts adequately.

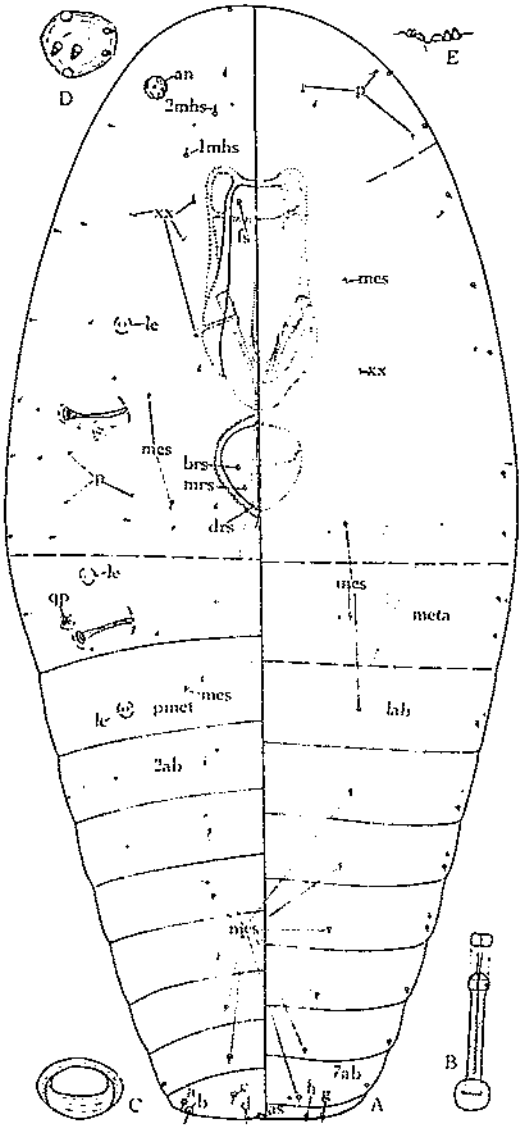

FIGURE 15.—*Palmaricoccus attaleae*, second-stage male: *A*, Body, dorsal and ventral, × 380; *B*, 8-shaped pore, × 3,000; *C*, anal ring, × 2,000; *D*, antenna, × 2,000; *E*, antenna, lateral aspect, × 2,000.

FOURTH-STAGE MALE

(Fig. 16)

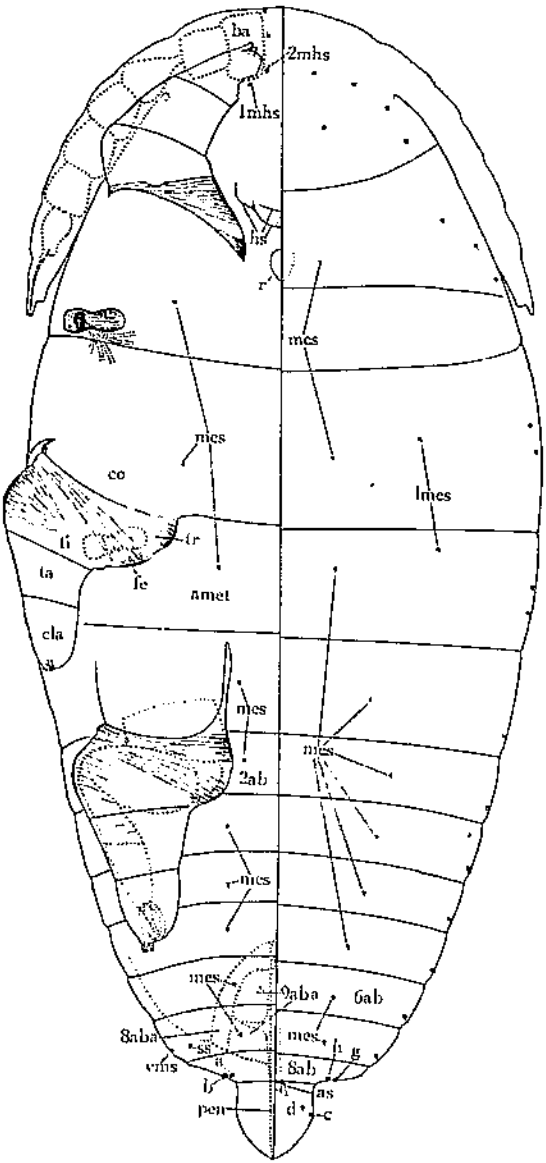

FIGURE 16.—*Palmaricoccus attaleae*, fourth-stage male: Body, dorsal and ventral, × 380.

Body.—Moderately elliptical; in outline gently tapering caudad from mesothorax, with posterior projection slightly longer and more pointed than in *Phoenicococcus marlatti;* segmentation of all segments defined except on ventral surface of prothorax and mesothorax. A typical specimen 0.40 mm long and 0.18 mm wide.

Spiraculariae.—Stout, cylindrical, strongly sclerotic, subequal.

Body setae.—Essentially as in *Phoenicococcus marlatti*, with the following typical exceptions: 3 pairs on head, lateromesal pair of dorsum on prothorax, dorsomesal pair on anterior section of mesothorax, 1 marginal pair on posterior section of mesothorax, a pair immediately caudad of mesothoracic spiracles, and the marginal and submarginal pairs on fourth, fifth, and sixth abdominal segments, all absent; ventromesal pair on second abdominal segment present; in all, 53 pairs present.

Antenna.—Slightly more elongate and segmentation less distinct than in *Phoenicococcus marlatti.*

Legs.—Broad at base, stocky, and tibiae characteristically sharply elbowed. With more or less sclerotization of trochanter, femur, and tibia. A pair of small, stout, apical projections on each leg, extensions to hold the developing distal tarsal setae of subsequent instar.

Anal segment.—Anus distinct, near cephalic margin of ninth abdominal segment.

ADULT MALE

(Fig. 17, *A–C*)

Body.—Vestiges of thoracic wing framework and wings absent. Posterior abdominal segment moderately sclerotic. A typical specimen 0.41 mm long and 0.10 mm wide.

Spiraculariae.—Stocky, almost barrel-shaped.

Body setae.—In distribution essentially as in *Phoenicococcus marlatti*, with the following setae absent: 2 pairs on head, lateromesal pair of dorsum on prothorax, dorsomesal pair on anterior section of mesothorax, 1 marginal and 1 small ventral pair on posterior section of mesothorax, the ventromesal pair of anterior section of metathorax, and 1 marginal or submarginal pair each on fourth, fifth, and sixth abdominal segments; in all, 56 pairs present.

Antenna.—Club stocky, with 5 segments appearing to be loosely connected; the 3 middle club segments considerably broader than the other 2 segments; typically with 4 slender setae and 1 fleshy seta on basal segment, 5 slender setae on second, 1 slender seta and 4 fleshy setae on third, 4 slender and 4 fleshy setae on fourth, 5 fleshy setae on fifth, 3 slender and 4 fleshy setae on sixth, and 2 slender and 6 fleshy setae on apical segment; all setae shorter or at most little longer than the segments from which they arise.

Head skeleton and rostrum.—A differentiated sclerotic area on ventromeson, possibly a vestige of head skeleton; otherwise no evidence of head skeleton or of rostrum; invagination leading to alimentary tube distinct.

Legs.—Metathoracic tibia and tarsus considerably stouter than the other tibiae and tarsi. Each coxa with 5 slender setae of various sizes, besides a minute basal one and 1 moderately long fleshy seta; each trochanter with 2 rather small slender setae, besides a minute basal one; prothoracic femur with 3 slender setae and each of the other 2 femora with 4 slender setae and 1 fleshy seta; prothoracic and mesothoracic tibiae each with 3 slender and 2 fleshy setae; metathoracic tibia with 5 slender and 2 fleshy setae; prothoracic tarsus with 4 slender setae and 1 fleshy seta; mesothoracic tarsus with 4 slender and 2 fleshy setae and metathoracic tarsus with 4 slender and 5 fleshy setae; each claw with 2 setae, 1 apparently fleshy and the other slender.

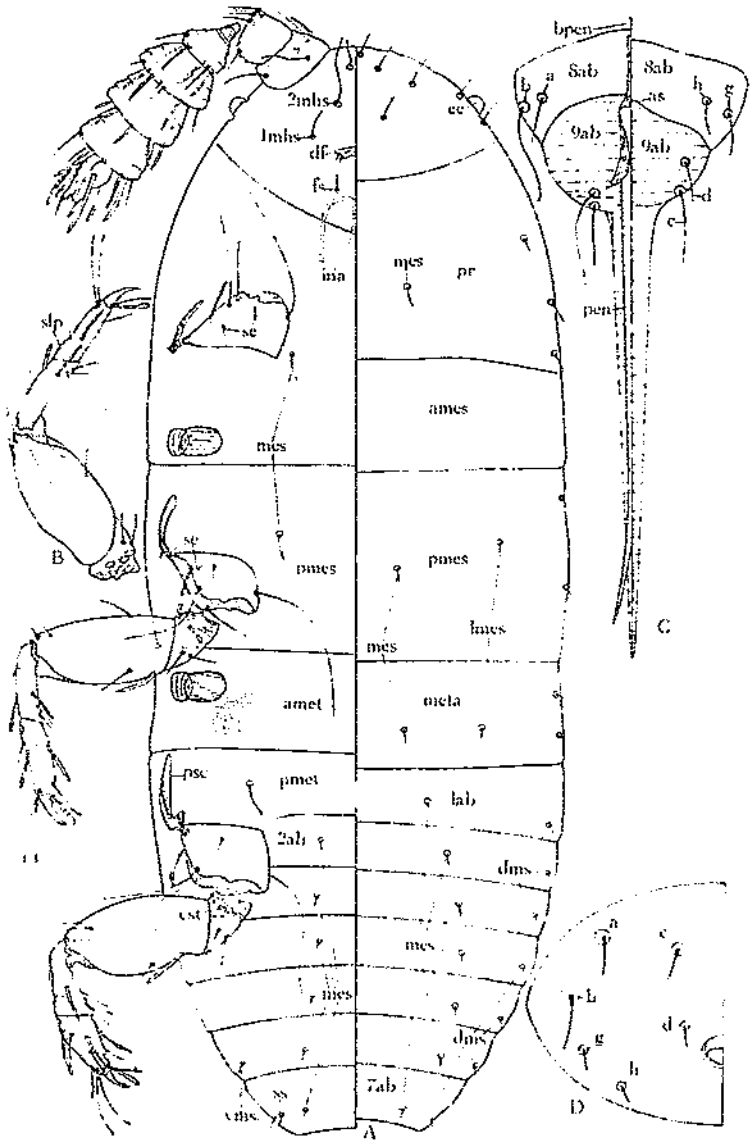

FIGURE 17.—*Palmaricoccus attaleae*: *A*, Adult male, body, dorsal and ventral, × 160; *B*, same, prothoracic leg, dorsum, × 450; *C*, same, posterior end, dorsal and ventral, × 990; *D*, second-stage male, anal segment, × 990.

PALMARICOCCUS PRITCHARDIAE, new species

Material from E. M. Ehrhorn. Two lots: One collected by J. F. Rock in 1919 on fruit of *Pritchardia hardyi* at 3,000-foot elevation, Molokai Island, Hawaii; the other collected by O. H. Swezey in 1916 on fruit of *Pritchardia rockiana* at Punaluu, Oahu, Hawaii.

EGG

(Fig. 18, *E*)

Oviparous. Spine strongly sclerotic.

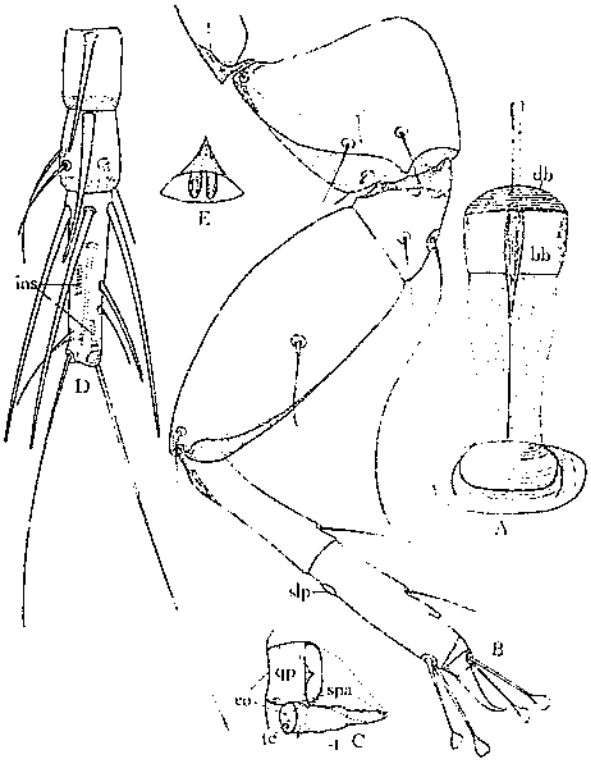

FIGURE 18.—*Palmaricoccus pritchardiae*: *A*, First-stage nymph, caudodorsal pore, × 3,000; *B*, same, metathoracic leg, × 1,600; *C*, same, mesothoracic spiracle, × 1,200; *D*, same, antenna, apical part, × 1,600; *E*, egg spine, × 1,500.

FIRST STAGE

(Fig. 18, *A–D*)

Body.—Elongate elliptical. Usually with a distinctly sclerotic area laterocephalad of head skeleton. A distinct furca on meson between mesothoracic and metathoracic segments. Two posterior abdominal segments more sclerotic than other body segments. Typical newly hatched specimen 0.36 mm long and 0.16 mm wide; fully developed female specimen 0.46 mm long and 0.28 mm wide; fully developed male specimen 0.39 mm long and 0.21 mm wide. Male instar not puparial, its derm not strongly sclerotic.

Pores.—8-shaped pores larger than, but in structural details essentially as, in *Palmaricoccus attaleae*. In distribution 8-shaped pores typically as follows: 2 pairs on or near dorsal margin of head, 1 pair cephalad of eyes and the other caudad of eyes; 4 dorsomesal pairs in a row on thorax; 1 dorsomarginal pair each on sixth and eighth abdominal segments; 1 ventromarginal pair near each spiracle and on each of second to fifth abdominal segments, inclusive; in all, 14 pairs present. A single quinquelocular pore associated with each of four spiracles.

Spiracles.—Spiracularine approximately alike, small, elongate, strongly sclerotic.

Body setae.—Nearly as in *Palmaricoccus attaleae*, with the following most noticeable variations: Third ventromesal head pair almost as large as second ventromesal head pair; the small ventromesal pair of anterior section of metathorax and the dorsomesal pair of seventh abdominal segment absent; dorsomesal pairs approximately same size as marginal pairs; in all, 67 pairs present. In one specimen, outer and inner long caudal pairs, respectively, 67 and 187 microns long.

Antenna.—Essentially like that of *Palmaricoccus attaleae* except larger, with the minute seta near inner margin of third segment possibly absent, and a large fleshy seta present on fourth segment; resembling *Phoenicococcus marlatti* in these two particulars.

Rostralis.—With 1 long caudal loop and 1 or 2 roundish caudal loops, when uncoiled within body; length more like that of *Phoenicococcus marlatti;* in one specimen, 1.10 mm long.

Legs.—In structure essentially like those of *Palmaricoccus attaleae* except for presence of a seta on inner margin of each tibia.

Exuviation.—No data available.

Dried material.—In crevices; light brown; moderately well covered with matted filaments.

SECOND-STAGE FEMALE

(Fig. 19, *A–E*)

Body.—More or less pyriform, especially in older individuals; segmentation obscure except for the 4 or 5 posterior abdominal segments; in younger individuals derm membranous except seventh abdominal segment and anal valve, which are distinctly sclerotic; sclerotization spreading cephalad, but in decreasing degree, to and including fourth abdominal segment, before general thickening of derm takes place. Stout, spinelike, but not typically curved, papillae thickly covering both surfaces; comparatively large marginally, decreasing in size mesad, more rapidly on ventral than on dorsal surface; fully developed specimens heavily sclerotic, obscuring papillae. In older specimens, with a membranous area on each side of head skeleton for penetration of adult rostralis; less circular and more caudad in position than that of *Palmaricoccus attaleae.* A typical newly molted specimen 0.64 mm long and 0.33 mm wide; a rather small puparium 1.3 mm long and 0.7 mm wide; a rather large puparium 1.65 mm long and 0.85 mm wide.

Pores.—8-shaped pores scattered over both surfaces; numerous, most abundant along cephalic and lateral margins and submargins, particularly on ventral surface; stouter in general than those in *Palmaricoccus attaleae,* marginal ones largest, dorsomesal ones of abdomen smallest; partitions extending through tubes nearly to their external openings; bars can be distinguished apart; bullae delicate; number on one side of each of following segments or combination of segments of a single specimen approximately as follows: Head, 40 ventral, 19 dorsal; prothorax and anterior section of mesothorax together, 55 ventral, 26 dorsal; posterior section of mesothorax, 40 ventral, 18 dorsal; metathorax and first abdominal segment together, 65 ventral, 30 dorsal; second and third abdominal segments each, 25 ventral, 12 dorsal; fourth abdominal segment, 12 ventral, 9 dorsal; sixth abdominal segment, 1 ventral, none dorsal; fifth and seventh abdominal segments, none on either surface; on one side of one typical specimen, in all, 263 on venter and 126 on dorsum, thus approximately twice as many on ventral as on dorsal surface, and altogether three and a half times as many as in *Palmaricoccus attaleae.* A rather compact group of quinquelocular pores associated with each of 4 spiracles; in a count of 40 groups of quinquelocular pores, 20 associated with mesothoracic and 20 with metathoracic spiracles, the range in number in each group being 14 to 54 and 12 to 56, and the average number 37.6 and 34.8, for the mesothoracic and metathoracic spiracles, respectively.

Spiracles.—Both pairs and their accompanying quinquelocular pores open practically on surface, with no surrounding distinct sclerotic thickenings or plates.

Body setae.—Essentially as in *Palmaricoccus attaleae,* with typically the following 13 additional setae: 1 ventromesal pair laterad of head skeleton; 1 dorsosubmarginal pair each on first to sixth abdominal segments, inclusive; 1 ventromesal pair each on fourth, fifth, and sixth abdominal segments; 3 pairs on anal valve; in all, 11 pairs on head, 12 pairs on prothorax and mesothorax together, 7 pairs on metathorax, 3 pairs on first, 6 pairs each on second and third, 7 pairs each on fourth, fifth, and sixth, 5 pairs on seventh abdominal segment, and 6 pairs on anal valve, or a total of 77 pairs present.

Antenna.—More elongate than in *Palmaricoccus attaleae;* with a raised, membranous base and sclerotic distal part lacking a sunken area; with 5 fleshy setae varying in size and position, and 2 small, slender, almost wholly evaginated setae, which are considered to be homologous with the pair of invaginated setae of *Palmaricoccus attaleae;* all setae arising from distal part of antenna.

Rostralis.—In one typical specimen, 2.2 mm long.

Anal valve.—Covered with sclerotic tissue, which in younger specimens is usually marked with irregular lines and numerous spinelike thickenings; in older specimens tissue heavy, obscuring markings; with 6 pairs of setae, 2 cephalolateral pairs being slightly larger than the others. Anus cephalad in position; anal ring apparently present but insignificant.

Dried material.—Puparium more frequently observed wedged beneath calyces of fruit; dark reddish brown; much matted wax scattered over body; varying in size and form; dorsum more convex than in *Palmaricoccus attaleae,* but body never globular; margins rounded; posterior end pointed dorsocaudad.

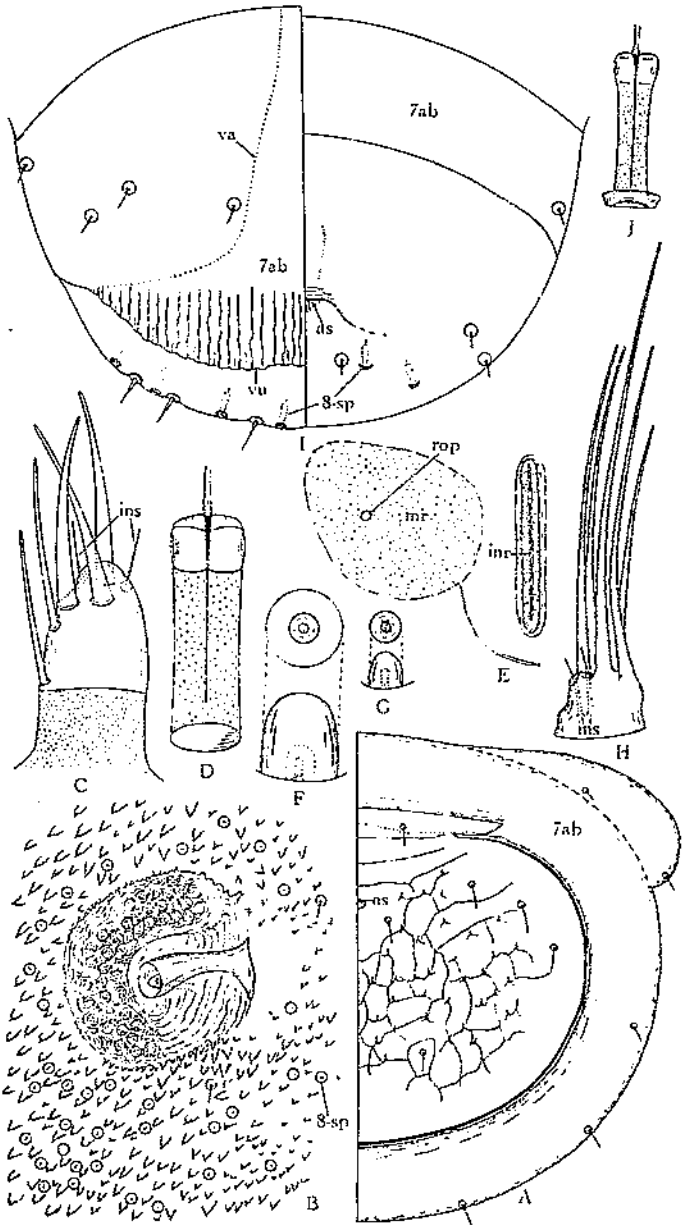

FIGURE 19.—*Palmaricoccus pritchardiae*: *A*, Second-stage female, posterior end, dorsal surface, × 500; *B*, same, mesothoracic spiracle, × 500; *C*, same, antenna, × 1,000; *D*, same, 8-shaped pore, × 3,000; *E*, same, midventral region of puparium, × 100; *F*, *G*, third-stage female, large and small derm tubercles, × 1,500; *H*, adult female, antenna, × 1,000; *I*, same, posterior end, dorsal and ventral, × 500; *J*, same, 8-shaped pore, × 3,000.

THIRD-STAGE FEMALE

(Fig. 19, *F* and *G*)

Pyriform; derm membranous but firm; many rounded tuberculate structures of varying sizes scattered over both surfaces, possibly thickenings around pores of preceding instar; spiracles similar to those in *Palmaricoccus attaleae;* with two clear areas where one would normally expect to find antennae.

ADULT FEMALE

(Fig. 19, *H–J*)

Body.—Moderately elliptical to pyriform; posterior end drawn out a little more than in *Palmaricoccus attaleae;* segmentation obscure except on both surfaces of the five posterior segments; derm membranous except for faint sclerotization of caudal part of anal segment; papillae very small and numerous around spiracles and ventromesal surface of thorax. Typical specimen 1.1 mm long and 0.74 mm wide.

Pores.—8-shaped pores distributed over ventral surface of all segments of body with possible exception of sixth and seventh abdominal ones; considerably concentrated on this surface about midway between lateral margins and meson; apparently absent on dorsum; in structure essentially as in second-stage female except external openings surrounded by sclerotic rims. On one side of typical specimen, the following number of 8-shaped pores: 67 from cephalic margin of head to, but not including, posterior section of mesothorax; 53 on next two segments, practically embracing the area between lines drawn through caudal margins of spiracles; 20, 16, 12, 6, and 2 on the segments immediately following, in consecutive order; in all, 176 counted on one side; with a moderate variation in their number on the different segments, especially on thorax. Quinquelocular and other types of pores absent.

Spiracles.—A moderate number, not a brush, of trachcoles, issuing from inner end of each tracheal chamber.

Body setae.—Distributed essentially as in second-stage female except typically 1 more pair on head, 5 more pairs on thorax, and 1 more pair on third abdominal segment; in all, 12 pairs on head, 16 pairs on prothorax and mesothorax together, 8 pairs on metathorax, 3 pairs on first, 6 pairs on second, 7 pairs each on third to sixth abdominal segments, inclusive, 5 pairs on seventh abdominal segment, and 6 pairs on anal segment; in all, 84 pairs present.

Antenna.—With five long fleshy setae of varying sizes and a pair of small setae, which are only partially invaginated.

Rostralis.—With 1 elongate loop, 2 large roundish loops, and the small cephalic loop, when uncoiled within body; in one typical specimen, 3.8 mm long.

Anal segment.—Somewhat less reduced in size than in *Palmaricoccus attaleae;* with typically 6 pairs of 8-shaped pores, 2 pairs distinctly on dorsal surface and 4 pairs along caudal margin; 6 pairs of setae, 3 pairs approximately the size of the other body setae on dorsum and the remaining 3 pairs stout; anal ring obscure, if not absent.

SECOND-STAGE MALE

(Fig. 20)

Body.—Moderately elliptical, with both ends about equally rounded; segmentation distinct except on ventral surface of head, prothorax, and mesothorax; in younger individuals lightly sclerotic, with increasing sclerotization posteriorward on the four posterior abdominal segments, which in older individuals are likewise sclerotic, though remainder of body appears to become more or less membranous. Papillae small and spinelike; numerous marginally and submarginally on both surfaces, gradually disappearing mesally on both surfaces, but here numerous irregular rows of spiny and serrated spicules occur. A typical newly molted specimen 0.36 mm long and 0.20 mm wide; a fully developed specimen 0.44 mm long and 0.21 mm wide.

Pores.—8-shaped pores fairly numerous; scattered over both surfaces of body; subequal in size; in structure essentially as in *Palmaricoccus attaleae* except slightly larger and external openings surrounded with narrow sclerotic rims; on one side of one typical specimen were: 18 on head, 54 on thorax, 6 on first, 16 on second, 14 on third, 15 on fourth, 14 on fifth, 16 on sixth, and 10 on seventh abdominal, and 13 on anal segment, or 104 on abdomen; in all, 176 on one side of body. Typically from 4 to 8 quinquelocular pores associated with each mesothoracic and 1 to 3 with each metathoracic spiracle; all rather closely grouped about each spiracle.

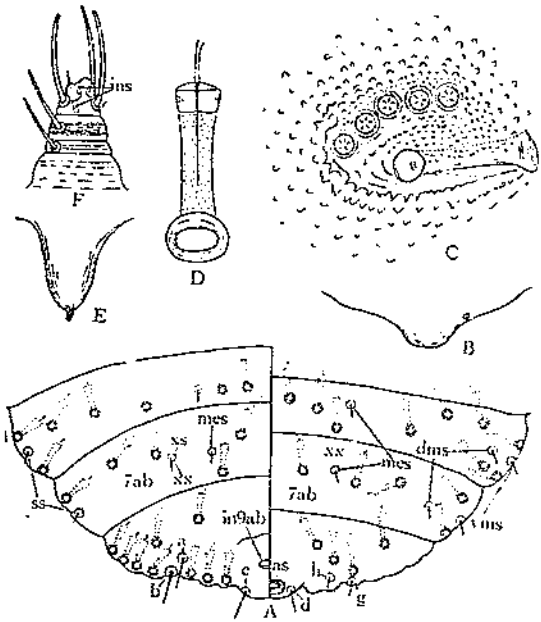

FIGURE 20.—*Palmaricoccus pritchardiae*, second-stage male: *A*, Posterior end, dorsal and ventral, × 500; *B*, metathoracic leg, × 1,500; *C*, mesothoracic spiracle, × 1,000; *D*, lateromarginal 8-shaped pore, × 3,000; *E*, another metathoracic leg, × 1,500; *F*, antenna, × 1,000.

Body setae.—Essentially as in *Phoenicococcus marlatti*, with the following exceptions: 2 less pairs on or near margin of head, the lateromesal pairs of dorsum on prothorax and anterior section of mesothorax absent, 1 ventromesal pair present on second abdominal and 1 extra pair, considered to belong to the ventromesal series, on seventh abdominal segment, 1 less pair on anal segment; thus in all, 75 pairs present.

Antenna.—Rather elongate; apparently composed of 4 segments; with 5 large fleshy setae and apparently 2 minute spinelike ones, besides the small invaginated pair.

Rostralis.—With 1 elongate loop, 2 broad rather deep loops, and the characteristic small cephalic loop, when uncoiled within body; in one typical specimen, 0.93 mm long.

Legs.—May or may not be evident; usually vestigial in character.

Anus.—On or near caudal margin, which projects slightly here; anal ring rather broad and strongly sclerotic.

Exuviation.—No data available.

THIRD, FOURTH, AND ADULT MALE STAGES

Not available.

PALMARICOCCUS NESIOTES (Laing) (*10*)

Material from Frederick Laing, on "palm sp.", Lord Howe Island, South Pacific Ocean; E. E. Green, same source; United States Bureau of Entomology (Kotinsky no. 134), "on palm", Macheno, Hawaii, August 24, 1906. All along depressions of pinnae.

EGG

Not identified.

FIRST STAGE

(Fig. 21)

Body.—Moderately elliptical. Usually with a distinctly sclerotic area cephalad of head skeleton. Thoracic furcae obscure. Posterior abdominal segment typically more or less sclerotic. Dorsal surface of abdomen becoming clearly sclerotic and sharply delimited in fully developed female specimens, but not in the male. Typical newly hatched specimen 0.22 mm long and 0.13 mm wide; fully developed specimen of either sex about 0.29 mm long and 0.20 mm wide. Male instar not puparial.

Pores.—8-shaped pores occurring typically as follows: 2 large dorsomarginal pairs on head, 1 cephalad and 1 caudad of eyes; 5 small dorsomesal pairs in a row on thorax and second abdominal segment together; 1 small dorsosubmarginal pair each on mesothorax and first and seventh abdominal segments; 1 large dorsomarginal pair on eighth abdominal segment; 1 large ventromarginal pair laterad of each spiracle, and on each of second, fourth, and sixth abdominal segments; in all, 16 pairs present. A single quinquelocular pore associated with each mesothoracic spiracle.

Spiracles.—Spiraculariae elongate, distinctly sclerotic.

Body setae.—In distribution about as in *Palmaricoccus altaleae*, with the following exceptions: Frontal pair on head absent, the small ventromarginal pair and the more mesal pair caudad of mesothoracic coxa on anterior section of metathorax apparently always absent; ventromesal pair not observed on second abdominal segment; in all, 65 pairs present. In one specimen, outer and inner long caudal pairs, respectively, 29 and 101 microns long.

Antenna.—Much like that in *Palmaricoccus pritchardiae*, though much smaller.

Rostralis.—With a single long caudal loop besides the characteristic small cephalic loop, when uncoiled within body; in two specimens, 0.44 and 0.47 mm long, respectively.

Legs.—About as in *Palmaricoccus altaleae*, except for presence of a single seta on femur and none on tibia.

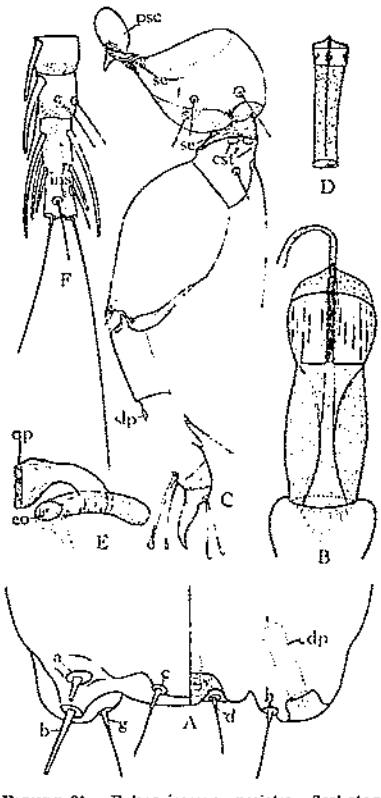

FIGURE 21.—*Palmaricoccus nesiotes*, first-stage nymph: *A*, Posterior end, dorsal and ventral, × 1,200; *B*, dorsal 8-shaped pore, × 3,000; *C*, metathoracic leg, × 1,000; *D*, dorsomesal 8-shaped pore, × 3,000; *E*, mesothoracic spiracle, × 2,000; *F*, antenna, apical part, × 1,000.

Exuviation.—In male, the break occurring caudad of antennae and eyes, the ventral skin, with head skeleton and rostrum not in an inverted position, being pushed toward posterior end, leaving a dorsal shell; in female, anterior half of dorsal surface appearing to break irregularly, the ventral derm of anterior half, including antennae, folding over onto posterior half of body, thus placing antennae near anus, with head skeleton and rostrum in an inverted position.

Dried material.—Bright reddish brown at first, old specimens darker brown; moderately well covered with whitish matted filaments.

SECOND-STAGE FEMALE

(Fig. 22)

Body.—Moderately elliptical; seventh abdominal segment characteristically projecting caudally; segmentation distinct on venter of abdomen, elsewhere

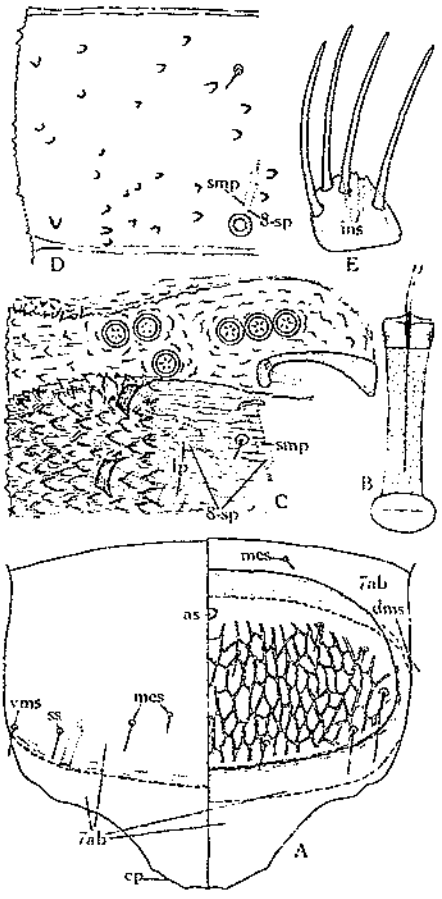

FIGURE 22.—*Palmaricoccus mesiotes*, second-stage female: *A*, Posterior end, dorsal and ventral, × 500; *B*, 8-shaped pore, × 3,000; *C*, mesothoracic spiracle, × 1,000; *D*, dorsolateral surface, second abdominal segment, × 1,000; *E*, antenna, × 1,000.

obscure; membranous except for possibly a narrow border of seventh abdominal segment immediately around anal valve, and for anal valve, which is moderately sclerotic in its entirety; sclerotization increasing little, if any, cephalad of here before general thickening of derm takes place preceding puparial state. Entire ventral margin thickly covered with stout papillae, rather acutely pointed, uniformly arranged, and restricted to a moderately narrow band around this margin, but the ventromesal region of thorax and abdomen with numerous rows of small spicules; on dorsum a number of small blunt papillae extending to meson. Membranous areas laterad of head skeleton not distinguished, rostralis of adult apparently being forced through the more or less undifferentiated derm. Puparium but moderately sclerotic on dorsum, less so on venter. A newly molted specimen 0.37 mm long and 0.19 mm wide; a typical puparium 0.74 mm long and 0.36 mm wide.

Pores.—8-shaped pores situated largely along margin and submargin of both surfaces of thorax and abdomen, with a few scattered elsewhere; of two different sizes; partitions extending nearly to external openings; bars can be distinguished apart. The distinctly larger 8-shaped pores situated typically as follows: 4 to 6 pairs each on ventral margin of head, prothorax, and anterior section of mesothorax together, and posterior section of mesothorax; 2 or 3 pairs on each section of metathorax and each abdominal segment to and including the sixth; 1 pair on seventh abdominal segment. The smaller 8-shaped pores situated typically as follows: Submarginally and mesally on ventral surface, 8 to 10 pairs on prothorax and mesothorax together, and 2 or 3 pairs on metathorax and on each abdominal segment except seventh; marginally and submarginally on dorsal surface, 4 pairs on head, 6 pairs on prothorax, and 1 to 3 pairs on each remaining body segment except anal valve; mesally on dorsal surface, 1 pair on each body segment except sixth and seventh abdominal ones and anal valve. In one typical specimen, 56 pairs of 8-shaped pores of both sizes on venter and 36 pairs on dorsum; along ventrosubmargin the two sizes almost intermingling. Typically 4 to 6 quinquelocular pores associated with each mesothoracic and a single pore with each metathoracic spiracle; mesothoracic pores in shallow depressions leading to spiracles and not closely bunched.

Spiracles.—Mesothoracic but not metathoracic pair in shallow depressions reaching to body margin; with no surrounding distinct sclerotic plates; spiraculariae quite slender.

Body setae.—Essentially as in *Palmaricoccus attaleae*, with the following variations: 1 less pair on head; 2 additional pairs on posterior section of mesothorax, 1 caudad of mesothoracic spiracles and the other laterad of rostrum; 2 additional pairs on posterior section of metathorax and first abdominal segment together, these near ventral margin; 1 additional pair each near ventral margin of second to seventh abdominal segments, inclusive, but apparently no ventral mesal pair on second abdominal segment; 3 additional pairs on anal valve; thus typically 10 pairs on head, 13 pairs on prothorax and mesothorax together, 9 pairs on metathorax, 2 pairs on first abdominal segment, 5 pairs on second, 6 pairs each on third to seventh abdominal segments, inclusive, and 6 pairs on anal valve, or a total of 75 pairs present.

Antenna.—Restricted to a single distinctly sclerotic apical piece without a sunken area; with typically 4 fleshy subequal setae and a pair of small wholly invaginated setae.

Rostralis.—In one typical specimen, 1.44 mm long.

Anal valve.—Covering tissue reticulate in appearance with 6 pairs of setae, the 2 most lateral pairs somewhat larger than the others. Anus situated near cephalic border; anal ring apparently absent.

Dried material.—Puparium bright to dark brown; well covered with matted filaments; moderately flattened, with rounded margins; posterior end pointed dorsocaudad.

THIRD-STAGE FEMALE

Not identified.

ADULT FEMALE

(Fig. 23)

Body.—Elongate elliptical, with moderate slope toward posterior end, which projects less roundly than in *Palmaricoccus altaleae* and *P. pritchardiae*, and has a characteristic wavy margin; segmentation distinct on ventral surface of thorax and abdomen, and on dorsum of the three posterior abdominal segments; membranous except for moderate sclerotization of caudodorsal part of anal segment. Papillae absent except for some prominent ones and some others small, all more or less spinelike, grouped with spicules and ridges in irregular rows about each spiracle. A typical specimen 0.67 mm long and 0.30 mm wide.

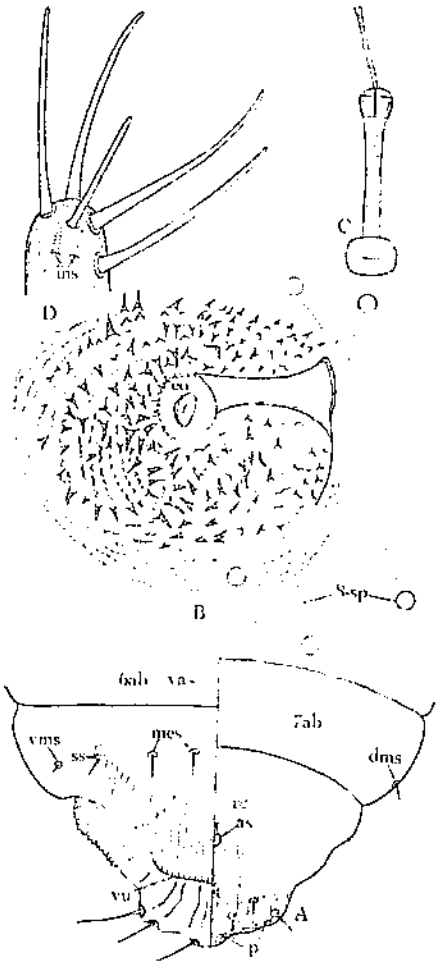

FIGURE 23.—*Palmaricoccus mesides*, adult female: *A*, Posterior end, dorsal and ventral, × 500; *B*, mesothoracic spiracle, × 1,000; *C*, 8-shaped pore, × 3,000; *D*, antenna, × 1,000.

Pores.—Not numerous; typically located in submarginal and mesal regions of ventral surface of thorax and abdomen, except on anal segment; partitions apparently no more than through bars; bars can be distinguished apart; bullae elongate; external openings somewhat expanded and not surrounded by sclerotic rims; typically no pores on head, 11 or 12 scattered pairs in the general region around each mesothoracic spiracle and between latter and head skeleton, 5 or 6 scattered pairs around each metathoracic spiracle, none to 3 pairs on each abdominal segment; in one typical specimen 29 pairs counted. Quinquelocular pores absent.

Spiracles.—With a moderate number of tracheoles issuing from tracheal chamber.

Body setae.—More limited in distribution than in second-stage female; apparently absent submarginally and mesally on dorsum, except on the 5 posterior abdominal segments. Typically 7 scattered pairs on head, 19 pairs on thorax, 1 pair on first, 3 pairs each on second and third, 5 pairs on fourth, 6 pairs each on fifth and sixth, and 5 pairs on seventh abdominal segment, and 6 pairs on anal segment; in all, 61 pairs present.

Antennae.—With five fleshy setae and pair of small setae, which are wholly invaginated.

Rostralis.—With one elongate loop and the small cephalic loop, when uncoiled within body; in one typical specimen, 2.2 mm long.

Anal segment.—Less reduced in size than in *Palmaricoccus altaleae;* typically with 3 pairs of 8-shaped pores along caudal margin; with 6 pairs of setae, 3 pairs being on dorsum and of approximately the same size as the other body setae, and 3 prominent pairs along caudal margin, long and somewhat stout; anal ring, if present, inconspicuous.

SECOND-STAGE MALE

(Fig. 24)

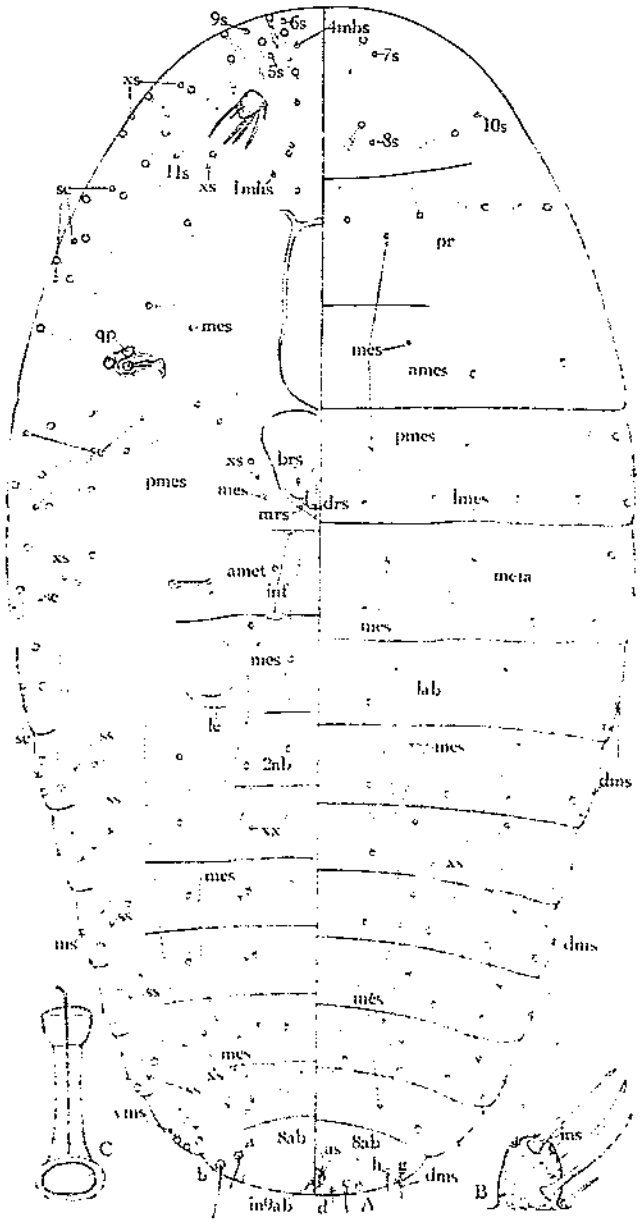

FIGURE 24.—*Pulmaricoccus nesiotes*, second-stage male: *A*, Body, dorsal and ventral, × 500; *B*, antenna, × 1,000; *C*, 8-shaped pore, × 3,000.

Body.—Moderately elliptical, with both ends about equally rounded; segmentation distinct except on ventral surface of head, prothorax, and mesothorax; in younger specimens very lightly sclerotic, with increasing sclerotization posteriorward on the four posterior abdominal segments, which in older specimens are like-

wise sclerotic, though remainder of body appears to be membranous. Papillae small, spinelike, numerous marginally and submarginally, but rapidly disappearing mesad, where numerous irregular rows of spiny and serrated spicules occur on ventral surface. A newly molted specimen 0.29 mm long and 0.17 mm wide; a fully developed specimen 0.46 mm long and 0.21 mm wide.

Pores.—8-shaped pores fairly numerous; scattered generally over both surfaces; slightly smaller mesad on both surfaces; in structure essentially as in *Palmaricoccus attalcae* except slightly larger and external opening surrounded by a narrow sclerotic rim; on one side of one typical specimen were: 16 on head, 50 on thorax, and 66 on abdomen; in all, 132 on one side of body. Typically 2 to 3 but sometimes only 1 quinquelocular pore associated with each mesothoracic spiracle, and 1 or, more often, none associated with metathoracic spiracles.

Body setae.—Essentially as in *Phoenicococcus marlatti*, with the following exceptions: Frontal pair on head absent and second ventromesal pair on head not distinctly larger than adjacent pairs; the lateromesal pairs of dorsum on prothorax and anterior section of mesothorax absent; 1 marginal pair absent from mesothorax and from metathorax, and the ventromesal pair on anterior section of metathorax absent, but an additional ventromesal pair on posterior section of mesothorax; 1 extra pair each, considered as belonging to "lateromesal" series, on first to sixth abdominal segments, inclusive; 1 extra pair each, considered as belonging to the ventromesal series, on sixth and seventh abdominal segments; 1 less pair on anal segment; in all, 80 pairs present.

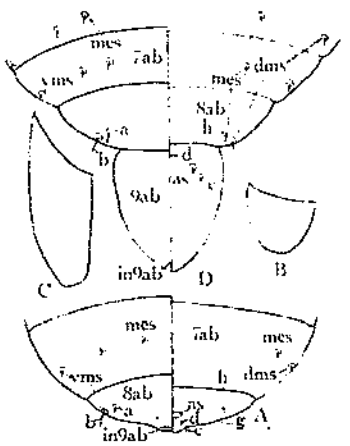

FIGURE 25.—*Palmaricoccus nesiotes*: *A*, Third-stage male, posterior end, dorsal and ventral; *B*, same, wing pad; *C*, fourth-stage male, wing pad; *D*, same, posterior end, dorsal and ventral. ×400.

Antenna.—Occurring as a rounded tubercle; apparently composed of 3 segments; with 4 large fleshy setae, 2 smaller fleshy setae, and a pair of small invaginated setae.

Rostralis.—With 1 elongate loop, 2 broad rather deep loops, and the characteristic small cephalic loop, when uncoiled within body; in one typical specimen, 1.03 mm long.

Legs.—Not always in evidence; when so, vestigial in character.

Anus.—On or near dorsocaudal margin, which does not project here; anal ring rather narrow but well sclerotized.

Exuviation.—No data available.

THIRD-STAGE MALE

(Fig. 25, *A* and *B*)

All available specimens too delicate for adequate study; short rounded wing pads present; delicate setae on various body segments; 5 pairs of setae on eighth abdominal, and 6 pairs, including 1 marginal pair distinctly larger than the others, on anal segment. One specimen 0.39 mm long and 0.20 mm wide.

FOURTH-STAGE MALE

(Fig. 25, *C* and *D*)

All available specimens too delicate for adequate study; posterior projection essentially as in *Palmaricoccus attalcae;* wing pads present, distinctly longer than in preceding instar; with delicate setae on the various segments, including 5 pairs each on sixth and seventh abdominal segments, 4 pairs on eighth, and 2 pairs on anal segment; legs sharply elbowed. One specimen 0.41 mm long and 0.20 mm wide.

ADULT MALE

(Fig. 26)

Body.—Vestiges of thoracic wing framework may be indicated by pronounced depressions along cephalic and caudal borders of dorsal surface of mesothorax.

Anal segment only segment clearly sclerotic. A typical specimen 0.51 mm long and 0.18 mm wide.

Spiraculariae.—Elongate, with lateral ends somewhat expanded; strongly sclerotic, subequal.

Body setae.—Available material not in condition for full determination, but at least as fully represented as in *Palmaricoccus attaleae.*

Antenna.—Club elongate, with seven segments, all closely joined. Typically 3 slender setae on basal segment, 2 slender setae on second, 1 slender and 6 fleshy setae on third, 3 slender and 5 fleshy setae each on fourth and fifth, 4 slender and 8 fleshy setae on sixth, 3 or 4 slender and 6 fleshy setae on seventh and eighth, and 1 slender and 6 fleshy setae, besides a pair of minute at least partially evaginated setae on apical segment; setae of club large, nearly all longer and many considerably longer than the segments from which they arise.

Head skeleton and rostrum.—Vestiges of head skeleton and rostrum distinct; invagination leading to alimentary tube in evidence.

Legs.—The three pairs subequal. The setae of a metathoracic leg occur typically as follows: Coxa 4 slender and 4 fleshy setae besides the minute basal one, trochanter 1 slender and 2 fleshy setae, femur 4 slender and 5 fleshy setae, tibia 8 slender and 8 fleshy setae, tarsus 4 slender and 12 fleshy setae, claw 2 setae. Slender setae of various sizes, mostly rather small; fleshy setae large. Setae on the other 2 pairs of legs approximately as on metathoracic legs.

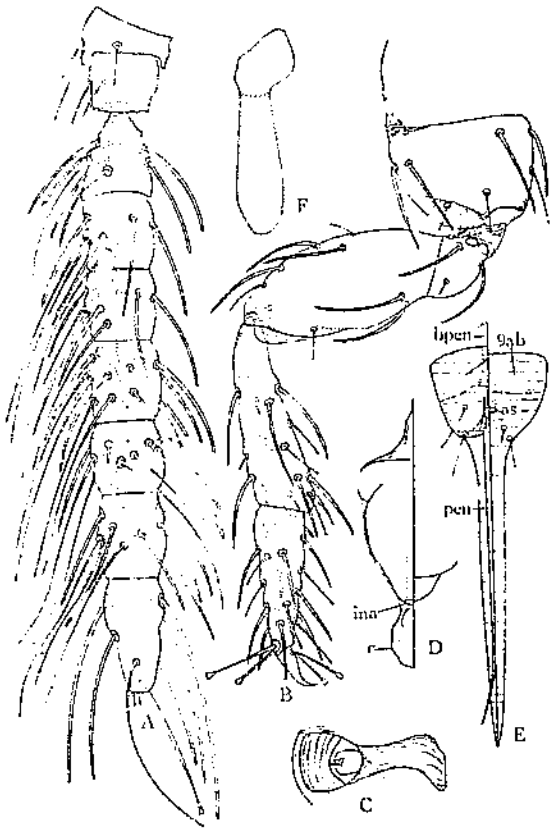

FIGURE 26.—*Palmaricoccus nesiotes*, adult male: *A*, Antenna, × 400; *B*, metathoracic leg, × 400; *C*, mesothoracic spiracle, × 1,000; *D*, head skeleton, dorsal and ventral, × 400; *E*, posterior end, dorsal and ventral, × 400; *F*, wing pad, × 400.

Genus HALIMOCOCCUS
Cockerell

FIRST STAGE

Body elongate elliptical; caudal margin of abdomen may or may not bulge; segmentation of head, prothorax, and mesothorax ill defined, elsewhere more or less clear; posterior end may or may not be distinctly sclerotic. 8-shaped pores may be prominent or insignificant; partitions may be scarcely in evidence, even through distal bars, at most extending apparently only slightly through tubes; external openings flush with surface; typically 1 to 14 pairs present along marginal, submarginal, and dorsomesal regions of body. A single quinquelocular or trilocular pore associated with each mesothoracic spiracle, but not with metathoracic spiracles. Mesothoracic spiracles open to exterior through a distinct tube arising in vicinity of tracheal collar, but metathoracic spiracles open apparently on surface; spiracular iae may or may not be well defined, strongly sclerotic, or subequal. Either with or apparently without clear area laterad of each metathoracic coxa. Typically 10 or 11 pairs of setae on head, frontal pair

on ventral surface between arms of head skeleton being absent, and 1 to 4 of ventral mesal pairs being long and slender; 3 or 4 pairs on prothorax; 4 to 6 pairs on mesothorax; 3 to 5 pairs on metathorax; none to 4 pairs on each of first to seventh abdominal segments, inclusive; 4 or 6 pairs on posterior abdominal segment. Antenna of the 6-segmented type; basal segment twice as broad, or distinctly less than twice as broad, as any other segment; apical segment moderately elongate. Antennal setae occurring typically as follows: 2 slender setae on basal segment; 1 slender seta and a spinelike process, which apparently may be present or absent, on second segment; 1 seta, either minute or moderately long and slender or fleshy, on third segment; 1 fleshy seta each on fourth and fifth segments; 4 slender and 5 fleshy setae on apical segment. Rostrum apparently with 3 pairs of minute apical setae; rostralis with a single long caudal loop and the small cephalic loop, when uncoiled within body. Legs moderately slender; neither trochanter and femur nor tibia and tarsus fused. Leg setae occurring typically as follows: 5 or 6 setae, including minute basal one, on each procoxa, and only 5 setae each, including minute basal one, on each of other coxae; 2 setae, 1 the minute basal seta, the other comparatively short, on trochanter; none to 2 setae on femur; none or 1 seta on tibia; 3 setae and the spinelike process, which may or may not be evident, on tarsus; 2 setae on claw. Anus small and delicate; on or near ventrocaudal margin; anal ring absent. Male instar puparial.

SECOND-STAGE FEMALE

Body elongate elliptical to pyriform, or largely subcircular; general outline not continued evenly around posterior end, which projects slightly; segmentation, except that of anal valve, obscure or indicated in part on ventral surface of abdomen; membranous except posterior end. Papillae present; numerous or scarce. With 8-shaped pores present or apparently absent; if present, few in number, situated on or near body margin, and delicate; partitions apparently may or may not extend through both bars, but at least no more than very slightly through tubes; bars difficult to distinguish apart; bullae delicate; external openings may or may not be on sclerotic projections. All spiracular pores quinquelocular; of two contrasting sizes, and several of intermediate size may be present; typically 10 to 40 of all sizes associated with each mesothoracic spiracle, and none to 7 of all sizes associated with each metathoracic spiracle; the larger and intermediate-sized ones invaginated and opening on body surface, the smaller ones apparently not invaginated and, together with accompanying spiracles, opening within deep pockets; no other quinquelocular pores on body. Mesothoracic spiracles always open, metathoracic spiracles may or may not open within deep pockets; spiraculariae may or may not be elongate, strongly sclerotic, subequal, or even clearly defined. Body setae scarce; usually 1 pair or none, but not more than 2 pairs, to any one segment except on the 4 posterior abdominal segments; from none to 3 pairs on fifth, none to 4 pairs on sixth, and 1 to 5 pairs on seventh abdominal segment. Antenna limited to a small, rounded, sclerotic piece having 2 minute, slender, partially invaginated setae. Rostrum apparently with at least 2 pairs of minute apical setae; rostralis with 1 elongate loop, 2 large roundish loops, and the characteristic small cephalic loop, when uncoiled within body (data for one species lacking); a membranous area through which rostralis of adult is forced may or may not be evident. Anal valve always present; with characteristic markings either distinct, obscure, or possibly absent; pores lacking, but with from 4 to 7 pairs of setae. Anus situated caudally on anal valve; anal ring apparently absent. Becomes puparium, which may or may not be heavily sclerotic.

ADULT FEMALE

Body moderately or elongate elliptical to pyriform, or largely subcircular; posterior end distinctly projecting beyond general body margin; segmentation obscure, or may be evident on parts of ventral surface and on both surfaces of posterior 3 or 4 segments; in both young and old specimens derm membranous except for some sclerotization of anal segment and parts of ventral surface of seventh abdominal segment, which may also appear slightly sclerotic. Distinct papillae absent. 8-shaped pores distinct; partitions extending through bars, and apparently may extend partially through tubes; bars may be difficult to distinguish apart; bullae delicate; external openings flush with surface and not surrounded by sclerotic rims; localized in region mesad of mesothoracic and ceph-

alad of metathoracic spiracles; may be few in number or moderately abundant. Quinquelocular pores absent. Spiracles flush with surface; spiraculariae moderately elongate or stout, strongly sclerotic, and may or may not be subequal. Body setae few in number and all rather small except perhaps on anal segment; apparently none on head, typically 6 to 21 pairs on thorax and 11 to 28 pairs on abdomen, absent on dorsum except possibly in midthoracic region, marginally on the 4 or 5 posterior abdominal segments, and always on anal segment. Antenna limited to a single sclerotic piece having a pair of small, slender, partially invaginated setae. Rostrum with 1 and possibly 2 minute pairs of apical setae; rostralis with 1 elongate loop, 2 large roundish loops, and the characteristic small cephalic loop, when uncoiled within body. Anal segment on both surfaces of posterior end; partially or wholly sclerotic on dorsum; pores apparently absent; with from 2 to 6 pairs of setae, no more than 1 pair prominent. Anus well up on dorsum; small, almost minute; anal ring apparently absent.

SECOND-STAGE MALE

Body moderately or elongate elliptical; sides may be almost parallel; segmentation may be practically obscure throughout, in evidence mesally on ventral surface of abdomen, or distinct on both surfaces of abdomen; membranous except for a very slight sclerotization of the 2 posterior abdominal segments, or a heavy sclerotization of the 3 or 4 posterior abdominal segments. Papillae absent or restricted to posterior end, where they are small, rather numerous, and blunt, appearing frequently as hardly more than short irregular lines. 8-shaped pores may be apparently absent or occur along lateral margins of several abdominal segments; very few in number, and very small and delicate; partitions apparently extending no farther than partly through bars, which can be distinguished apart with difficulty; bullae delicate; external openings flush with surface, and not surrounded by sclerotic rims. The asymmetrical type of tubular pore may be present; bar pronounced, tube moderately stout, external opening considerably expanded and not on a projection or surrounded by a sclerotic rim; restricted to two ends of body. None, 1, or 2 quinquelocular pores associated with each mesothoracic, spiracle, but none with metathoracic spiracles; no other quinquelocular or any other pore type present on body. Spiraculariae elongate, strongly sclerotic, subequal. From none to 5 pairs of setae on each of thoracic and abdominal segments except anal segment, which may possess as few as 2 pairs or as many as 6 pairs. Antenna reduced to a flattened, lightly sclerotic, irregularly outlined tubercle, or at most occurring only as a small, rounded, moderately sclerotic tubercle with never more than minute setae present. Rostral setae either obscure or, at most, no more than 2 minute pairs present, these apical in position; rostralis with 1 elongate loop or 2 large roundish loops, in either case also with the characteristic small cephalic loop, when uncoiled within body (data for one species lacking). Legs may or may not be in evidence. Anus minute; may be on caudal margin or distinctly up on dorsal surface; anal ring absent.

ADULT MALE [6]

Body elongate elliptical, with posterior end occurring as a fairly large, moderately slender, rapierlike projection; segmentation may be nearly complete, with unusually clear definition of segments except for all of anterior section of mesothorax and for the separation of metathorax and second abdominal segment on ventral surface, or obscure on greater part of ventral surface and rather faintly indicated on dorsal surface; anal segment only may be clearly sclerotic, or both eighth abdominal segment and anal segment may be partially sclerotic; vestiges of thoracic wing framework and wings absent. Spiraculariae stout and strongly sclerotic, with metathoracic pair slightly more slender than mesothoracic pair. Body setae absent on ventral surface of thoracic segments and may be absent on the dorsal and ventral surfaces of 3 to 6 abdominal segments. Typically 9 pairs of setae on head, 4 pairs on prothorax, 2 or 4 pairs each on mesothorax and metathorax, and none to 4 pairs on each abdominal segment, with anal segment limited to 3 pairs. Antenna with basal segment rather short on one side; second segment longer than broad; club stout, with either 3 or 4 segments not compactly joined,

[6] Data for one species lacking.

the distal segment being twice as long as any other segment of club; basal and second antennal segments with 2 and 3 small slender setae, respectively; segments of club having either only small fleshy setae, excluding one rather long, slender, apical seta on distal segment, or 2 slender setae on its basal segment and several small, stocky, spinelike setae on each of remaining segments, and, in addition, several rather small fleshy setae and a slender seta on its distal segment. With 2 pairs of eyes, 1 on margin and the other, a distinctly smaller pair, on ventral surface. With a vestige of head skeleton possibly remaining on ventromeson as a differentiated area having a short, inward-projecting piece; invagination of alimentary tube present. Rostrum absent. Legs rather large; size of corresponding segments of each pair and number and character of their setae may be nearly alike, or metathoracic tibiae and tarsi may be appreciably stouter than those of the other pairs, and also prothoracic and metathoracic femora may be stouter than mesothoracic femora; all setae rather small, except perhaps 1 or 2 on each coxa, a distal pair on each tarsus, and the basal pair on claw; typically 5 and 1 slender setae on each coxa and trochanter, respectively, besides the minute basal seta on each; slender, fleshy, or stout spinelike setae on each femur, tibia, and tarsus, ranging in number typically as follows: Femur 4 to 6, tibia 5 to 9, tarsus 5 to 10; definite sensory areas apparently absent. Anus on or near cephalic border of anal segment, or obscure.

Type of genus, *Halimococcus lampas* Cockerell.

Keys to Species of Halimococcus

FIRST STAGE

a. With apparently only one pair of 8-shaped pores on body, situated on margin of second abdominal segment; mesothoracic spiracular pores comparatively large, with star-shaped margins; with no dorsomesal setae on second to seventh abdominal segments, inclusive..... lampas Cockerell.

aa. With 9 or 10 pairs of marginal or submarginal and 1 or more pairs of dorsomesal 8-shaped pores; mesothoracic spiracular pores moderate in size and without star-shaped margins; with one pair of dorsomesal setae each on second to seventh abdominal segments, inclusive.

b. With only one pair of dorsomesal 8-shaped pores normally present; mesothoracic spiracular pores trilocular and slightly invaginated; dorsomarginal setae of ordinary size; basal segment of antenna twice as wide as any other segment..... thebaicae Hall.

bb. With 5 pairs of dorsomesal 8-shaped pores normally present; mesothoracic spiracular pores quinquelocular and appreciably invaginated; dorsomarginal setae conspicuously large and rather stout; basal segment of antenna not twice as wide as any other segment.... borassi Green.

SECOND-STAGE FEMALE

a. Typically with 7 to 10 small 8-shaped pores, their external openings at the apices of sclerotic projections; mesothoracic spiracles surrounded by a characteristic subtriangular area with roundish margins composed of papillae, spicules, and irregular lines; metathoracic spiraculariae ill defined; covering tissue of anal valve with numerous reticulate or imbricate markings..... lampas Cockerell.

aa. With apparently no more than one pair of 8-shaped pores, their external openings flush with surface and not surrounded by sclerotic rims; mesothoracic spiracles not surrounded by a characteristic differentiated area; metathoracic spiraculariae well defined; covering tissue of anal valve without characteristic markings, at most with only irregular puckers or ridges.

b. Body with numerous pronounced spinelike papillae along margin; typically with 15 or 20 (sometimes more or less) large deeply invaginated quinquelocular pores associated with each mesothoracic spiracle; metathoracic spiracles without accompanying pores and not in pockets; anal valve typically with 7 pairs of setae, 2 mesal pairs being distinctly larger than the others; typical puparium subglobular in form, about 0.9 mm long..... thebaicae Hall.

bb. Body without distinct papillae; with typically 7 or 8 (sometimes more or less) moderately large, moderately invaginated quinquelocular pores associated with each mesothoracic spiracle; typically with from 5 to 12 quinquelocular pores of various sizes associated with each metathoracic spiracle, which is in a distinct pocket; anal valve with only 4 pairs of setae, all subequal and very small; typical puparium elongate in outline, appreciably depressed in cross section and less than 0.6 mm long ..... borassi Green.

ADULT FEMALE

a. Mesothoracic spiraculariae distinctly larger than metathoracic pair; 3 pairs of setae in midthoracic region of dorsum; no ventromesal setae between spiracles; dorsal surface of anal segment strongly sclerotic, and entirely so; anal segment with only 4 pairs of setae ..... lampas Cockerell.

aa. The 2 pairs of spiraculariae subequal; no dorsal setae on thorax; 2 or more pairs of ventromesal setae between spiracles; dorsal surface of anal segment not entirely sclerotic or, if so, only moderately sclerotic; at least 5 pairs of of setae on anal segment.

b. Body subcircular in outline except for sharply narrowed posterior end; 8-shaped pores clustered almost wholly between 2 pairs of spiracles and rostrum, from 30 to 40 on each side of body; 8 or 9 setae mixed in with each pore cluster; at least 4 pairs of setae on each abdominal segment; anus near cephalic margin of anal segment ... thebaicae Hall.

bb. Body elongate elliptical to pyriform in outline; 8-shaped pores clustered mesocephalad of mesothoracic spiracles, from 12 to 18 on each side of body; no setae mixed in with pore clusters; no more than 2 pairs of setae on any abdominal segment except anal one; anus near central part of anal segment ..... borassi Green.

SECOND-STAGE MALE

a. Papillae present on the two posterior abdominal segments; tubular pores comparatively large, of the asymmetrical type, and limited to 3 pairs on the two posterior abdominal segments and 1 pair on head; typically with 1 pair of mesothoracic quinquelocular pores, but occasionally none or 2 pairs present ..... thebaicae Hall.

aa. Papillae absent; tubular pores minute or absent, when present, apparently of the 8-shaped type and localized along margin of abdomen; all quinquelocular pores absent.

b. All pores apparently absent; with only 2 pairs of setae on anal segment ..... lampas Cockerell.

bb. About 4 pairs of minute 8-shaped pores apparently along margin of abdomen cephalad of sclerotic posterior end; with 6 pairs of setae on anal segment ..... borassi Green.

ADULT MALE

a. Body margins subparallel laterally and continuing rather evenly around anterior end; head indistinctly delimited; club of antenna 3-segmented, with distal segment tapering to a slender apical projection; all fleshy setae of antenna and legs elongate ..... lampas Cockerell.

aa. Body margins tapering perceptibly toward both ends and plainly constricted at suture separating head from thorax; head clearly delimited; club of antenna 4-segmented, with distal segment bluntly rounded at apex; all fleshy setae of antenna and legs short and spinelike ..... thebaicae Hall.

HALIMOCOCCUS LAMPAS Cockerell (2)

Material from Stanford collection of Coccidae (received through T. D. A. Cockerell); United States Bureau of Entomology (Fuller collection). Both lots from coast of Natal, "on palms", in depressions on sections of leaves.

EGG

(Fig. 27, *F*)

Oviparous. A group of usually about 6, and sometimes as many as 8, spines, rather well spaced and varying slightly in size; sclerotic body derm extending appreciab'y around spines.

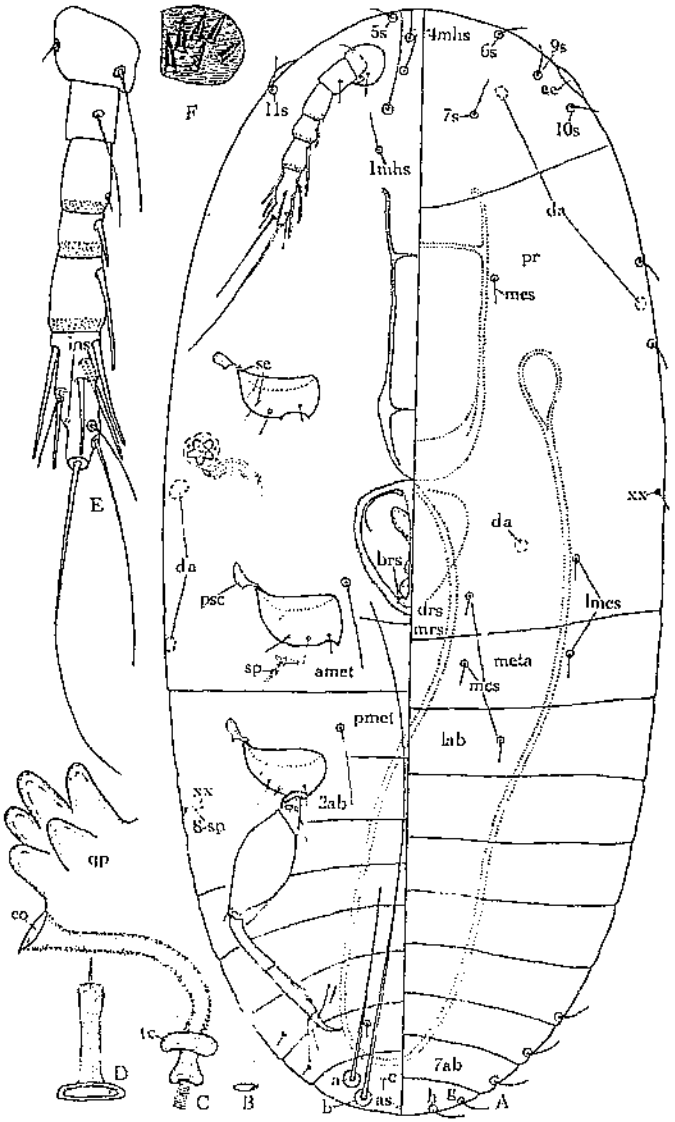

FIGURE 27.—*Halimococcus lampas*: *A*, First-stage nymph, body, dorsal and ventral, × 500; *B*, same, anus, × 1,500; *C*, same, mesothoracic spiracle, × 2,000; *D*, same, marginal pore, × 3,000; *E*, same, antenna, × 1,000; *F*, egg, spine group, × 1,500.

FIRST STAGE

(Fig. 27, *A–E*)

Body.—Rather delicate at first. The following structures apparently absent: Distinct sclerotic areas near head skeleton, distinct furca on meson of thorax, appreciably heavier sclerotization of posterior end, bulge along caudal margin of abdomen, clear area laterad of each metathoracic leg. A newly hatched specimen 0.28 mm long and 0.12 mm wide; a fully developed female specimen 0.50 mm long and 0.20 mm wide. Male puparium rather strongly sclerotic. A typical specimen 0.36 mm long and 0.18 mm wide.

Pores.—Only one 8-shaped pair observed, on margin of second abdominal segment; sometimes apparently absent; rather delicate; partitions through bars and tubes obscure; bars difficult to distinguish apart; bullae delicate; external openings large. With dark areas in several places on head and thorax where 8-shaped pores are found in other species. One comparatively prominent quinquelocular pore, having a star-shaped margin, associated with each mesothoracic spiracle.

Spiracles.—Mesothoracic pair deeply invaginated, with characteristic curved, rather delicate tubes connecting tracheae with external openings. Mesothoracic spiracularlae obscure or at least not well defined; metathoracic pair irregular in form and lightly sclerotic.

Body setae.—Majority prominent. Typically 11 pairs on head, second ventromesal head pair being distinctly larger than the other head setae; 2 marginal pairs and 1 dorsomesal pair on prothorax; 1 marginal, 2 dorsomesal pairs, including what is considered to be a lateromesal pair, and 1 comparatively long ventromesal pair on mesothorax; 2 dorsomesal pairs, including a lateromesal pair, and 1 comparatively long ventromesal pair on metathorax; 1 dorsomesal pair on first abdominal segment; no setae on second, third, and fourth abdominal segments; 1 dorsomarginal pair on fifth, 1 dorsomarginal and 1 small ventromarginal pair on sixth, and 1 dorsomarginal, 1 small ventromarginal, and 1 ventromesal pair on seventh abdominal segment; 5 pairs on posterior abdominal segment; in all, 33 pairs present. Outer and inner long caudal setae in one specimen, 55 and 133 microns long, respectively.

Antenna.—Basal segment not twice as broad as any other segment. Two setae, 1 comparatively long, on basal segment; 1 comparatively long seta on second segment, but spinelike process apparently absent; 1 minute seta on third segment; 1 comparatively short fleshy seta on fourth segment; 1 comparatively long fleshy seta on fifth segment; 4 slender and 5 fleshy setae, all comparatively long, on apical segment.

Rostralis.—In one typical specimen, 0.75 mm long.

Legs.—Coxae slightly broad; femora slightly stout. With 5 setae, including minute basal one, on each coxa; a single seta, apically situated, on femur; none on tibia; 3 setae, but spinelike process apparently absent, on tarsus; 2 setae on claw.

Exuviation.—In male the break occurring similarly as in *Palmaricoccus altaleae*, but almost invariably complete, leaving a characteristic differentiated sclerotic band around caudal margin of sixth abdominal segment; head skeleton and rostrum of male simply drop down. Not definitely determined in female.

Dried material.—Bright brown in both young and old specimens; naked in appearance; male roundish in cross section.

SECOND-STAGE FEMALE

(Fig. 28)

Body.—Moderately elliptical in younger specimens, pyriform in older ones; seventh abdominal segment projecting roundly; segmentation, except for that of anal valve, obscure in younger specimens; distinguished by slightly sclerotic lobules along ventral margin of thorax and abdomen, and with faint indications of sutures on posterior abdominal segments in older specimens; in younger specimens derm membranous except for distinct sclerotization of anal valve; eventually sclerotization spreads over seventh abdominal segment only, before general thickening of derm takes place. With a few small blunt papillae around margin, more easily observed cephalad of mesothoracic spiracles; these papillae obscured in older specimens; membranous areas laterad of head skeleton apparently absent. Puparium only moderately sclerotic. A newly molted specimen 0.36 mm long and 0.16 mm wide; a typical puparium 0.65 mm long and 0.41 mm wide.

Pores.—8-shaped pores few in number, usually observed along margin of thorax and abdomen; delicate, rather elongate, subequal; partitions extending through bars but hardly into tubes; external openings on sclerotic conical projections; typically 3 or 4 pairs cephalad and 4 to 6 pairs caudad of mesothoracic spiracles. A varying number of quinquelocular pores, typically about 7 large ones, 1 or 2 intermediate-sized ones, and 7 small ones, associated with each mesothoracic spiracle but none with metathoracic spiracles; the larger ones rather scattered, margins not indented and slightly invaginated; the smallest ones closely grouped and apparently not at all invaginated.

Spiracles.—Mesothoracic pair, with accompanying smallest pores, within deep pockets; surrounded by numerous shallow papillae, which extend out of the pockets dorsally, gradually becoming hardly more than slight ridges on dorsum, the whole effect of the papillae about the pockets appearing as a characteristically subtriangular mildly sclerotic area; all, or almost all, quinquelocular pores within these areas, the larger ones mostly along their ventral margin, the intermediate-sized ones near openings into pockets. Metathoracic spiracles open on surface; inconspicuous; unusually mesad in position; spiracularine of both pairs ill defined.

Body setae.—On or near margin, apparently with 1 pair each on prothorax, posterior section of mesothorax, anterior section of metathorax, and fifth and sixth abdominal segments; 2 minute marginal and 3 ordinary-sized marginal pairs on seventh abdominal segment; 2 mesal pairs on dorsum of what is apparently the thorax; 1 minute mesal pair on venter of sixth abdominal segment; 4 pairs on anal valve; in all, 17 pairs present.

Antenna.—With two minute setae only, largely invaginated.

Rostralis.—In one typical specimen, 2.2 mm long.

Anal valve.—Covering tissue distinctly sclerotic, with numerous faint reticulate or imbricate markings which are sometimes obscured; 4 pairs of setae along caudolateral margin, 2 pairs somewhat larger than the others; anus small, distinctly caudad in position, and usually surrounded by thickened tissue; anal ring probably absent.

Dried material.—Puparium bright brown; naked except for occasional few waxy filaments; body dome-shaped, almost globular, deeply rounded dorsally and laterally as far ventrad as lobules; posterior end pointed straight dorsad.

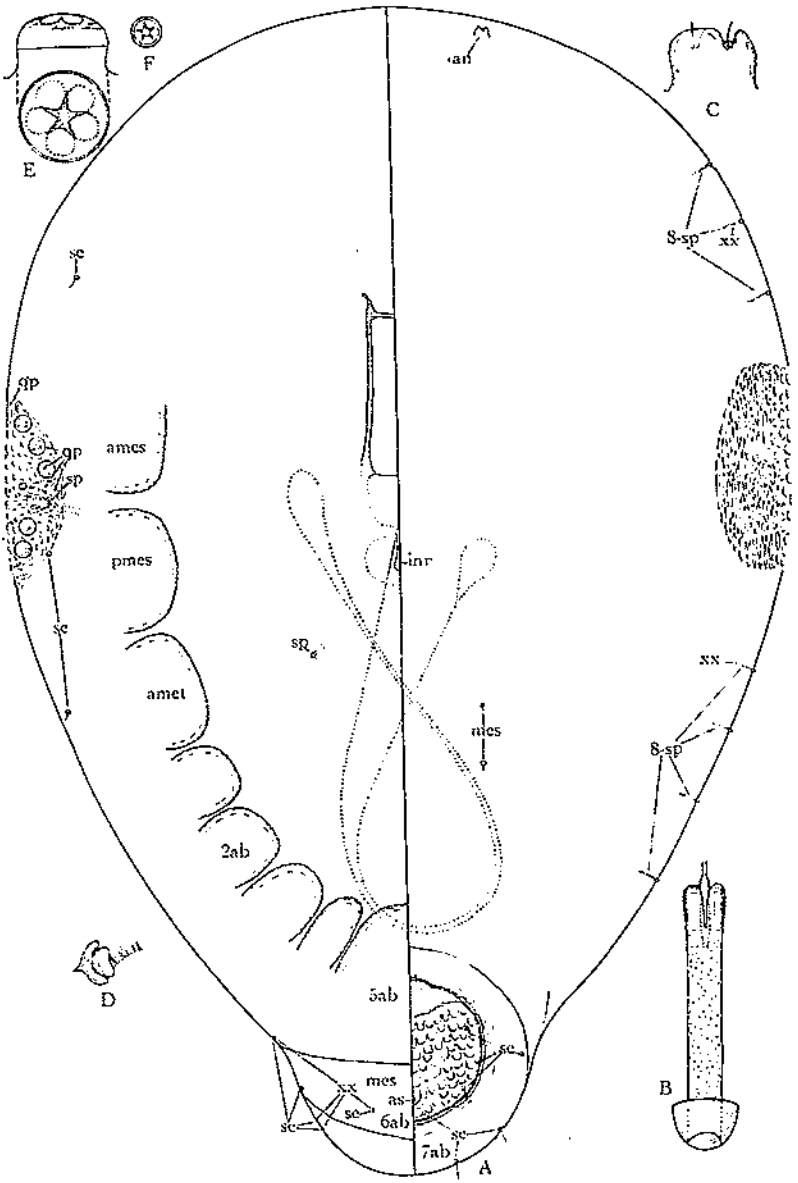

FIGURE [illegible].—*Halimococcus tampas*, second-stage female: *A*, Body (partially developed), dorsal and ventral, × 300; *B*, marginal 8-shaped pore, × 3,000; *C*, antenna, × 2,000; *D*, metathoracic spiracle, × 2,000; *E*, large quinquelocular pore associated with mesothoracic spiracle, × 2,000; *F*, small quinquelocular pore associated with mesothoracic spiracle, × 2,000.

THIRD-STAGE FEMALE

Present, but not in condition to distinguish any parts satisfactorily.

ADULT FEMALE

(Fig. 29)

Body.—Moderately elliptical to pyriform; segmentation indistinct except that of anal segment; apparently entire dorsum of anal segment strongly sclerotic. A typical specimen 0.52 mm long and 0.39 mm wide.

Pores.—8-shaped pores restricted to area between mesothoracic spiracles and head skeleton and rostrum; partitions extending part way through tubes; bars difficult to distinguish apart; bullae distinct and possessing thickened areas near their inner ends; external openings slightly expanded; 42 counted in the group on one side of one typical specimen.

Spiracles.—Spiraculariae moderately elongate; mesothoracic distinctly larger than metathoracic pair.

Body setae.—All nearly subequal; apparently absent on head; apparently 1 ventrosubmarginal pair each on prothorax, mesothorax, and metathorax; 1 ventromesal pair each on second, third, and fourth abdominal segments; 1 ventromarginal or submarginal pair each and 1 ventromesal pair each on fifth, sixth, and seventh abdominal segments; 2 dorsomesal and 1 lateromesal pair of dorsum in midthoracic region; 4 pairs on anal segment; in all, 19 pairs present.

Antenna.—Essentially as in second-stage female.

Rostralis.—In one typical specimen, 3.2 mm long.

Anal segment.—Well defined; with 4 pairs of subequal setae along laterocaudal margin; anus slightly cephalad of center.

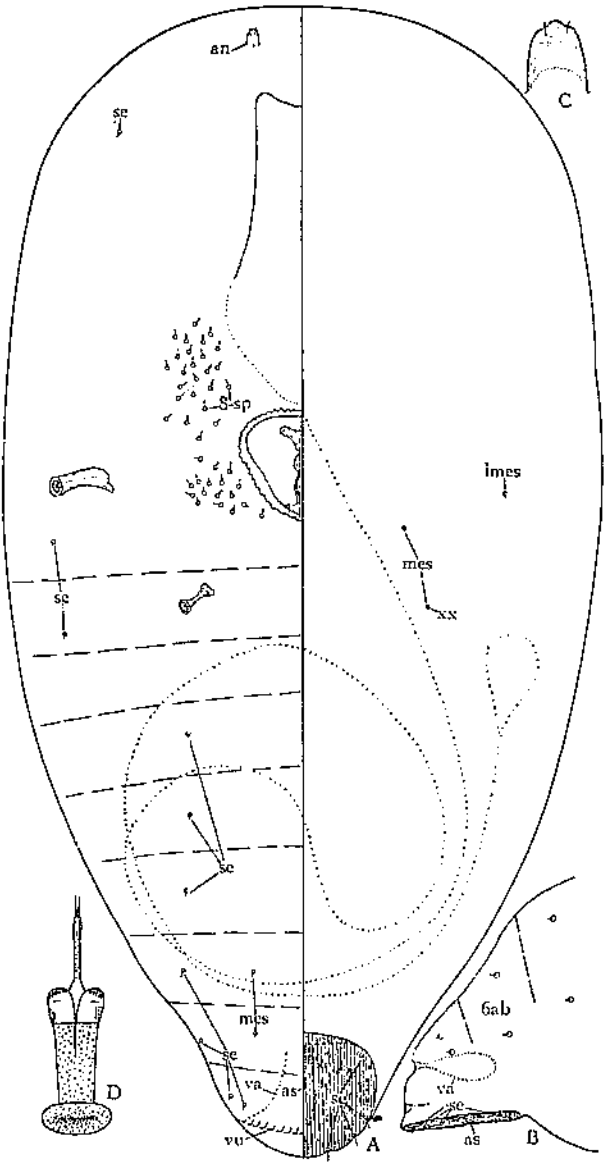

FIGURE 29.—*Hallimococcus tampas*, adult female: *A*, Body, dorsal and ventral, × 300; *B*, lateral aspect of posterior end, × 300; *C*, antenna, × 2,000; *D*, midventral 8-shaped pore, × 3,000.

SECOND-STAGE MALE

(Fig. 30)

Body.—Elongate elliptical, with sides nearly parallel; anterior end broadly rounded, posterior end less so; segmentation in evidence mesally on ventral surface caudad of rostrum to and including fourth abdominal segment, elsewhere obscure; membranous except for the four posterior abdominal segments, which are rather sharply differentiated from remainder of body and uniformly moderately sclerotic at first, and uniformly heavily sclerotic toward maturity of instar, though at this time the remainder of the body appears more delicate than when newly molted. Papillae absent. One specimen 0.36 mm long and 0.12 mm wide; another 0.44 mm long and 0.17 mm wide.

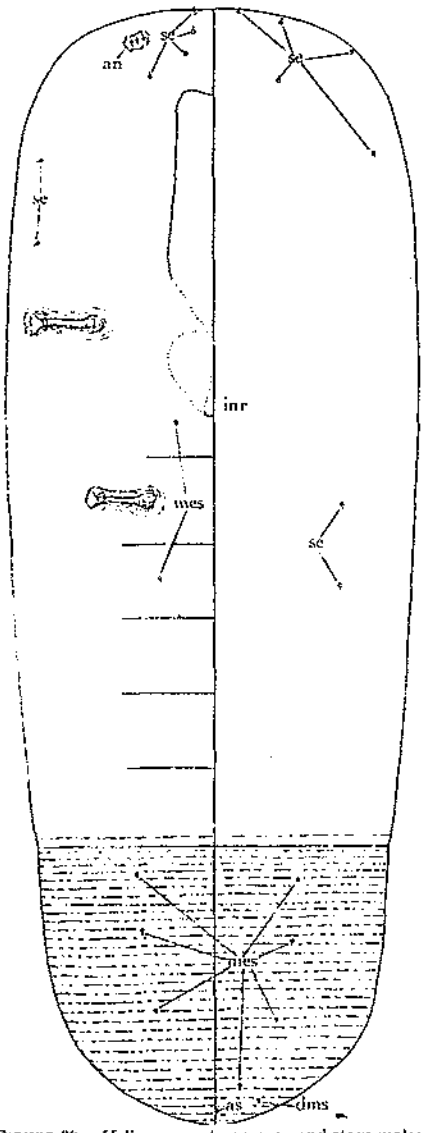

FIGURE 30.—*Hallimococcus lampas*, second-stage male: Body, dorsal and ventral, ×350.

Pores.—Apparently no pores of any type present.

Body setae.—Subequal; typically with 8 pairs on head; 2 ventromarginal pairs and 1 dorsomarginal pair on prothorax; 1 ventromesal pair each on mesothorax, metathorax, and fifth, sixth, and seventh abdominal segments; 1 dorsomesal pair each apparently on metathorax, and first, fifth, sixth, and seventh abdominal segments; 2 dorsal pairs on anal segment; in all, 23 pairs present.

Antenna.—Structurally hardly more than a mildly sclerotic thickening, with about 3 minute setae, 2 of which appear to be invaginated.

Rostralis.—Not available.

Legs.—Not in evidence.

Anus.—On dorsal surface near caudal margin.

Exuviation.—The heavily sclerotic posterior end projecting from puparium and appearing to break off from remainder of body and to be pushed away at time of emergence of adult.

THIRD-STAGE MALE

No specimens available.

FOURTH-STAGE MALE

No specimens in condition to distinguish the parts satisfactorily.

ADULT MALE

(Fig. 31)

Body.—Margins subparallel laterally and continuing more or less evenly around anterior end; head indistinctly delimited; segmentation obscure over greater part of ventral surface and not well defined on dorsal surface; anal segment sclerotic, remainder of body membranous. A typical specimen 0.44 mm long and 0.13 mm wide.

Body setae.—Small except second ventromesal head pair and 2 pairs on anal segment; typically 4 ventral and 5 dorsal pairs on head, 3 marginal or submarginal pairs and 1 dorsomesal pair on prothorax, 1 dorsomesal and 1 lateromesal pair of dorsum each on mesothorax and metathorax, 1 dorsomesal pair each on first and fifth to eighth abdominal segments, inclusive, 1 marginal pair each on sixth and seventh, 2 marginal pairs on eighth, 1 apparently ventromesal pair each on seventh and eighth abdominal segments, and 3 pairs on anal segment; in all, 31 pairs present.

Antenna.—Club with three segments only, its distal segment tapering apically to a fine projection capped by a long slender seta; all other setae of club fleshy in structure and rather small and short, except possibly 4 or 5 of varying lengths near apex of distal segment. Setae of club occurring typically as follows: 4 in a whorl near apex of first segment, 6 near apex of middle segment, and 18, excluding slender apical one, scattered over distal segment.

Legs.—Subequal; femora stout, the mesothoracic pair appearing slightly less so than the other 2 pairs; tibiae and tarsi noticeably slender, with tarsi distinctly elongate and appreciably longer than tibiae; metathoracic tibiae and tarsi very slightly stouter than those of other 2 pairs, with tibiae slightly shorter and tarsi slightly longer than those of other 2 pairs; number and character of setae of corresponding segments of each pair nearly alike; each coxa with a comparatively long seta on its inner margin, each femur with 2 slender and 2 rather small fleshy setae, each tibia with 4 slender and 2 small fleshy setae, each tarsus with 3 or 4 rather short slender setae, and a pair of long slender ones near its outer distal margin.

Anus.—On or near cephalic border of anal segment.

HALIMOCOCCUS THEBAICAE Hall (*S, pp. 2–3*)

Material collected in 1924 by W. J. Hall, Karnak, Egypt, on doum palm (*Hyphaene thebaica*); also collected by him at Luxor, Nag-Hamadi, and Motana, Upper Egypt, on same palm. Mixed in with downy mass of brownish-white filaments of host, "literally in millions" in this matter, according to Hall, and "the growth of which is apparently induced by the insect attack"; also on under surface of leaves, particularly near midrib. Material also from E. E. Green, F. Laing, and United States Bureau of Entomology, presumably from same source, a part of type material collected by W. J. Hall, Luxor, Egypt, 1922.

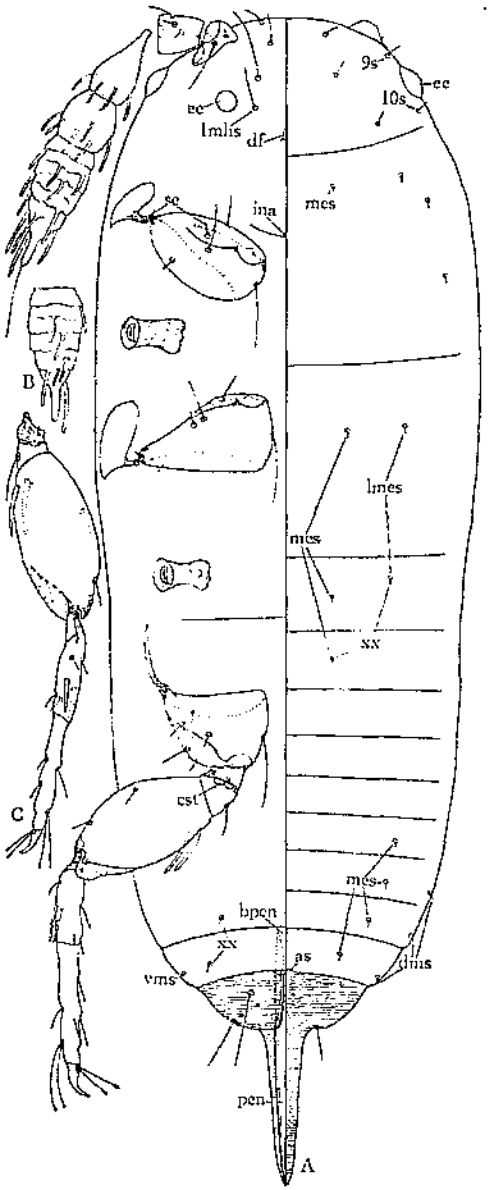

FIGURE 31.—*Halimococcus lampas*, adult male *A*, Body, dorsal and ventral; *B*, antenna, dorsal surface of apical segment; *C*, prothoracic leg. × 350.

EGG

(Fig. 32, *G*)

Oviparous. With a group of from 6 to 10, usually 7 or 8, spines, rather well spaced and varying considerably in size; sclerotic body derm extending appreciably around spines.

FIRST STAGE

(Fig. 32, *A–F*)

Body.—Not delicate. With distinct sclerotic areas near head skeleton. A faintly discernible pair of furcae on each side of meson between mesothorax

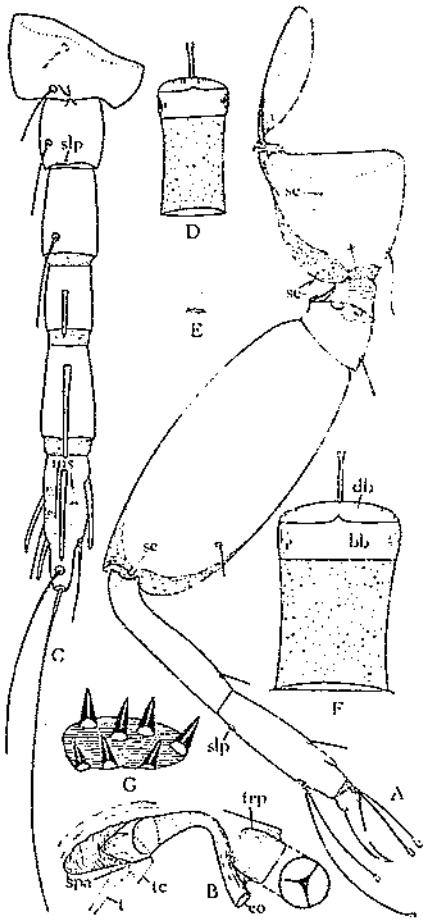

FIGURE 32.—*Halimococcus thebaicae: A*, First-stage nymph, metathoracic leg, × 1,000; *B*, same, mesothoracic spiracle, × 2,000; *C*, same, antenna, × 1,000; *D*, same, head pore, × 3,000; *E*, same, anus, × 1,500; *F*, same, caudodorsal 8-shaped pore, × 3,000; *G*, egg, spine group, × 1,500.

and metathorax. In younger individuals the two posterior abdominal segments slightly sclerotic; in older ones of both sexes appreciably sclerotic, with sclerotization extending in a decreasing degree cephalad over the next segment or so. Typically a slight bulge on each side and a more pronounced one on meson along caudal margin. Clear area present laterad of each metathoracic coxa. In female the body becomes much swollen, except the two posterior segments, producing a characteristic appearance. A typical newly hatched specimen 0.36

mm long and 0.12 mm wide; a fully developed female 0.46 mm long and 0.23 mm wide; male puparium only moderately sclerotic, typically 0.36 mm long and 0.18 mm wide.

Pores.—8-shaped pores prominent; relatively broad; progressively larger caudad on the three posterior abdominal segments; partitions indistinct, extending through no more than distal bars, which are difficult to distinguish; bullae delicate. Twelve 8-shaped pores typically present as follows: 2 marginal pairs each on head and anterior section of mesothorax; 1 marginal pair on metathorax and on first, second, and fifth to eighth abdominal segments, inclusive; 1 dorsomesal pair on second abdominal segment. A slightly invaginated trilocular pore associated with each mesothoracic spiracle.

Spiracles.—Invaginated tubes of mesothoracic pair connecting trachea to exterior only moderate in length; spiraculariae of both pairs moderately sclerotic, not elongate, subequal.

Body setae.—Eleven pairs of head setae, in number and character essentially as in *Halimococcus lampas;* 3 marginal pairs on prothorax, 2 marginal pairs on metathorax, 1 marginal pair each on apparently the anterior section of mesothorax, posterior section of mesothorax, and first to seventh abdominal segments, inclusive; 1 dorsomesal pair each on prothorax, posterior section of mesothorax, metathorax, and on first to seventh abdominal segments, inclusive; 1 pair of lateromesal setae of dorsum each on mesothorax and metathorax; 1 ventrosubmarginal pair each on second to seventh abdominal segments, inclusive; 1 ventromesal pair each on mesothorax, metathorax, and seventh abdominal segment; 6 pairs on posterior abdominal segment; in all, 52 pairs present. In one specimen, outer and inner long caudal setae, 62 and 195 microns long, respectively.

Antenna.—Basal segment twice as broad as any other segment. All setae approximately as in *Halimococcus lampas*, except that a spinelike process on second segment is distinct and one long slender seta, instead of a minute seta, is present on third segment.

Rostralis.—In one typical specimen, 1.1 mm long.

Legs.—Coxae not relatively broad; femora rather elongate. In essentials, setae as in *Halimococcus lampas*, except for presence of 6 setae on each procoxa, 2 on each femur, 1 on each tibia, and a spinelike process on tarsus.

Exuviation.—Male essentially as in *Halimococcus lampas* except with no pronounced sclerotic band on sixth abdominal segment; female becoming much swollen, eventually rupturing irregularly but largely around margins, usually leaving some ventral skin, except antenna and posterior end, in a single piece; head skeleton and rostrum of female simply dropping down to about the line of metathoracic legs.

Dried material.—Bright brown in both old and young specimens; practically naked in appearance; male instar roundish in cross section.

SECOND-STAGE FEMALE

(Fig. 33, *A–F*)

Body.—Moderately elliptical in younger specimens to pyriform or subcircular in older ones, except for posterior end, which is sharply constricted in the latter; seventh abdominal segment projecting less roundly than in *Halimococcus lampas*, being in its entirety characteristically subtriangular, apex of triangle constituting caudal margin of body; segmentation obscure except that of anal valve, and possibly the 2 or 3 other posterior abdominal segments; in younger specimens derm membranous except that of anal valve and seventh abdominal segment; latter strongly sclerotic; sclerotization spreading slightly cephalad in decreasing degree, before general thickening of body wall takes place. Numerous distinct spinelike papillae along margin and ventrosubmargin from about the fifth or sixth abdominal segment almost, if not quite, to head; cephalic margin of body practically free of papillae; mesothoracic but not metathoracic spiracles within papillary area; papillae surrounding spiracles irregular in form, mostly platelike, typically with serrated borders. A membranous area through which rostralis of adult is forced present on meson cephalad of rostral slit. Puparium heavily sclerotic. A typical newly molted specimen 0.47 mm long and 0.20 mm wide; a moderately large puparium 0.9 mm long and 0.6 mm wide.

Pores.—8-shaped pores apparently absent. A varying number of quinquelocular pores associated with each mesothoracic spiracle, but none with metathoracic spiracles; on one side of one typical specimen occurred 22 deeply invaginated large pores, 4 invaginated intermediate-sized ones, and 14 noninvaginated small ones; large pores widely scattered along margin and ventrosubmargin, appearing in some specimens to reach almost to head or to posterior end; intermediate-sized ones situated near external openings to pockets; small ones bunched within latter; margins of large and intermediate-sized pores slightly indented.

Spiracles.—Mesothoracic spiracles with accompanying small pores open into clearly defined pockets, which are almost globular; metathoracic spiracles open on surface. Spiracular ae much enlarged at their inner ends, but rather slender toward spiracles; both pairs distinctly sclerotic, subequal.

Body setae.—Apparently none present on dorsum except possibly on or near margin of posterior 3 or 4 abdominal segments. Typically 1 pair mesad of and 1 or 2 pairs immediately caudad of mesothoracic spiracles; 1 pair near margin laterad of metathoracic spiracles; 1 marginal pair each on third and fourth abdominal segments; 2 marginal pairs on fifth abdominal segment; 3 more or less marginal pairs each on sixth and seventh abdominal segments; 1 ventromesal pair each on fourth to seventh abdominal segments, inclusive; 7 pairs on anal valve; in all, 24 or 25 pairs present.

Antenna.—With two small partially invaginated setae only.

Rostralis.—In one typical specimen, 2.9 mm long.

Anal valve.—In younger specimens covering tissue slightly sclerotic around margins, membranous elsewhere; distinctive markings obscure or absent. With 5 rather small pairs of setae along caudolateral margin and 2 distinctly larger mesal pairs. Anus caudally located; rather small; surrounding tissue thickened, but anal ring probably absent.

Dried material.—Puparium dark to blackish brown; naked in appearance; unusually thick, almost globular; posterior end characteristically curved dorsocephalad.

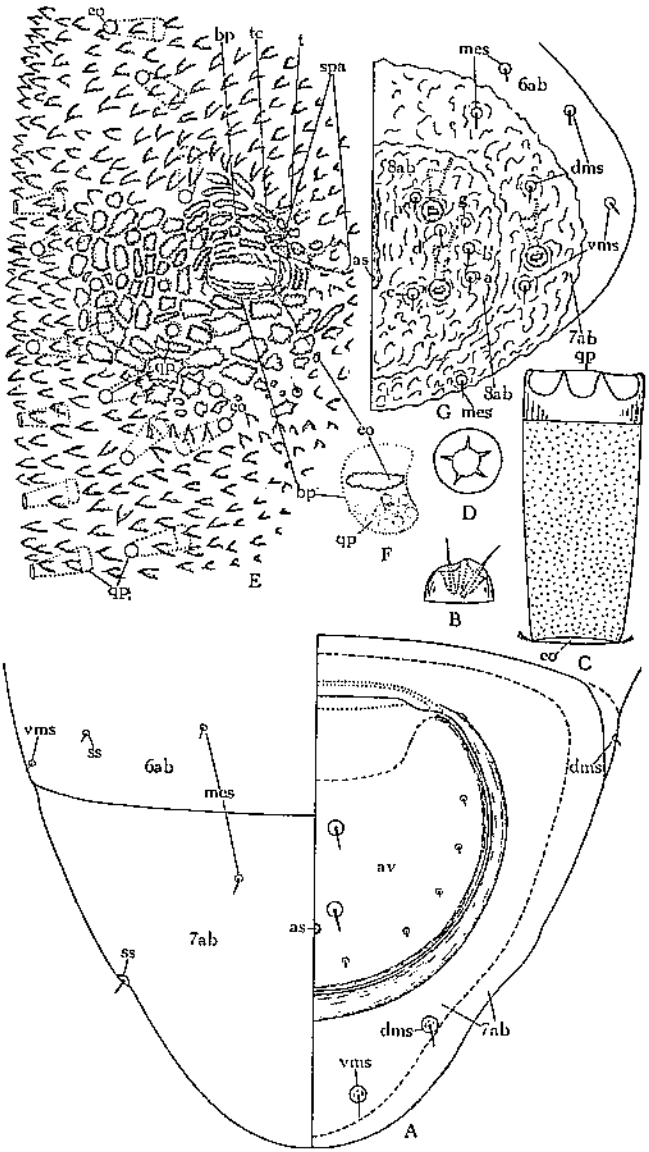

FIGURE 33.—*Halimococcus thebaicae: A*, Second-stage female, posterior end, dorsal and ventral × 500; *B*, same, antenna, × 2,000; *C*, same, large mesothoracic quinquelocular pore, × 2,000; *D*, same, small mesothoracic quinquelocular pore, × 2,000; *E*, same, mesothoracic region, × 500; *F*, same, outline of mesothoracic spiracular pocket, × 500; *G*, second-stage male, posterior end, dorsal, × 1,000.

THIRD-STAGE FEMALE

(Fig. 34, *E* and *F*)

Subglobular in mass except for sharply narrowed posterior projection; derm membranous but firm; tubercles or other pronounced dermal configurations, such as pore impressions, apparently absent. Mesothoracic spiracles, slightly larger than metathoracic spiracles; each with a single trachea and a brush of tracheoles, those of the mesothoracic spiracles being distinctly the larger. With a distinct roundish area on meson through which rostralis of adult is forced.

ADULT FEMALE

(Fig. 34, *A*–*D*)

Body.—Subglobular in appearance except for a sharply narrowed posterior end; segmentation obscure except that of the two posterior segments; anal segment partially or entirely sclerotic, also ventrocaudal region of seventh abdominal segment. A typical specimen 0.82 mm long and 0.62 mm wide.

Pores.—8-shaped pores closely bunched between the 2 pairs of spiracles and rostrum; partitions extending only through tubes; bars difficult to distinguish apart; external openings much expanded; typically 30 to 40 on each side of body.

Spiracles.—Both pairs of spiracular stout; mesothoracic pair slightly larger than metathoracic pair.

Body setae.—Approximately subequal; apparently absent on dorsum except for 1 pair each on margin of third to sixth abdominal segments, inclusive, and 5 pairs on anal segment. On venter, 1 submarginal pair apparently on prothorax; 1 marginal, 2 submarginal, and 8 or 9 scattered pairs mixed in with 2 groups of pores on mesothorax; 4 marginal, 2 submarginal, and 2 mesal pairs on metathorax; 4 pairs on second and 3 pairs each on third to seventh abdominal segments, inclusive; in all, 48 or 49 pairs present.

Antenna.—Comparatively large; with one pair of slender partially invaginated setae, and with apparently a single minute spinelike seta.

Rostralis.—In two specimens, 4.91 and 5.69 mm long, respectively; tips of two of its component parts each with about 4 minute teeth projecting backwards.

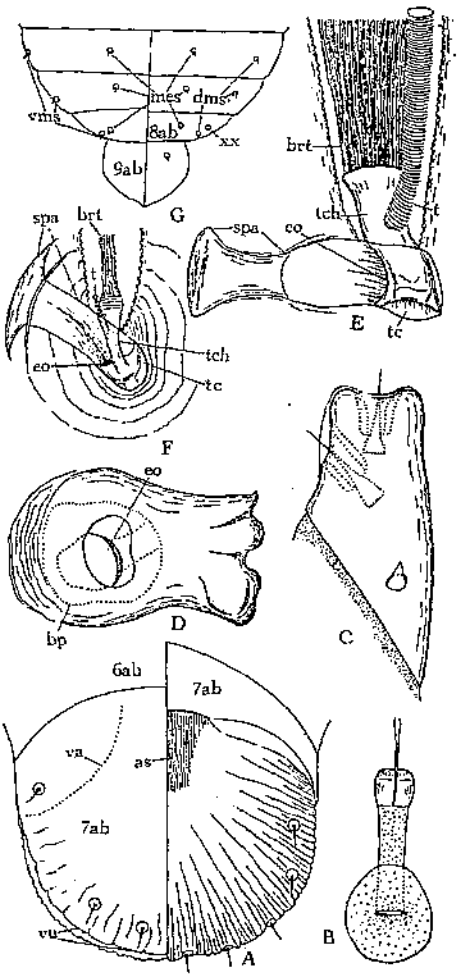

FIGURE 34.—*Halimococcus thebaicae: A*, Adult female, posterior end, dorsal and ventral, × 450; *B*, same, midventral 8-shaped pore, × 3,000; *C*, same, antenna, × 1,500; *D*, same, mesothoracic spiracle, × 750; *E*, third-stage female, mesothoracic spiracle, × 750; *F*, same, metathoracic spiracle, × 750; *G*, fourth-stage male, posterior end, dorsal and ventral, × 450.

Anal segment.—Slightly sclerotic in general, with a heavier sclerotization around anus; lateral and caudal margins faintly crenulate; vulva extending nearly to caudal margin; five pairs of subequal setae along laterocaudal margin. Anus distinctly cephalad in position.

SECOND-STAGE MALE

(Figs. 33, *G*, and 35)

Body.—Moderately to somewhat elongate elliptical; anterior end rounded, posterior end mildly truncated; segmentation rather distinct on both surfaces

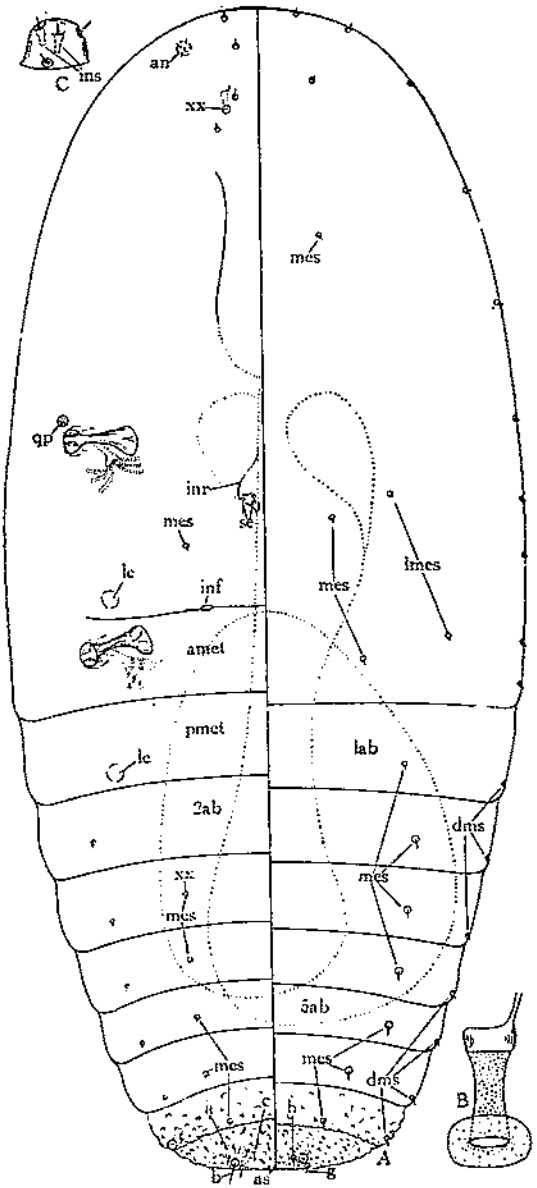

FIGURE 35.—*Halimococcus thebaicae*, second-stage male: *A*, Body, dorsal and ventral, × 450; *B*, invaginated pore (asymmetrical), × 3,000; *C*, antenna, × 2,000.

of abdomen; membranous except for slight sclerotization of the two posterior abdominal segments. Papillae present but delicate, frequently appearing as hardly more than short irregular lines; restricted to both surfaces of the two

posterior abdominal segments, being more numerous on anal than on preceding segment. A typical specimen 0.34 mm long and 0.15 mm wide.

Pores.—8-shaped pores absent. Asymmetrical pores present, subequal; restricted to head and the 2 posterior abdominal segments; typically 1 pair on ventral surface of head, 1 marginal pair on seventh abdominal segment, and 1 mesal pair on each surface of anal segment. Either none, 1, or 2 quinquelocular pores associated with each mesothoracic spiracle, but none with metathoracic spiracles.

Body setae.—Subequal except for 1 ventromarginal pair on anal segment. Typically 8 pairs scattered on head; 2 marginal pairs and 1 dorsomesal pair on prothorax; 3 marginal pairs, 1 dorsomesal and 1 lateromesal of dorsum, and 1 ventromesal pair on mesothorax; 2 marginal pairs, 1 dorsomesal and 1 lateromesal pair of dorsum, on metathorax; 1 marginal and 1 dorsomesal pair on first abdominal segment; 1 marginal, 1 dorsomesal, and 1 ventromarginal pair on each of second to seventh abdominal segments, inclusive, and in addition 1 ventromesal pair on third to seventh abdominal segments, inclusive; anal segment with 6 pairs; in all, 52 pairs present.

Antenna.—Varying from a shallow mildly sclerotic disk to a moderately sclerotic rounded tubercle; with apparently 2 minute surface setae and a pair of minute partially invaginated setae.

Rostralis.—With two large roundish loops and the characteristic small cephalic loop, when uncoiled within body; in one specimen, 1.8 mm long.

Legs.—May or may not be in evidence; always extremely vestigial.

Anus.—On caudal margin.

Exuviation.—All of derm pushed to one side as a shapeless mass within puparium.

THIRD-STAGE MALE

Available material too delicate to distinguish the parts adequately. One specimen 0.33 mm long and 0.16 mm wide.

FOURTH-STAGE MALE

(Figs. 34, *G*, and 36, *F*)

Body moderately elliptical, with posterior end a short, stocky, slightly pointed projection; segmentation of body and appendages distinguishable. Body setae about as in adult male, except submarginal setae of latter on posterior abdominal segments apparently replaced by mesal ones in this stage. Legs proportionately longer and not so elbowed as in *Palmaricoccus attaleae;* each with two pronounced fleshy apical projections for holding the pair of developing apical tarsal setae of subsequent instar. A typical specimen 0.37 mm long and 0.17 mm wide.

ADULT MALE

(Fig. 36, *A–E*)

Body.—Margins tapering perceptibly toward both ends and plainly constricted at the suture separating head from thorax, so that head is plainly delimited.

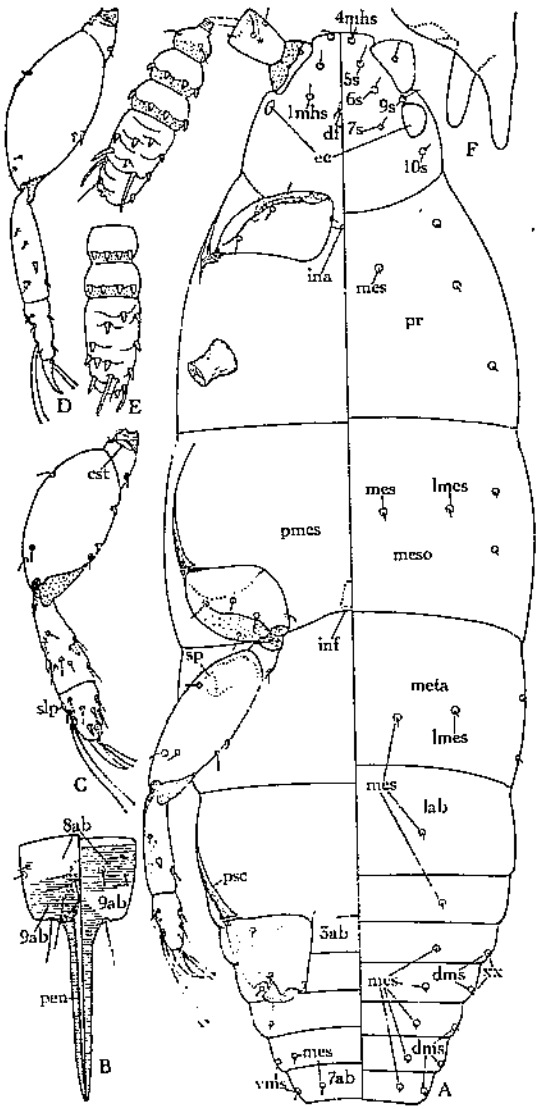

FIGURE 36.—*Halimococcus thebaicae: A*, Adult male, body, dorsal and ventral, × 400; *B*, same, posterior end, dorsal and ventral, × 400; *C*, same, metathoracic leg, × 400; *D*, same, prothoracic leg, × 400; *E*, same antenna, dorsum of apical part, × 400; *F*, fourth-stage male, tip of ventral surface of metathoracic leg, × 1,000.

Eighth abdominal segment and anal segment each partially sclerotic, and separation between the two obscure; segmentation of remaining segments pronounced, except no evidence on either surface of anterior section of mesothorax or of a suture between metathorax and second abdominal segment on ventral surface. One typical specimen 0.45 mm long and 0.12 mm wide.

Body setae.—Distinct, subequal, except that the 3 pairs on anal segment are appreciably longer than the other body setae; typically 3 and 6 pairs on ventral and dorsal surfaces of head, respectively; 3 marginal pairs and 1 dorsomesal pair on prothorax; 2 marginal pairs, the lateromesal pair of dorsum, and 1 dorsomesal pair on mesothorax and metathorax each; 1 dorsomesal pair on each of first to eighth abdominal segments, inclusive, 1 marginal pair each on third to eighth, inclusive, 1 ventromarginal pair each on fourth to eighth, inclusive, 1 ventrosubmarginal pair each on sixth, seventh, and eighth, 1 additional marginal pair on eighth, and 1 ventromesal and 2 marginal pairs on anal segment; in all, 47 pairs present.

Antenna.—Club with four segments, distal segment bluntly rounded apically. Club setae occurring typically as follows: 2 slender setae on first segment; 8 short, stout, spinelike setae each in a whorl near apical margins of second and third segments; 17 short, stout, spinelike setae, 6 small fleshy setae, and 1 small slender seta, all irregularly scattered, on distal segment.

Legs.—Prothoracic and metathoracic femora subequal and noticeably stouter than mesothoracic femora; prothoracic and mesothoracic tibiae and tarsi subequal and noticeably more slender than metathoracic tibiae and tarsi; tibiae and tarsi of all pairs distinctly less slender than in *Halimococcus lampas;* all tibiae appreciably longer than tarsi; no setae on coxae appreciably long, those on the other segments, except the distal pair on tarsus and the pair on claw, either slender and short or short, stocky, and spinelike. Number and character of setae on corresponding segments of prothoracic and mesothoracic legs practically alike, but setae less numerous than on corresponding segments of metathoracic pair; typically with 4 slender and 1 or 2 spinelike setae on each femur, 3 or 7 slender and 2 spinelike setae on each tibia, and 4 or 5 short, slender setae and none or 3 spinelike setae on each tarsus.

Anus.—Obscure.

HALIMOCOCCUS BORASSI Green (6)

Material from E. E. Green, exposed on leaves of "Palmyra palm" (*Borassus flabellifer*), Peradeniya, Ceylon; United States Bureau of Entomology, exhibit collection Green, presumably same lot.

EGG

(Fig. 37, *J*)

Oviparous. With a group of 3 or 4 spines, moderately spaced and varying but little in size; sclerotic body derm extending slightly around spines.

FIRST STAGE

(Fig. 37, *A–I*)

Body.—Large compared with that of adult female. Rather rugose on dorsum. Posterior end not distinctly sclerotic. Caudal margin without bulge. With

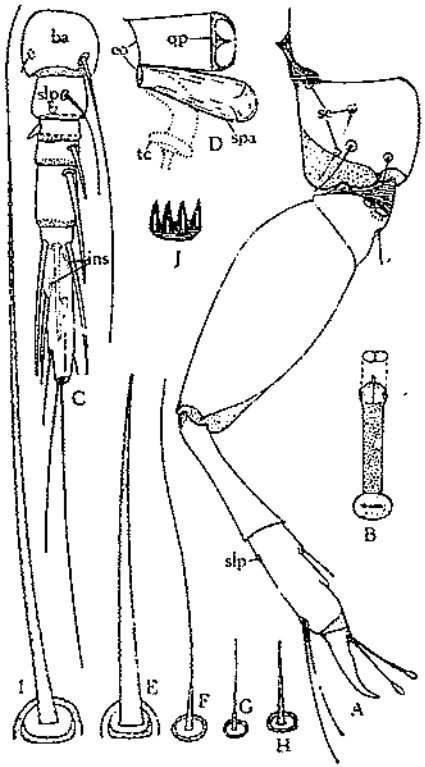

FIGURE 37.—*Halimococcus borassi:* *A*, First-stage nymph, metathoracic leg, × 1,000; *B*, same, dorsocaudal 8-shaped pore, × 3,000; *C*, same, antenna, × 1,000; *D*, same, mesothoracic spiracle, × 2,000; *E*, same, dorsomarginal seta, × 2,000; *F*, same, third head seta, × 2,000; *G*, same, ventromesal seta of posterior segment, × 2,000; *H*, same, dorsomesal seta, × 2,000; *I*, same, smaller, long caudal seta, × 2,000; *J*, egg, spine group, × 1,500.

clear area laterad of each metathoracic coxa. A typical newly hatched specimen 0.25 mm long and 0.11 mm wide. Male puparium uniformly heavily sclerotic; typically 0.38 mm long and 0.13 mm wide.

Pores.—All 8-shaped pores comparatively small; partitions distinguishable through bars but not through tubes; bars difficult to distinguish apart; bullae delicate. Three pairs of 8-shaped pores on head, 1 dorsomesal pair on each section of mesothorax, metathorax, and second abdominal segment; 1 marginal pair each on prothorax, anterior sections of mesothorax and metathorax, posterior section of metathorax and fifth, sixth, and eighth abdominal segments; in all, 14 pairs present. One distinctly invaginated quinquelocular pore associated with each mesothoracic spiracle, but none with metathoracic spiracles.

Spiracles.—Mesothoracic invaginated tube rather short; spiraculariae of both pairs slightly elongate, strongly sclerotic, subequal.

Body setae.—A row of rather large spinelike setae along dorsal margin as follows: 4 pairs on head; 2 pairs each on prothorax, metathorax, and eighth abdominal segment; 1 pair each on all other thoracic and abdominal segments. One dorsomesal pair of setae present on head and each segment of thorax and abdomen, except anterior section of mesothorax; 1 small marginal pair on head; apparently 1 lateromesal pair of dorsum on prothorax; 4 rather long ventromesal pairs on head; 1 ventromesal pair each on mesothorax, metathorax, and seventh and eighth abdominal segments; 2 long caudal pairs on eighth abdominal segment; in all, 43 pairs present. Outer and inner long caudal setae in one specimen, 39 and 125 microns long, respectively, the smaller pair twice or more the length of the prominent dorsomarginal setae.

Antenna.—Basal segment not twice as broad as any other segment; third and fourth segments comparatively small. In structure and occurrence all setae essentially as in *Halimococcus lampas*, except that the spinelike process is distinct on second segment and there is a noticeably short and fleshy seta on third segment.

Rostralis.—In one typical specimen, 0.51 mm long.

Legs.—Coxae not broad; setae essentially as in *Halimococcus lampas* except apparently none on femur, and spinelike process of tarsus faint.

Exuviation.—In male, head skeleton and rostrum simply drop down, and dorsal part of the four posterior abdominal segments is sloughed; in female, parts of marginal and ventral surfaces are ruptured, leaving practically the entire dorsum intact, and generally on one side the lateral and ventral parts, to and including the legs, are left attached to the dorsum, making a single shell that serves as covering for puparium.

Dried material.—Rich brown in younger specimens to almost black in fully developed ones; naked in appearance; male instar roundish in cross section.

SECOND-STAGE FEMALE

(Fig. 38, *A–E*)

Body.—Elongate elliptical, seventh abdominal segment subtriangular, but margins more rounded than in *Halimococcus thebaicae;* surface much convoluted, especially along margin, in all prepared material; segmentation obscure except for definition of anal valve; membranous in younger specimens except for slight sclerotization of seventh abdominal segment; eventually latter becoming strongly sclerotic, and a mild sclerotization spreading to sixth abdominal segment before general thickening of body wall takes place. Papillae apparently absent, though convolutions of derm frequently resemble them. A membranous area near head skeleton for penetration of adult rostralis apparently absent. Puparium heavily sclerotic laterally and dorsally, but largely membranous ventromesally; sclerotic

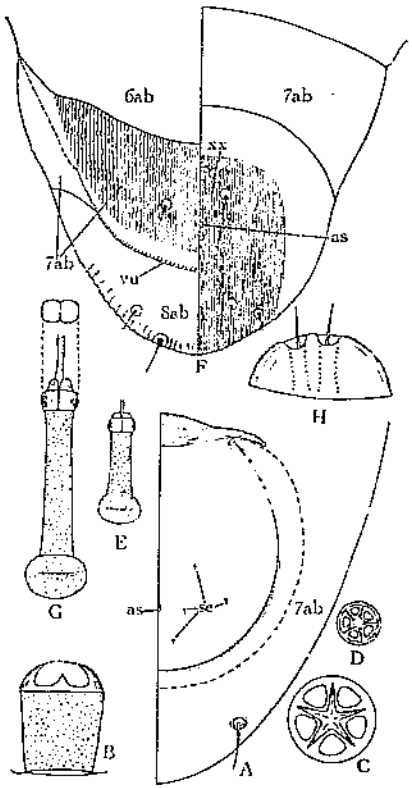

FIGURE 38.—*Halimococcus borassi: A*, Second-stage female, posterior end, dorsal, × 500; *B*, *C*, same, large quinquelocular pore, lateral and end views, × 2,000; *D*, same, small quinquelocular pore, end view, × 2,000; *E*, same, 8-shaped pore, × 3,000; *F*, adult female, posterior end, dorsal and ventral, × 500; *G*, same, midventral 8-shaped pore, × 3,000; *H*, same, antenna, × 2,000.

derm rugose. A typical newly molted specimen 0.44 mm long and 0.10 mm wide; a puparium 0.66 mm long and 0.22 mm wide.

Pores.—At least 1 pair of minute 8-shaped pores on ventromesal surface of head; no others definitely distinguished on body; partitions extending through bars but hardly into tubes; bars can be distinguished apart; external openings on surface. A varying number of quinquelocular pores associated with each pair of spiracles; in one specimen 8 and 8 large ones, 3 and 1 intermediate-sized ones, and 5 and 6 small ones associated with mesothoracic spiracles of each side, respectively; in same specimen 5 and 7 large ones, no intermediate-sized ones, and 4 and 4 small ones associated with metathoracic spiracles on corresponding sides, respectively. In a count of 9 groups of quinquelocular pores on mesothorax, the range in number was 4 to 13 for the large ones separately, and 5 to 11

for all the others together, the average being 7.7 in each case; similarly, in 6 groups on metathorax, the range was 2 to 7 and 3 to 5, the average 5.8 for the large ones separately and 4.0 for all the others together. The intermediate-sized quinquelocular pores not much larger than the small ones; the large pores without indented margins and only moderately invaginated; all grouped fairly close about their respective spiracles.

Spiracles.—Both pairs of spiracles opening into pockets, having relatively large external openings, which are at the inner ends of pronounced depressions leading to body margin.

Body setae.—Typically 1 ventrosubmarginal pair immediately caudad of each pair of spiracles; 1 ventromesal pair between mesothoracic spiracles; 1 rather large pair near caudal margin of seventh abdominal segment; 4 pairs on anal valve; in all, 8 pairs present.

Antenna.—Essentially as in *Halimococcus lampas.*

Rostralis.—Not available.

Anal valve.—Covering tissue in younger specimens largely membranous, with no characteristic markings; in prepared specimens inclined to pucker or ridge up; with apparently four minute pairs of setae, all situated away from margin, in vicinity of anus; latter minute; anal ring absent.

Dried material.—Puparium nearly black; naked in appearance; sides slightly rounded in cross section; body more cylindrical than dome-shaped, posterior end pointed nearly straight dorsad.

THIRD-STAGE FEMALE

Present, but available material not in condition to distinguish any parts satisfactorily.

ADULT FEMALE

(Fig. 38, *F–H*)

Body.—Elongate elliptical; segmentation distinguished on ventral surface of thorax caudad of rostrum, on abdomen, and on dorsum of the 3 or 4 posterior abdominal segments; anal segment partially sclerotic, and ridged effect on ventral surface of seventh abdominal segment giving the parts the appearance of being sclerotic. A typical specimen 0.58 mm long and 0.28 mm wide.

Pores.—8-shaped pores apparently limited to the region between mesothoracic spiracles and head skeleton, partitions extending apparently only through bars; bars rather easily distinguished apart; external openings slightly expanded; typically 12 to 18 pairs present.

Spiracles.—Spiraculariae rather stout, subequal.

Body setae.—All approximately subequal except for 1 pair on caudal margin of anal segment. None observed dorsally except 3 pairs on anal segment. On venter, typically 1 submarginal pair and 2 or 3 mesal pairs on apparently the posterior section of mesothorax; 1 submarginal and 1 mesal pair on posterior section of metathorax; 1 mesal pair each on second to seventh (excluding sixth) abdominal segments, inclusive; 2 marginal pairs on anal segment; in all, 16 or 17 pairs present.

Antenna.—Slightly flattened; with 2 small, slender, partially invaginated setae.

Rostralis.—In one specimen, 2.4 mm long.

Anal segment.—Moderately sclerotic mesocaudally; with 6 pairs of setae, 4 pairs being on dorsal surface, 2 of which are mesocephalad in position, and 2 pairs, 1 of which is comparatively large, on or near ventrocaudal margin; anus slightly cephalad of center.

SECOND-STAGE MALE

(Fig. 39, *A–D*)

Body.—Elongate elliptical, with sides nearly parallel; the two ends nearly equally rounded; segmentation obscure except for differentiation of posterior end from remainder of body; posterior end not segmented, but apparently composed of three posterior abdominal segments; membranous except for moderate to strong sclerotization of posterior end. Papillae absent. A typical specimen 0.29 mm long and 0.09 mm wide.

Pores.—Apparently about four pairs of minute 8-shaped pores present along body margin between metathoracic spiracles and sclerotic posterior end. No other pore types present.

Body setae.—Subequal; typically with 8 pairs apparently on head; 2 marginal pairs and 1 dorsomesal pair on prothorax, 1 dorsomesal pair each on first to seventh abdominal segments, inclusive, 1 ventromesal pair on mesothorax and 6 pairs on anal segment; in all, 25 pairs present.

Antenna.—Essentially as in *Halimococcus lampas*, except possibly with 4 minute setae, 2 being slender and 2 invaginated.

Rostralis.—With one elongate caudal loop and the small cephalic loop, when uncoiled within body; in one specimen, 0.63 mm long.

Legs.—Not in evidence.

Anus.—On dorsal surface near caudal margin.

Exuviation.—No data available.

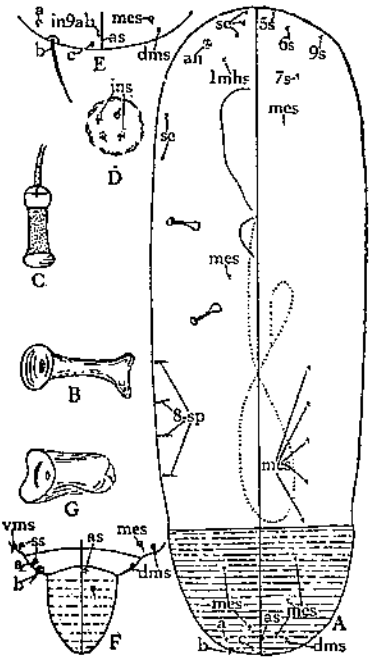

FIGURE 39.—*Halimococcus borassi*: *A*, Second-stage male, body, dorsal and ventral, × 400; *B*, same, mesothoracic spiracle, × 1,000; *C*, same, marginal pore, × 3,000; *D*, same, antenna, × 2,000; *E*, third-stage male, posterior end, dorsal and ventral, × 400; *F*, fourth-stage male, posterior end, dorsal and ventral, × 400; *G*, same, mesothoracic spiracle, × 1,000.

THIRD-STAGE MALE

(Fig. 39, *E*)

Available material too delicate to distinguish the parts satisfactorily except on anal segment; the latter with 5 pairs of setae, 1 pair unusually prominent.

FOURTH-STAGE MALE

(Fig. 39, *F* and *G*)

Available material in condition to distinguish very few structures satisfactorily. Body elongate elliptical, with posterior projection evenly rounded and moderately sclerotic nearly to its base. Spiraculariae inclined to be stout, moderately sclerotic, subequal. Four pairs of setae on or near margin of seventh, and 3 pairs similarly located, 1 of which is comparatively large and spinelike, on eighth abdominal, and 1 dorsomesal pair on anal segment. One specimen 0.22 mm long and 0.07 mm wide.

ADULT MALE

No available material.

Genus PLATYCOCCUS, new genus

First Stage

Body elongate elliptical, distinctly flat in cross section; caudal margin of abdomen without a bulge; segmentation of head, prothorax, and mesothorax obscure, elsewhere more distinct; neither posterior end nor any other part of body derm distinctly sclerotic. 8-shaped pores delicate, elongate; partitions not in evidence through tubes, scarcely so through bars; latter difficult to distinguish apart; bullae distinct, comparatively long; external openings flush with surface; typically 4 pairs present, all dorsomesally situated. A single trilocular pore associated with each mesothoracic spiracle, but no pores associated with metathoracic spiracles. No invaginated tubes connecting tracheae to exterior; spiraculariae elongate, moderately sclerotic, subequal. Clear area laterad of each metathoracic coxa apparently absent. Typically 9 pairs of setae on head, frontal pair between arms of head skeleton being absent, 3 pairs on prothorax, 4 pairs on mesothorax, 5 pairs on metathorax, 1 pair on first abdominal segment, 3 pairs each on second to sixth abdominal segments, inclusive, 4 pairs on seventh, and 5 pairs on posterior abdominal segment. Antenna 6-segmented; basal segment not twice as broad as any other segment; apical segment noticeably elongate. Antennal setae occurring typically as follows: 3 slender setae on basal segment; no setae, but a spinelike process, on second segment; none on third; 1 fleshy seta on fourth; 2 slender setae and 1 fleshy seta on fifth; 2 slender and 5 fleshy setae on apical segment. Rostrum apparently with only 1 pair of setae, this one near apex; rostralis with a single long caudal loop besides the small cephalic loop, when uncoiled within body. Legs distinctly elongate; neither trochanter and femur nor tibia and tarsus fused. Leg setae occurring typically as follows: 4 setae, including minute basal one, on procoxa; 3 setae, including minute basal one, on each of other coxae; 2 setae, including minute basal one and a comparatively long one, on trochanter; none on femur or tibia; 3 setae on tarsus; 2 setae on claw. Anus small and delicate; on ventrocaudal margin; anal ring absent. Male partially puparial.

Second-Stage Female

Body elongate elliptical; general outline continued evenly around posterior end, but head characteristically prolonged; markedly flat in cross section; dorsal and ventral surfaces in juxtaposition entirely around for an appreciable distance within margin; segmentation obscure throughout except that of anal valve; membranous in younger individuals except for anal valve. Distinct papillae absent, but in older specimens with shallow dermal thickenings scattered over dorsum. 8-shaped pores present, all minute, comparatively numerous, the majority scattered along margin and submargin of body; partitions obscure both through bars and tubes; bars difficult to distinguish apart; bullae delicate; external openings delicate, flush with surface. In older specimens with distinct channels connecting 8-shaped pores with interior of body. Typically 1 or 2 quinquelocular pores associated with each of 4 spiracles, in slight depressions leading to latter; no other quinquelocular pores on body. All 4 spiracles in shallow depressions, none surrounded by any pronounced sclerotization; spiraculariae elongate, moderately sclerotic, subequal. All body setae minute; at least 5 pairs each on head and seventh abdominal segment, 1 to 3 pairs each apparently on all remaining body segments except anal valve. Antenna on or near margin; limited to a single, relatively small, roundish sclerotic piece, having 2 minute, slender, partially invaginated setae; in older specimens with a channel leading to interior of body. Rostral setae, if present, obscure; rostralis not available. A membranous area, through which rostralis of adult is forced, absent. Anal valve present with characteristic markings; lacking pores but with 4 pairs of setae; anus cephalad in position on anal valve; anal ring apparently absent. Becomes puparium; dorsal derm strongly sclerotic.

Adult Female

Body pyriform (inverted); head prolonged as in second-stage female; general outline continued more or less evenly around posterior end; segmentation obscure except on ventral surface of thorax caudad of rostrum and on abdomen; in both young and old specimens derm membranous except for a ridged effect resembling sclerotization on more or less of ventral surface of seventh abdominal segment. Papillae absent except around spiracles; largely spinelike and serrated in appearance. 8-shaped pores small; confined to region between mesothoracic spiracles

and head skeleton and rostrum; moderately numerous; partitions obscure or absent through bars as well as through tubes; bars difficult to distinguish apart; bullae comparatively large, slightly enlarged and thickened through one section; external openings flush with surface and considerably expanded. Quinquelocular pores absent. Both pairs of spiracles flush with surface; spiraculariae moderately elongate, distinctly sclerotic, subequal. Body setae small in general, almost minute, and subequal except on anal segment; typically 7 pairs on head, 9 pairs on thorax, and 31 pairs on abdomen. Antenna essentially as in second-stage female; limited to a single sclerotic piece having one pair of minute partially invaginated setae. Rostral setae obscure; no available data on rostralis. Anal segment on both surfaces of posterior end; membranous; pores absent; with 4 pairs of setae, 2 pairs on ventrocaudal margin slightly larger than the others. Anus well up on dorsum; moderate in size; anal ring probably absent.

Second-Stage Male

Body apparently elongate elliptical; segmentation obscure except ventrally on sclerotic abdominal segments; five of latter moderately sclerotic, remainder of body delicately membranous. Papillae absent. 8-shaped pores rather numerous, subequal, restricted to marginal or submarginal regions on the sclerotic posterior end, but scattered elsewhere; partitions apparently extending through bars but not into tubes; bars can be distinguished apart with difficulty; bullae long and delicate; external openings expanded and at apices of sclerotic projections. All other pore types absent. Spiraculariae elongate, moderately sclerotic, subequal. At least 3 pairs of setae on each of the 6 posterior abdominal segments, none dorsomesal in position and all about subequal. Antenna occurring as a distinctly projecting tubercle; with several pairs of small setae only. Anus small; on caudal margin; anal ring absent.

Adult Male[9]

Body elongate elliptical, with posterior end occurring as a fairly large, moderately slender, rapierlike projection; membranous except for anal segment. Vestiges of thoracic wing framework and wings apparently absent. Spiraculariae expanded at both ends and narrow in middle; not elongate, moderately sclerotic, subequal. Eighth abdominal segment with 4 pairs and anal segment with 3 pairs of setae. Antenna with 2 stocky basal segments and an elongate club having 5 segments more or less compactly joined, of which the apical segment is elongate but not twice the length of any other segment of club; basal antennal segment with 2 slender setae, second segment with none, and each segment of club with 2 or 3 long slender and 3 to 5 long fleshy setae. With a single pair of eyes, marginal in position. A vestige of head skeleton apparently present as a differentiated area on ventromeson; invagination to alimentary tube in evidence. Legs stocky, rather large, and approximately subequal, though metathoracic femora, tibiae, and tarsi appear to be slightly larger than those of the other two pairs; tarsus shorter than tibia; setae either slender and small and few in number, or fleshy, comparatively long, and rather plentiful in number; definite sensory areas on any segment apparently lacking. Anus on or near cephalic border of anal segment.

Type of genus, *Platycoccus tylocephalus*, new species.

Platycoccus tylocephalus, new species

Material collected in 1920 by L. A. Whitney on "palm", Honolulu, Hawaii. All specimens on green leaves in exposed places.

[9] Available material not in condition for determination of all parts.

EGG

(Fig. 40, *F*)

Oviparous. With a pair of separate spines along ventromesal line; the cephalic spine usually appearing approximately between the basal antennal segments and slightly smaller than the caudal spine.

FIRST STAGE

(Fig. 40, *A–E*)

Body.—With no clearly defined sclerotic areas near head skeleton. Delicate pair of mesal furcae between mesothorax and metathorax. A typical newly hatched specimen 0.35 mm long and 0.16 mm wide; a typical puparium 0.82 mm long and 0.39 mm wide.

Pores.—8-shaped pores subequal. Typically 5 pairs of 8-shaped pores present, all dorsomesally situated as follows: 1 pair on head; 1 pair either on prothorax or on anterior section of mesothorax; 1 pair each on or near suture separating mesothorax from metathorax, and metathorax from first abdominal segment; 1 pair on seventh abdominal segment. The trilocular pore associated with each mesothoracic spiracle prominent; margins slightly indented.

Spiracles.—Spiraculariae slender, slightly curving, subequal; mesothoracic pair closely attached to trilocular pores by sclerotic extensions.

Body setae.—Typically 9 pairs on head, first 2 ventromesal pairs comparatively long, third ventromesal pair and a dorsomesal pair quite small, fourth ventromesal pair moderately long, 4 remaining pairs moderate in size and all on or near margin; 2 marginal pairs and 1 dorsomesal pair on prothorax; 1 marginal pair on anterior section of mesothorax; 1 marginal, 1 ventromesal, and 1 dorsomesal pair on posterior section of mesothorax; 2 marginal pairs, 1 ventrosubmarginal, 1 ventromesal, and 1 dorsomesal pair on metathorax; 1 dorsomesal pair on first abdominal segment; 2 marginal and 1 ventrosubmarginal pair each on second to sixth abdominal segments, inclusive; 2 marginal, 1 ventrosubmarginal, and 1 ventromesal pair on seventh abdominal segment; 5 pairs on posterior abdominal segment; in all, 46 pairs present. All marginal pairs on thorax and abdomen and both ventromesal pairs on thorax moderate in size; all submarginal and dorsomesal pairs on thorax and abdomen comparatively small. Shafts of all setae on thorax and abdomen, except those of the 2 long caudal pairs, comparatively short. In one specimen, outer and inner long caudal setae 53 and 121 microns long, respectively.

Antenna.—Moderately elongate. One distal seta of apical segment long and rather fleshy, the other long and threadlike.

Rostralis.—In one typical specimen, 0.68 mm long.

Legs.—Elongate. With 2 minute setae, including basal one, and 2 other setae on each procoxa.

Anal ring.—Absent.

Exuviation.—Rupture in both sexes occurring caudad of antennae, the ventral skin rolling back toward posterior end. In male, the head skeleton and legs come to rest in an inverted position slightly beyond the middle of the body.

Dried material.—Pale brown; naked in appearance; flat.

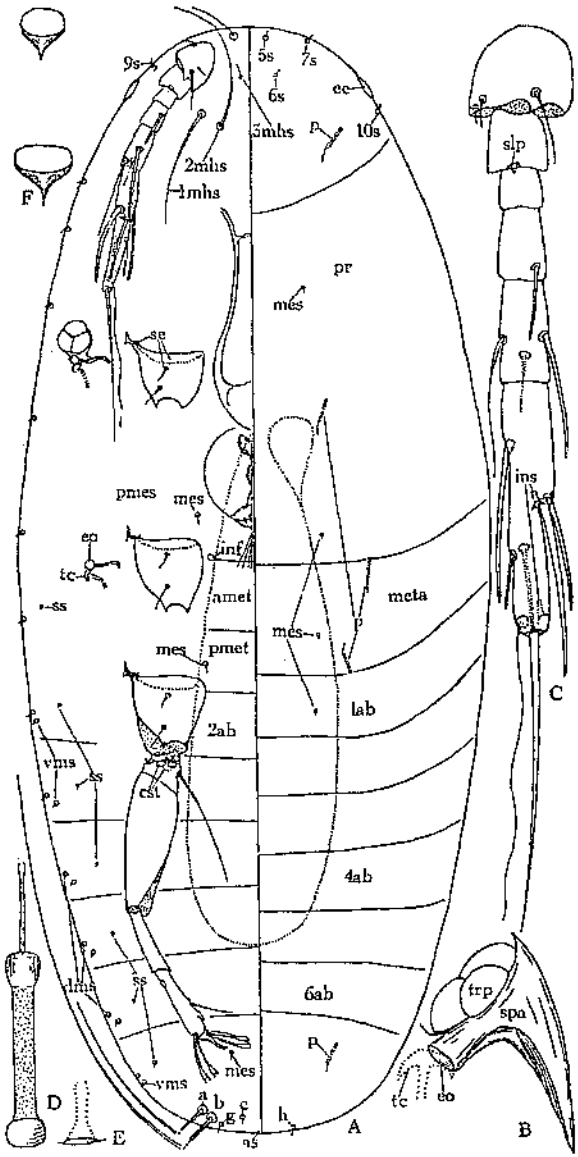

FIGURE 40.—*Platycoccus tylocephalus: A,* First-stage nymph, body, dorsal and ventral, × 400; *B,* same, mesothoracic spiracle, × 2,000; *C,* same, antenna, × 1,000; *D,* same, 8-shaped pore, × 3,000; *E,* same, anus, × 1,500; *F,* egg, pair of spines, in size and distance apart, relatively as shown, × 1,500.

SECOND-STAGE FEMALE

(Figs. 41 and 42)

Body.—A newly molted specimen in good condition was not available. Puparium heavily sclerotic on dorsum, almost membranous on venter. A membranous area near head skeleton for penetration of adult rostralis lacking, latter being forced through derm near caudal end of a comparatively long rostral slit. A typical puparium 2.2 mm long and 0.8 mm wide.

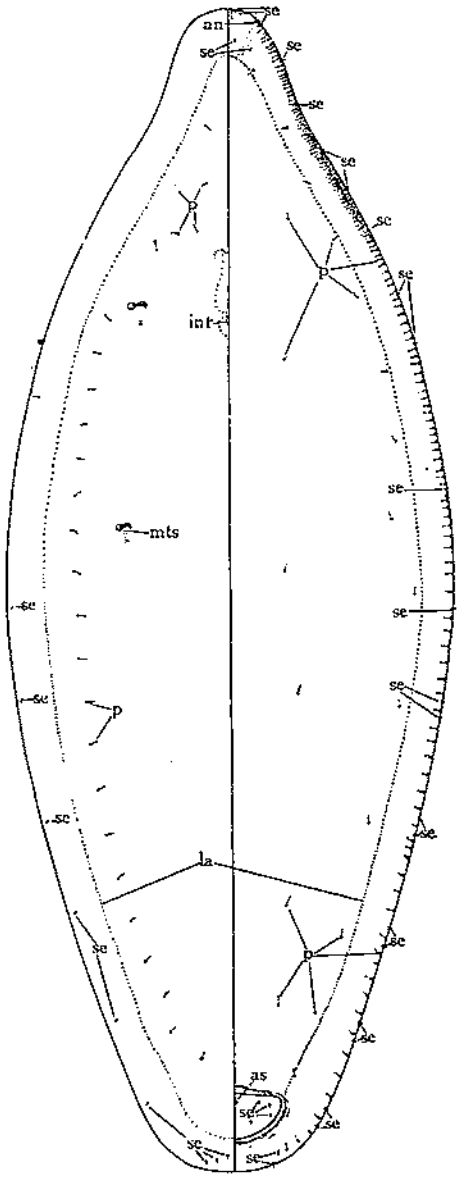

FIGURE 41.—*Platycoccus tylocephalus*, second-stage female: Body (puparium), dorsal and ventral, × 70.

Pores.—8-shaped pores comparatively small; situated ventromesally on head, prothorax, and posterior end, and in distinct rows marginally and submarginally

on both surfaces and dorsomesally on head. The following pores counted in the marginal row on one side of one typical specimen: 1 on head, 109 from antenna to mesothoracic spiracle, 25 between spiracles, and 41 caudad of metathoracic spiracle; on one side of same specimen, 14 dorsosubmarginal, 23 ventrosubmarginal, 6 dorsomesal, and 3 ventromesal ones; in all, 222 present on one side of body. Either 1 or 2 quinquelocular pores associated with each mesothoracic and 1 slightly smaller quinquelocular pore associated with each metathoracic spiracle; all noninvaginated.

Spiracles.—Opening into shallow roundish depressions, along with accompanying quinquelocular pores; mesothoracic depressions slightly larger than metathoracic ones; spiracularlae approximately alike.

Body setae.—All minute and apparently on or near margin except those on anal valve, as follows: 5 pairs apparently on head; then well spaced, in order,

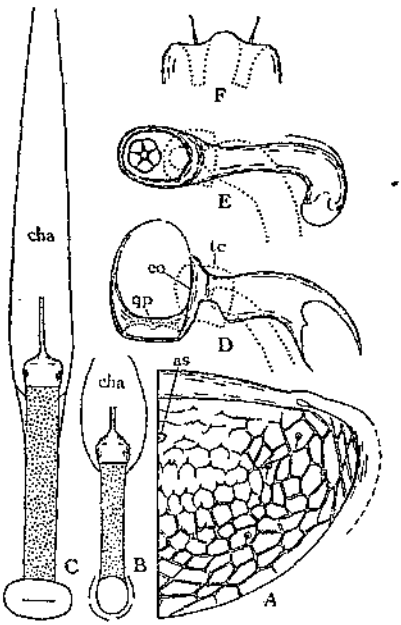

FIGURE 42.—*Platycoccus tylocephalus*, second-stage female: *A*, Anal valve, × 350; *B*, mesal 8-shaped pore, × 3,000; *C*, marginal 8-shaped pore, × 3,000; *D*, mesothoracic spiracle, × 1,000; *E*, metathoracic spiracle, × 1,000; *F*, antenna, × 2,000.

8 single pairs, 1 set of 2 pairs and 5 sets of 3 pairs each, 1 set of 5 pairs (on seventh abdominal segment); 4 pairs on anal valve; in all, 39 pairs present.

Antenna.—Essentially as in *Halimococcus lampas*.

Rostralis.—Not available.

Anal valve.—In younger specimens covering tissue moderately sclerotic, typically spiny mesocephalad, reticulated laterad and caudad; with four pairs of setae of approximately the same size and situated laterad but away from margin. Anus small; distinctly cephalad in position.

Dried material.—Puparium dark brown; naked; decidedly flat but less so than in first stage; dorsal surface sloping gently to meet ventral surface along a sharp line; posterior end pointed nearly straight dorsad.

THIRD-STAGE FEMALE

Not identified.

ADULT FEMALE

(Figs. 43 and 44)

Body.—Segmentation, where obscure, indicated largely by positions of spiracles and setae. A typical specimen 1.3 mm long and 0.56 mm wide.

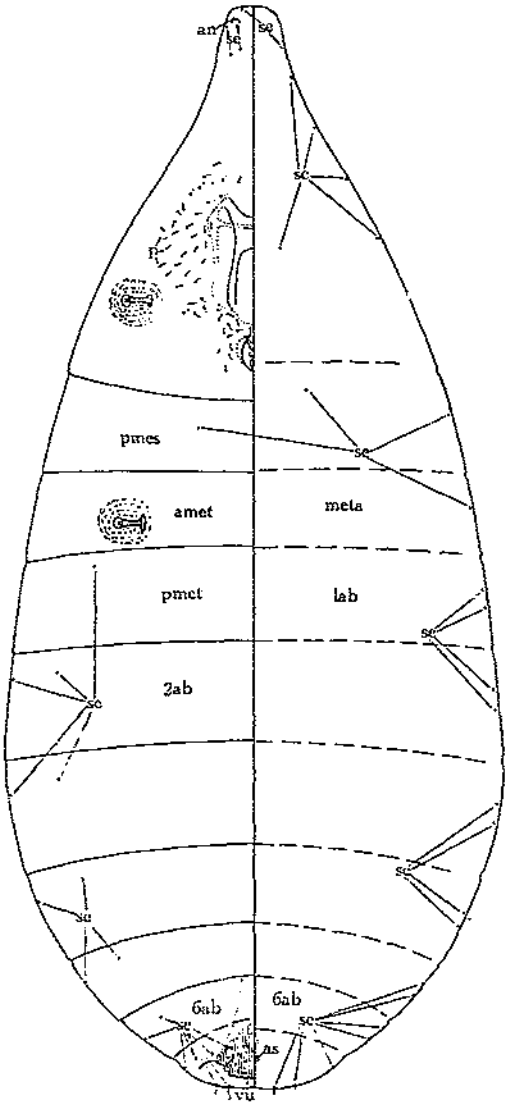

FIGURE 43.—*Platycoccus tylocephalus*, adult female: Body, dorsal and ventral, × 100.

Pores.—8-shaped pores distinct though small; irregularly grouped in general region mesad of mesothoracic spiracles on one side and head skeleton and rostrum on other side; 47 counted on one side of one specimen.

Spiracles.—Surrounding papillae distinctly sclerotic, either broad and shallow, with distinct serrations, or occurring as small spinelike structures, singly or in groups.

Body setae.—All small except on anal segment. Typically with apparently 7 pairs on head; 3 dorsomarginal and 1 dorsomesal pair on prothorax; 1 dorsomarginal, 1 dorsomesal, and 1 ventromesal pair on mesothorax; 1 dorsomarginal and 1 ventrosubmarginal pair on metathorax; 2 dorsomarginal pairs on first abdominal segment; 2 dorsomarginal pairs, 1 ventromarginal, and 1 ventrosubmarginal pair on each of second to seventh abdominal segments, inclusive

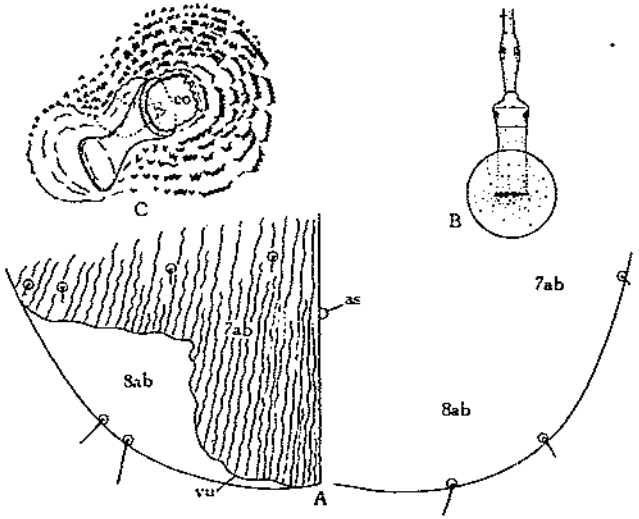

FIGURE 44.—*Platycoccus tylocephalus*, adult female: *A*, Posterior end, dorsal and ventral, × 500; *B*, midventral 8-shaped pore, × 3,000; *C*, metathoracic spiracle, × 500.

and 1 additional ventromesal pair on seventh abdominal segment; 2 dorsomarginal and 2 ventromarginal pairs on anal segment; in all, 47 pairs present.

Antenna.—Essentially as in second-stage female.

Rostralis.—Not available.

Anal segment.—Not clearly delimited on dorsum; with 4 pairs of laterocaudal setae, 2 of which at least are slightly longer than the other body setae; anus cephalad in position.

SECOND-STAGE MALE

(Fig. 45, *A–D*)

Body.—Delicate and inclined to wrinkle, except the five posterior abdominal segments; segmentation of latter distinct on venter, elsewhere obscure. One specimen about 0.47 mm long and 0.22 mm wide.

Pores.—8-shaped pores scattered in general on all body segments caudad to and including the third abdominal segment, but restricted more or less to marginal and submarginal regions of ventral surface on sclerotic posterior end; at least 85 counted on segments cephalad of third abdominal one, typically about 10 pairs

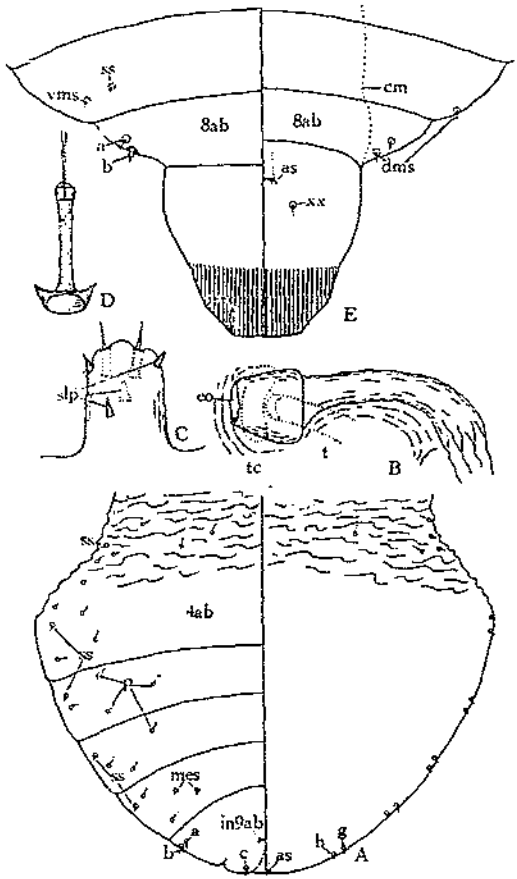

FIGURE 45.—*Platycoccus tylocephalus:* A, Second-stage male, posterior end, dorsal and ventral, × 250; B, same, mesothoracic spiracle, × 1,000; *C*, same, antenna, × 1,500; *D*, same, 8-shaped pore, × 3,000; *E*, fourth-stage male, posterior end, dorsal and ventral, × 400.

on both surfaces of latter, and 2 to 4 pairs each on fourth to seventh abdominal segments, inclusive, and apparently none on anal segment.

Body setæ.—About 6 sets of at least 2 or 3 pairs each on or near margin cephalad of third abdominal segment, including at least 3 and 2 ventromesal pairs on head and thorax, respectively; 3 pairs each on or near margin of third to seventh abdominal segments, inclusive; 2 ventromesal pairs on seventh abdominal segment; 5 pairs on anal segment.

Antenna.—With apparently four minute spinelike setæ and a pair of partially invaginated setæ.

Rostralis.—Not available.

Legs.—Obscure.

Exuviation.—The anterior derm is pushed back caudad against the five sclerotic posterior abdominal segments.

THIRD AND FOURTH MALE STAGES

(Fig. 45, *E*)

Specimens of both stages at hand, but none in sufficiently good condition to determine adequately many of the parts. Fourth stage with stocky posterior projection having slightly curving sides and a rather truncate, characteristically sclerotic apex; with 3 and 4 pairs of setae, marginal or submarginal in position, on seventh and eighth abdominal segments, respectively, and 1 dorsomesal pair on anal segment; legs sharply elbowed; one specimen 0.60 mm long and 0.28 mm wide.

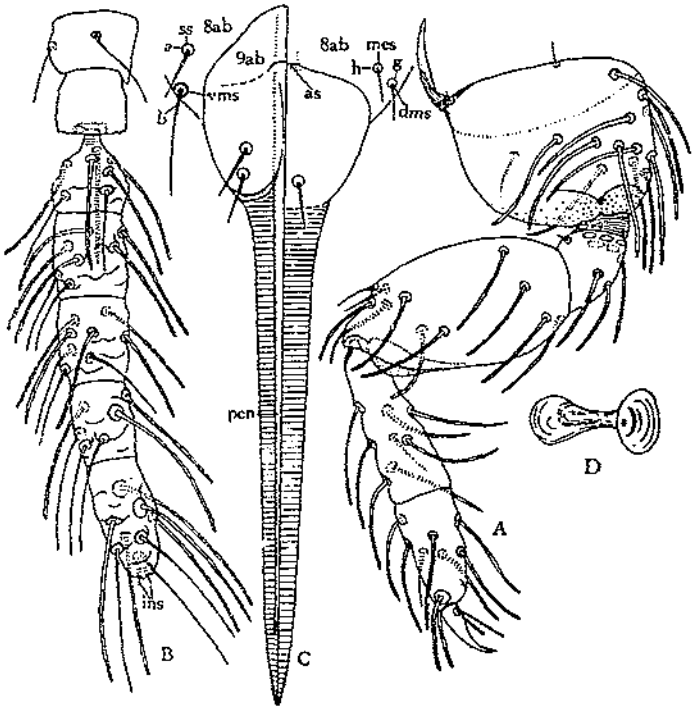

FIGURE 46.—*Platycoccus lytocephalus*, adult male: *A*, Metathoracic leg, × 400; *B*, antenna, × 400; *C*, posterior end, dorsal and ventral, × 400; *D*, mesothoracic spiracle, × 1,000.

ADULT MALE

(Fig. 46)

Body setae.—One comparatively large marginal pair on eighth abdominal segment.

Antenna.—Segments of club compactly joined; their setae irregularly scattered with typically the following slender and fleshy setae, respectively: First segment 2 and 5, second 2 and 5, third 3 and 5, fourth 3 and 3, fifth 3 and 5.

Legs.—Typically with the following number of slender and fleshy setae, respectively, on a metathoracic leg: Coxa 2 and 12, excluding minute basal one; trochanter none and 3, excluding minute basal one; femur 2 and 9; tibia 1 and 7; tarsus 1 and 8; claw 2 rather fleshy setae only.

Genus THYSANOCOCCUS, new genus

FIRST STAGE

Body elongate elliptical; margin firm and may be slightly serrated; caudal margin of abdomen without a bulge; segmentation of head, prothorax, mesothorax, and possibly dorsum of posterior abdominal segments ill defined, elsewhere dis-

tinguishable; posterior end not distinctly sclerotic. 8-shaped pores restricted to marginal and mesal regions of dorsum; majority small but some dorsomesal ones may be comparatively prominent; partitions extending hardly through bars or slightly into tubes; bars usually so closely joined as to be difficult to distinguish apart; bullae generally distinct; external openings situated at apices of distinctly sclerotic conical projections; typically 14 to 19 pairs present. A single quinquelocular pore associated with each mesothoracic spiracle, but no pores associated with metathoracic spiracles. Mesothoracic spiracles deeply invaginated, with granulate tubes connecting them to margin of body; quinquelocular pores either practically flush with surface or slightly invaginated, not within invaginated tubes but situated near external openings of latter and body margin; metathoracic spiracles not invaginated; spiraculariae of each pair more or less sclerotic and may or may not be subequal. Clear area laterad of each metathoracic coxa distinct or apparently absent. Typically 10 or 11 pairs of setae on head, frontal pair between arms of head skeleton absent, and first 3 or 4 ventromesal pairs comparatively prominent; 7 to 9 pairs on prothorax and mesothorax together; 4 to 6 pairs on methathorax; 2 pairs on first abdominal segment; 2 to 4 pairs each on second to fifth, inclusive; 2 to 5 pairs each on sixth and seventh; and 6 pairs on posterior abdominal segment. Antenna of the annulated type; 2 to 4 basal segments plainly distinguishable. Antennal setae occurring typically as follows: 2 slender setae, 1 large and 1 small, on basal segment; 1 large slender seta and a spinelike process on second segment; 1 small slender seta on third segment; 7 fleshy and 3 more slender setae on remainder of antenna; in all, 14 antennal setae present. Rostrum with apparently 3 minute pairs of setae, 2 apical and 1 basal in position; rostralis with a single long caudal loop and the small cephalic loop, when uncoiled within body. Legs moderately slender or inclined to be stout; trochanter and femur, and tibia and tarsus, may or may not be fused. Leg setae occurring typically as follows: Either 3 or 4 on each coxa; 2, 1 a minute basal seta and 1 comparatively long, on trochanter; none, 1, or 2 on femurs either none or 1 on tibia; 3 and a spinelike process on tarsus; 2 on claw. Anu; small but distinct; on or near ventrocaudal margin; anal ring apparently may os may not be present; anal-ring setae absent. In all available specimens malr instar partially puparial.

Second-Stage Female

Body moderately to elongate elliptical; general outline continued more or less evenly around posterior end; segmentation obscure except ventromesally on abdomen and on both surfaces of the 2 or 3 posterior abdominal segments; in younger specimens moderately sclerotic throughout, including anal valve; margin comparatively firm or rigid; dorsal and ventral surfaces meet along a distinct more or less fringed line, which, however, may not extend entirely around margin. Papillae may or may not be in evidence. Dorsum with a partial or almost wholly reticulated surface, or lacking reticulations. 8-shaped pores of the ordinary kind only, or both the ordinary and the variating kinds. The ordinary kind of 8-shaped pore small or moderate in size; partition extending through no more than both bars; latter difficult to distinguish apart; bullae delicate and slender, or more pronounced and broad; external openings surrounded by narrow sclerotic rims, but not on distinctly raised projections. 8-shaped pores scarce or, if moderate in number, largely in rows on or near body margin, especially to be noted being a ventrosubmarginal row curving more or less mesad toward both ends of body. Typically none to 2 subequal quinquelocular pores, noninvaginated in themselves, associated with each mesothoracic but not with metathoracic spiracles. A row of quinquelocular pores, singly or in groups of from 2 to 5, may or may not occur along body margin; when present, with typically 19 to 31 pores on each side of body. Mesothoracic spiracles, with associated quinquelocular pores, within deep, more or less granulate invaginated tubes which open on body margin; metathoracic spiracles open on surface; spiraculariae elongate, distinctly sclerotic, subequal or not subequal. A membranous area for pentration of adult rostralis apparently absent. Body setae comparatively few in number, confined almost wholly to ventral surface except on caudolateral surface of abdomen; typically none to 3 pairs on each body segment except anal valve; in all, 19 to 25 pairs present. Antenna limited to a single sclerotic piece having 1 or 2 large fleshy setae and none or 1 minute surface seta, besides the pair of small setae, which may be wholly or partially invaginated. Apparently 1 or 2 pairs of minute, almost indistinct, apically situated rostral setae present; rostralis with 1 elongate loop and the small cephalic loop or, in addition, with 2 large roundish loops, when uncoiled within body. Anal valve present; with or without

characteristic markings; may or may not posses pores; with 4 to 7 pairs of setae. Anus caudally situated; anal ring apparently may or may not be present, if so, insignificant; anal-ring setae apparently may or may not be present, if so, quite minute. Becomes puparium; moderately or heavily sclerotic on dorsum; lightly sclerotic on venter.

Adult Female

Body moderately or elongate elliptical for the most part, with posterior end projecting slightly; segmentation distinguished on venter caudad of mesothoracic spiracles, and usually on dorsum of the 2 or 3 posterior abdominal segments; membranous except on dorsum of posterior end in both young and older individuals. Papillae practically absent but with numerous irregular rows of small spinelike structures on ventromesal surface of thorax and first 2 or 3 abdominal segments; these hardly more than spicules. 8-shaped pores comparatively small; limited largely to a scattering group on each side of body, either mesad of mesothoracic spiracles or immediately caudad of metathoracic spiracles; partitions extending no more than through bars, which may or may not be difficult to distinguish apart; bullae delicate; external openings may or may not be at apices of sclerotic projections; typically from 4 to 35 present in the group on each side of body. Quinquelocular pores absent. Spiracles flush with surface or in shallow depressions; spiraculariae moderately stout or elongate, strongly sclerotic, subequal or not subequal. Body setae moderately pronounced; absent on dorsum except for none to 2 pairs on head and a single marginal pair each on 1 to 4 of posterior abdominal segments, excluding anal one; on venter, typically none or 1 pair on head, 4 to 6 pairs on thorax, and 13 to 16 pairs on abdomen caudad to and including seventh segment. Antenna essentially as in second-stage female. Rostrum with apparently 1 or 2 pairs of minute more or less apical setae; rostralis with 1 elongate loop and the small cephalic loop or, in addition, with 2 large roundish loops, when uncoiled within body (data not available for one species). Anal segment situated on both surfaces; mostly distinctly sclerotic; with from 2 to 6 pairs of small pores. Delicate plates or squamulae projecting from laterocaudal margin of anal segment may or may not be present; if present, varying somewhat in number, size, form, and position, apparently may possess very delicate and elongate pores. Anal segment with from 4 to 6 pairs of small subequal setae. Anus distinct; apparently with anal ring; apparently 1 pair of minute anal-ring setae may or may not be present.

Second-Stage Male [10]

Body moderately elliptical; segmentation obscure except on ventral surface caudad of metathoracic spiracles; faintly sclerotic throughout, anal segment a little more so than elsewhere. Papillae absent. 8-shaped pores restricted to marginal or submarginal regions of ventral surface; few in number and comparatively small; no partitions apparent through bars; bars difficult to distinguish apart; bullae broad, but delicate; external openings apparently flush with surface but surrounded by sclerotic rims. The asymmetrical type of tubular pore present; restricted to margin and submargin of ventral surface; fairly numerous and prominent; in structure, bar pronounced but slender, external opening moderately expanded and not on a projection but surrounded by a prominent sclerotic rim having an irregular outer border. Quinquelocular pores absent. Spiracular iae distinctly elongate, moderately sclerotic, mesothoracic pair slightly larger than metathoracic pair. Typically with 1 or 2 marginal or submarginal pairs of setae on venter of each body segment except anterior section of mesothorax, which lacks setae, and anal segment, which possesses 5 pairs; with 3 or 4 pairs each of ventromesal and dorsomarginal setae; with about 9 pairs of dorsomesal setae; all body setae subequal except 1 pair on anal segment. Antenna occurring as a rounded tubercle, with 1 prominent fleshy seta and several minute setae. Rostral setae obscure; rostralis with 1 elongate loop and the characteristic small cephalic loop, when uncoiled within body. Vestigial legs may be in evidence. Anus small, near dorsocaudal margin; anal ring apparently absent.

[10] Data available from one species only.

Adult Male [11]

Body elongate elliptical, with posterior end occurring as a fairly large, moderately slender rapierlike projection. Vestiges of thoracic wing framework and wings apparently absent. Spiraculariae rather elongate, moderately sclerotic, subequal. Three pairs of setae on eighth abdominal segment and 4 pairs on anal segment. Antenna appreciably elongate; with 2 subequal stocky basal segments and a club with 8 segments, the apical one elongate and twice the length of some, but not of all, the other club segments; first basal segment with 2, second with 3, rather small slender setae, and each segment of club with from 4 to 6 rather fleshy, mostly moderate-sized setae; the 2 basal antennal segments bare of spicules, but each segment of club with numerous whorls of them. With 2 pairs of eyes, 1 marginal in position, the other, distinctly smaller, located on ventral surface. Apparently a vestige of head skeleton occurring as a differentiated area on ventromeson; invagination to alimentary tube in evidence. Rostrum apparently absent. Metathoracic legs moderately larger than mesothoracic pair, which in turn are slightly larger than prothoracic legs; tibiae of all 3 pairs distinctly longer than tarsi, tibiae and tarsi rather stocky, each with a fair number of rather long, slender, irregularly scattered, spinelike setae and a number of whorls of spicules; latter apparently scarce if not practically absent from the other segments; apparently no definite sensory areas present on any segment.

Type of genus, *Thysanococcus chinensis*, new species.

Keys to Species of Thysanococcus

First stage

a. Dorsomarginal setae present on third to sixth abdominal segments, inclusive; the 4 basal antennal segments rather clearly defined, with remainder of antenna strongly annulated; no setae on femur or tibia.
  b. With 1 pair of dorsomesal 8-shaped pores on caudal margin of head and on dorsum of each of first and seventh abdominal segments distinctly larger than other 8-shaped pores; mesothoracic quinquelocular pores situated immediately dorsad of external openings of invaginated tubes leading to spiracles; with spiracular invaginated tubes gently curving; with only one row of ventromarginal or submarginal setae on abdomen. **chinensis**, new species.
  bb. All 8-shaped pores subequal; mesothoracic quinquelocular pores located cephalad of external openings of invaginated tubes leading to spiracles; with spiracular invaginated tubes practically straight; with two rows of ventromarginal or submarginal setae on abdomen.
    c. Mesothoracic quinquelocular pores moderate in size, with even margins; spiracular invaginated tubes comparatively broad throughout; with a conspicuous broad rounded granulate area on body margin immediately dorsad of each spiracular invaginated tube; trochanter and femur and also tibia and tarsus of each leg fused---------- **squamulatus**, new species.
    cc. Mesothoracic quinquelocular pores comparatively large, with distinctly indented margins; spiracular invaginated tubes more or less club-shaped; no distinct differentiated area near each spiracle; no leg segments fused---------- **calami**, new species.
aa. Dorsomarginal setae absent on third to sixth abdominal segments, inclusive; only 2 basal antennal segments clearly defined, remainder of antenna weakly annulated; usually with 2 pairs and always with at least 1 pair of setae on each femur and usually 1 pair on each tibia. **pandani**, new species.

Second-stage female

a. Dorsum largely covered with a number of scattered, distinct, mostly blunt papillae; antenna with two comparatively prominent fleshy setae. **chinensis**, new species.
aa. Dorsum without papillae or other sculpturing, or covered either largely with pronounced reticulations alone or partly with reticulations and partly with spiny areas; antenna with only one comparatively prominent fleshy seta.

[11] Available material not in condition to furnish full data for any species.

b. Dorsum with reticulations only; with a row of 8-shaped pores having single bars with flaring or folded-up sides, and bars, tubes, and bullae about equally sclerotic, along body margin; marginal quinquelocular pores absent---------- **squamulatus, new species.**

bb. Dorsum with reticulations and spiny areas or without any noticeable configurations; no 8-shaped pores as described above; marginal quinquelocular pores present.

c. Dorsum with reticulations and a large reniform area in center of each side covered with long, curving, strongly sclerotic spines; body margin nearly even all around; all setae of anal segment no more than moderate in size---------- **pandani, new species.**

cc. Dorsum without any particular sculpturing; body margin with irregular pronounced indentations; anal segment with one pair of unusually prominent setae---------- **calami, new species.**

ADULT FEMALE

a. 8-shaped pores confined largely to a cluster on each side of body caudad of metathoracic spiracles; no forked setae on anal segment.

b. 8-shaped pore cluster on posterior section of metathorax and second and third abdominal segments; antenna with two comparatively prominent fleshy setae---------- **chinensis, new species.**

bb. 8-shaped pore cluster not reaching to third abdominal segment; antenna with only one comparatively prominent fleshy seta.

c. 8-shaped pore cluster practically limited to posterior section of metathorax; from 4 to 12 8-shaped pores in the cluster on each side of body; with marginal plates or squamulae on anal segment. **squamulatus, new species.**

cc. 8-shaped pore cluster on posterior section of metathorax and second abdominal segment; typically with more than 20 8-shaped pores in the cluster on each side of body; anal segment without plates or squamulae---------- **calami, new species.**

aa. 8-shaped pore cluster situated mesad of mesothoracic and cephalad of metathoracic spiracles; marginal setae on anal segment typically forked. **pandani, new species.**

THYSANOCOCCUS CHINENSIS, new species

Material from E. O. Essig, collected at Yenping, China, in 1925, exposed on pinnae of *Calamus* sp.

EGG

Not identified.

FIRST STAGE

(Figs. 47 and 52, *B*)

Body.—Entire margin slightly serrated; segmentation of head, thorax, and posterior abdominal segments ill defined. Delicate pair of furcae on venter between mesothorax and metathorax. Distinct clear area laterad of each metathoracic coxa. A typical newly hatched specimen 0.32 mm long and 0.15 mm wide; a fully developed female 0.47 mm long and 0.25 mm wide.

Pores.—8-shaped pores differing in size; partitions apparently extending very slightly into tubes; bars difficult to distinguish apart; bullae distinct. Typically 2 marginal pairs of 8-shaped pores on head caudad of eyes; 1 marginal pair each on posterior section of mesothorax, metathorax, and second to sixth abdominal segments, inclusive; 1 comparatively large dorsomesal pair on or near suture between head and prothorax; 1 dorsomesal pair each near caudal margin of posterior section of mesothorax and metathorax; 1 comparatively large dorsomesal pair situated slightly laterad on each of first and seventh abdominal segments; in all, 14 pairs present. One moderate-sized quinquelocular pore, very slightly if at all invaginated, present immediately dorsad of external opening of invaginated tube of each mesothoracic spiracle.

Spiracles.—Mesothoracic tubes connecting spiracles to exterior long, usually gently curving, and with external openings of tubes on distinct marginal protuberances; spiraculariae elongate, distinctly sclerotic, subequal. No definite differentiated area along margin in neighborhood of mesothoracic invaginated tubes.

Body setae.—Typically 6 marginal, 4 ventromesal, and 1 dorsomesal pair on head; 9 marginal, 3 dorsomesal, and 2 prominent ventromesal pairs on thorax; 1 marginal and 1 mesal pair each on dorsum of first to seventh abdominal segments, inclusive; 1 ventrosubmarginal pair each on second to seventh abdominal segments, inclusive; 1 ventromesal pair on seventh abdominal segment; 6 pairs on posterior abdominal segment; in all, 52 pairs present. One marginal pair each on metathorax and posterior segment of abdomen; all ventrosubmarginal and ventromesal abdominal pairs very small. In one specimen, outer and inner long caudal setae 41 and 156 microns long, respectively.

Antenna.—With two relatively prominent basal segments, next two small but rather well defined, fifth segment ill defined, remainder of antenna sharply annulated.

Rostralis.—In one typical specimen, 0.73 mm long.

Legs.—Neither trochanter and femur nor tibia and tarsus fused; femur moderately stout; tarsus rather short. With 4 setae, including minute basal one, on each coxa; no seta on femur or tibia.

Anal ring.—May be present; if so, narrow and insignificant.

Exuviation.—In female the split occurring submarginally on ventral surface caudad of antennae; usually 1 or 2 pairs of legs pushed back toward posterior end, head skeleton and 1 pair of legs, apparently the metathoracic ones, remaining undisturbed.

Dried material.—New individuals decidedly flat, light or pale brown; old ones not so flat, dark brown; both distinctly oval; upper and lower surfaces meeting in sharp line; dorsomedian line carinate; naked in appearance.

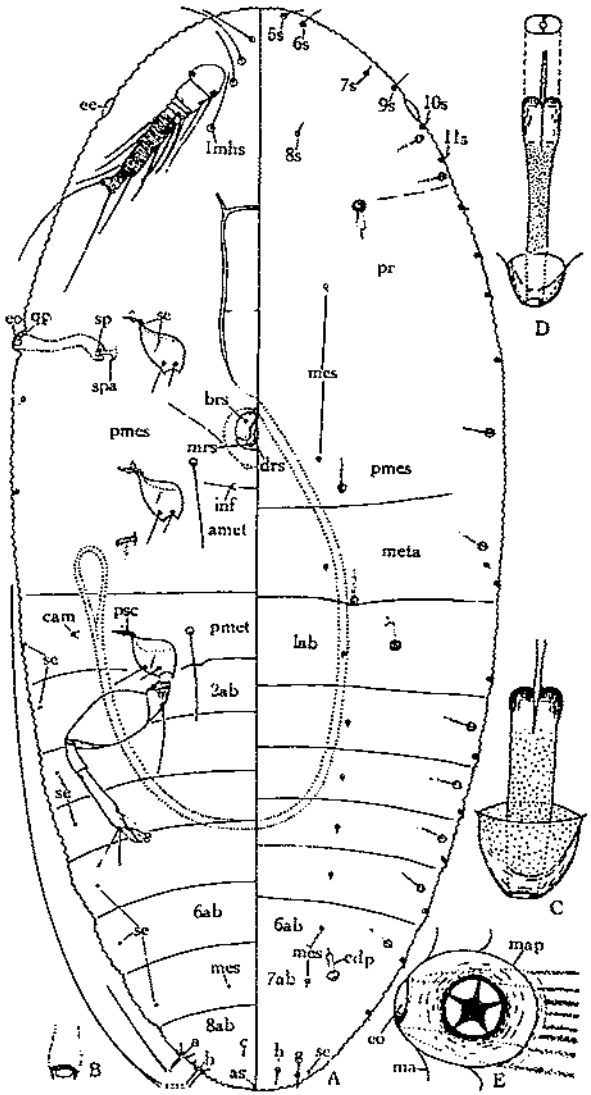

FIGURE 47.—*Thysanococcus chinensis*, first-stage nymph: *A*, Body, dorsal and ventral, × 450; *B*, anus, × 1,500; *C*, caudodorsal 8-shaped pore, × 3,000; *D*, marginal 8-shaped pore, × 3,000; *E*, mesothoracic quinquelocular pore, dorsal, × 2,000.

SECOND-STAGE FEMALE

(Figs. 48 and 49)

Body.—Moderately elliptical; slightly more sharply curved along cephalic than along caudal margin. Marginal fringe distinct; extending entirely around mar-

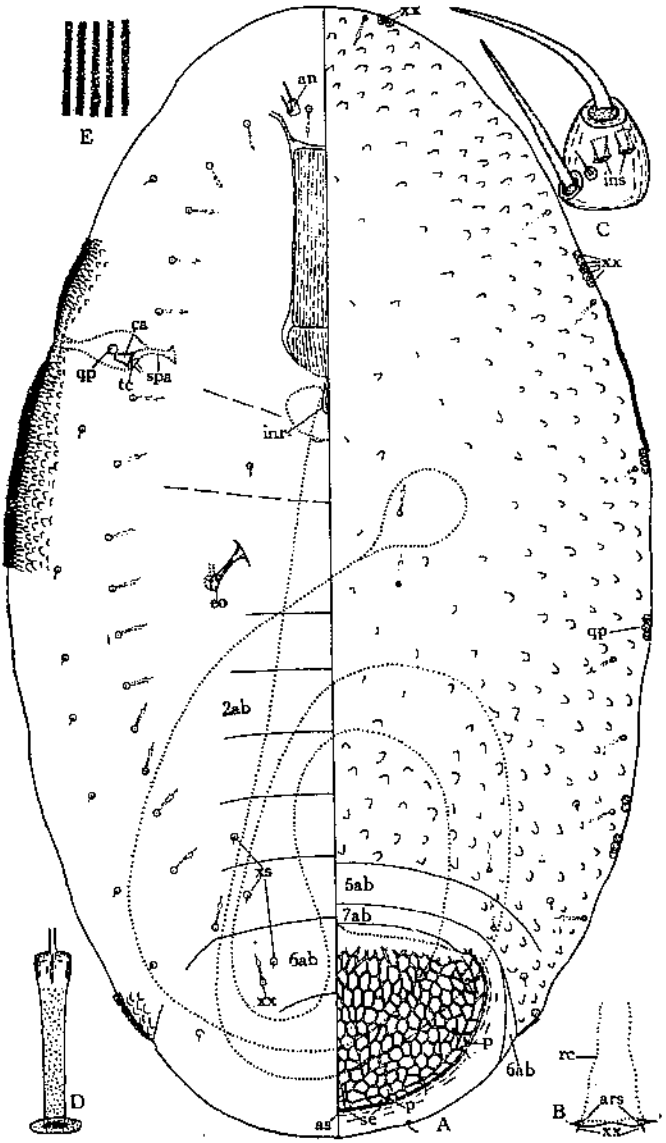

FIGURE 48.—*Thysanococcus chinensis*, second-stage female: *A*, Body, dorsal and ventral (marginal fringe indicated only in sections), × 350; *B*, anus, × 1,500; *C*, antenna, × 2,000; *D*, submarginal 8-shaped pore, × 3,000; *E*, looking down on fringe, × 1,500.

gin except on sixth and seventh abdominal segments; more pronounced ventrally than dorsally; occurring in about five parallel bands, appearing granular when one is looking straight down, or like a stiff brush of cilia when viewed laterally. Ventromarginal surface thickly covered with characteristic laterally directed,

stout, blunt papillae, which end rather abruptly submarginally; entire dorsal surface with a number of scattered distinct, blunt papillae, less numerous mesally in central region of body than along margin. Puparium moderately sclerotic on dorsum. A typical newly molted specimen 0.42 mm long and 0.23 mm wide; a puparium 0.52 mm long and 0.35 mm wide.

Pores.—8-shaped pores moderate in size; of the ordinary kind only; occurring singly and spaced rather regularly in rows, marginally on dorsum and submarginally on venter; bullae delicate; external openings delicate and flush with surface; a typical specimen having on one side of body 8 dorsomarginal, 4 dorsomesal, and 18 ventrosubmarginal pores. Typically with 1 quinquelocular pore associated with each mesothoracic spiracle. Typically with from 6 to 8 groups of quinquelocular pores of from 1 to 5 in each group along body margin; groups not always clearly defined; 19 pores on one side of one specimen.

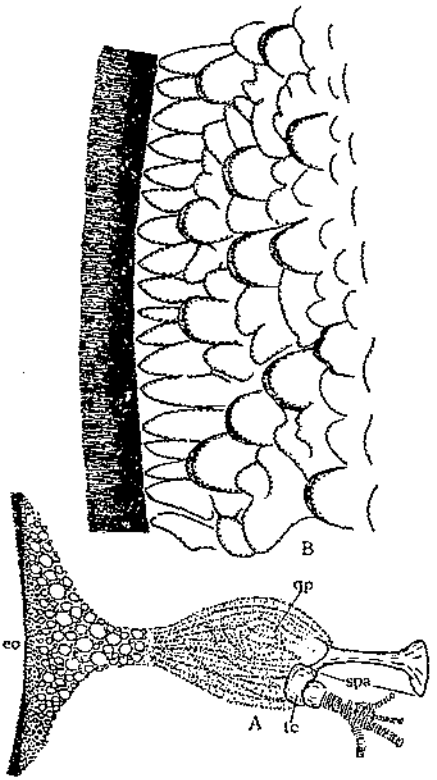

FIGURE 40.—*Thysanococcus chinensis*, second-stage female: *A*, Mesothoracic spiracle, × 1,600; *B*, marginal fringe, ventral, × 2,600.

Spiracles.—Invaginated tubes leading to mesothoracic spiracles bulbous mesally, somewhat constricted toward margin, against which they broadly expand; mesal part of tubes faintly granulate, remainder coarsely granulate; an irregularly formed clear area sometimes observed in bulbous part of a tube, possibly an opening into latter; spiraculariae subequal.

Body setae.—Comparatively prominent. Apparently none on head; 1 ventrosubmarginal pair each between antennae and mesothoracic spiracles and on the 8 consecutive segments caudad of latter; 1 pair on or near caudal margin of seventh abdominal segment; 1 ventromesal pair near rostrum and on each of fourth, fifth, and sixth abdominal segments; 1 dorsosubmarginal pair each on third, fourth, and fifth abdominal segments; 6 pairs on anal valve; in all, 23 pairs present.

Antenna.—Typically with a comparatively large fleshy apical seta, a smaller fleshy basal seta, 1 minute slender surface seta, and 1 pair of small, almost but not quite wholly invaginated, spinelike setae.

Rostralis.—With 1 elongate loop, 2 large roundish loops, and the characteristic small cephalic loop, when uncoiled within body; in one specimen, 2.3 mm long.

Anal valve.—Covering tissue reticulate; apparently 2 pairs of minute pores and 6 pairs of setae along caudal and lateral margins; anus distinct, on caudal margin; anal ring, if present, narrow; apparently a very minute pair of anal-ring setae present.

Dried material.—Puparium dull black above, rich brown around margin, naked, slightly dome-shaped; derm sloping evenly to margin, dorsal and ventral surfaces meeting along a sharp line; posterior end pointed dorsocaudad.

THIRD-STAGE FEMALE

(Fig. 50, *D*)

Distinct; moderately elliptical; derm membranous. With about 7 pairs of strongly sclerotic blunt tubercles spaced rather regularly around margin; their number and positions varying to some extent; an occasional one present elsewhere on body.

ADULT FEMALE

(Fig. 50, *A–C*)

Body.—Moderately elliptical, with posterior end projecting slightly and broadly. Dorsal sclerotization of posterior end covering anal segment and apparently at least part of mesal region of seventh abdominal segment. A typical specimen 0.48 mm long and 0.32 mm wide.

Pores.—8-shaped pores mostly restricted to a loose cluster on each side of body on three segments immediately caudad of metathoracic spiracles; partitions extending only through both bars; bars rather easily distinguished apart; external openings at apices of sclerotic projections; typically about 27 present in the cluster on each side of body.

Spiracles.—Spiraculariae rather elongate, subequal.

Body setae.—Typically 1 pair on head; 2 pairs each on posterior section of mesothorax and anterior section of metathorax; 1 pair on posterior section of metathorax; 3 pairs each on second and third abdominal segments; 4 pairs each on fourth, fifth, and sixth abdominal segments; 1 pair on seventh and 6 pairs on anal segment; in all, 31 pairs present; 1 or all 3 dorsomarginal pairs on the posterior segments and 1 or 2 ventromesal pairs on abdomen may be absent.

Antennae.—Essentially as in second-stage female, that is, with 2 prominent fleshy setae, a minute seta, and 2 small invaginated setae.

Rostralis.—With 1 elongate loop, 2 large round loops, and the small cephalic loop, when uncoiled within body; in one typical specimen, 2.8 mm long.

Anal segment.—Caudal margin nearly smooth; typically with four 8-shaped pores and 5 pairs of subequal setae along laterocaudal margin; anus centrally located; with apparently a small anal ring and 1 minute pair of anal-ring setae.

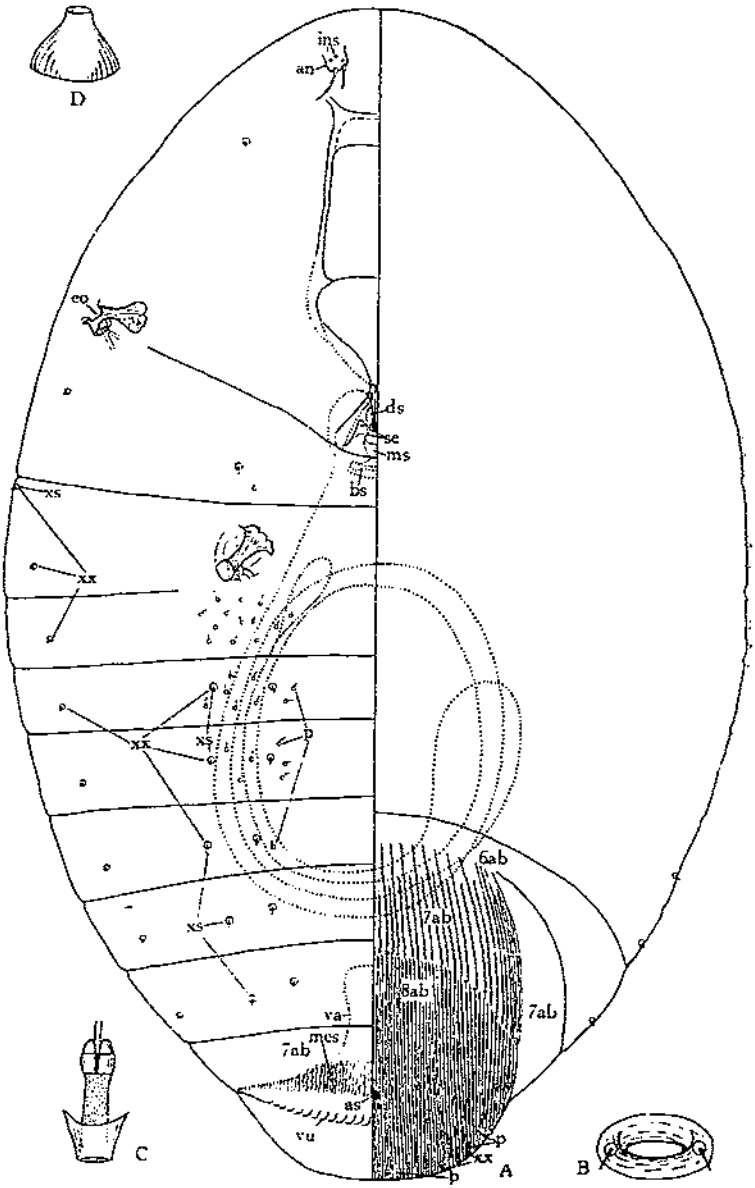

FIGURE 50.—*Thysanococcus chinensis: A*, Adult female, body, dorsal and ventral, ×300; *B*, same, anal ring, × 1,500; *C*, same, mid ventral 8-shaped pore, × 3,000; *D*, third-stage female, marginal tubercle, × 1,500.

MALE STAGES

Not available.

THYSANOCOCCUS PANDANI, new species [12]

Material from E. E. Green, from Buitenzorg, Java; C. L. Marlatt and A. Zimmermann on *Pandanus* sp., United States Bureau of Entomology; 2 lots from Buitenzorg, Java, 1 on *Pandanus* sp. (1901) collected by C. L. Marlatt, the other on *Pandanus tectorius*, received

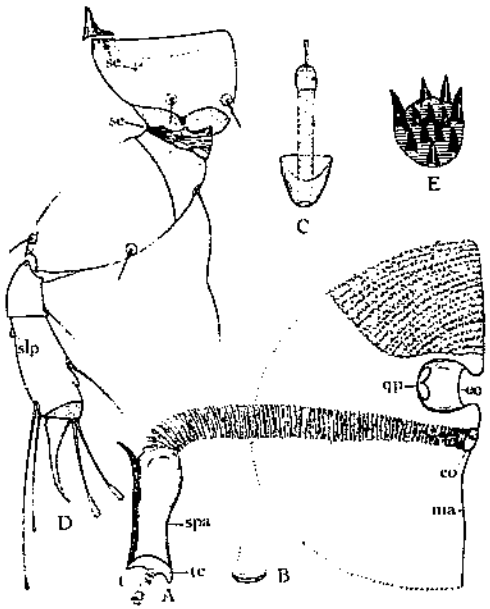

FIGURE 51.—*Thysanococcus pandani*: *A*, First-stage nymph, mesothoracic spiracle, showing full outline, but details of only a portion of dorsal sclerotic area, × 2,000; *B*, same, anus, × 1,500; *C*, same, 8-shaped pore, × 3,000; *D*, same, metathoracic leg, × 1,000; *E*, egg, spine group, × 1,500.

at quarantine, Washington, D.C., in 1920, collected by W. S. Fisher, United States Bureau of Entomology, 2 lots from Botanic Gardens, Singapore, 1 on *Pandanus utilis* (1917), the other on *Pandanus penangensis* (1917), both collected by C. F. Baker. Specimens in all these lots were exposed either on leaves or on what appeared to be the fruit.

EGG

(Fig. 51, *E*)

Oviparous. With a group of 8 to 12 spines, moderately spaced and varying distinctly in size of groups and of individual spines; sclerotic body derm extending appreciably around spines.

[12] The specific name is taken from the record one originally assigned to this insect by E. E. Green.

FIRST STAGE

(Figs. 51, *A–D*, and 52, *A*)

Body.—Margin serrated, but less so than in *Thysanococcus chinensis;* segmentation of head, prothorax, and mesothorax ill defined, elsewhere more distinct. Clear area laterad of each metathoracic leg apparently present but delicate. A typical newly hatched specimen 0.32 mm long and 0.19 mm wide; a fully developed female 0.57 mm long and 0.37 mm wide; male puparium typically 0.53 mm long and 0.29 mm wide.

Pores.—All 8-shaped pores approximately alike in size but comparatively small; partitions distinguishable through bars but apparently absent from tubes; bars difficult to distinguish apart; bullae delicate. 8-shaped pores differing from those of *Thysanococcus chinensis* as follows: 1 of the 2 marginal pairs on head located cephalad of eyes; 3 marginal pairs on thorax; 2 marginal pairs apparently on first abdominal segment; second, third, and fourth abdominal segments usually, though not always, without a marginal pair each; 1 dorsomesal pair on second but not on first abdominal segment; in all, 15 8-shaped pores present. The quinquelocular pore associated with each mesothoracic spiracle of moderate size, slightly invaginated, and situated cephalad of invaginated tube leading to spiracle.

Spiracles.—External openings of invaginated tubes leading to mesothoracic spiracles distinct, and not on marginal protuberances. Invaginated tubes relatively straight over their greater length, apparently faintly ridged. A rather large usually sub-semicircular granulate area bordering dorsal margin immediately dorsad of each invaginated tube. Mesothoracic spiraculariae frequently pointed caudocephalad; both pairs elongate, moderately sclerotic, subequal.

Body setae.—Essentially as in *Thysanococcus chinensis*, with the following typical variations: Apparently 6 instead of 9 marginal pairs on segments of thorax; apparently no marginal pairs on second to sixth abdominal segments, inclusive; no dorsomesal pair on seventh abdominal segment; in all, 43 pairs present. In one specimen outer and inner long caudal setae 31 and 43 microns long, respectively.

Antenna.—Differing from that of *Thysanococcus chinensis* chiefly in having only the two basal segments well defined and in having fewer and less distinct annulations on apical part; setae differing in size and position, but all readily homologized with those of *Thysanococcus chinensis.*

Rostralis.—In three typical specimens, 0.46, 0.48, and 0.49 mm long.

Legs.—Relatively stout; no fusion of any segments. Four setae, including minute basal one, on each coxa; 2 setae on femur; 1 seta in tibia. One seta each on coxa, femur, and tibia sometimes absent from leg.

Anal ring.—Essentially as in *Thysanococcus chinensis.*

Exuviation.—In both sexes head skeleton and rostrum drop down caudad; usually observed in an inverted position; ventral skin does not roll back, but remains in position and splits on ventrosubmarginal surface; subsequent male instars may or may not remain within skin. In female second instar normally remains within first-stage skin, and with increasing rotundity merely lifts up dorsal part of skin.

Dried material.—Similar to that of *Thysanococcus chinensis* except for a narrow fringe of wax frequently observable around margins.

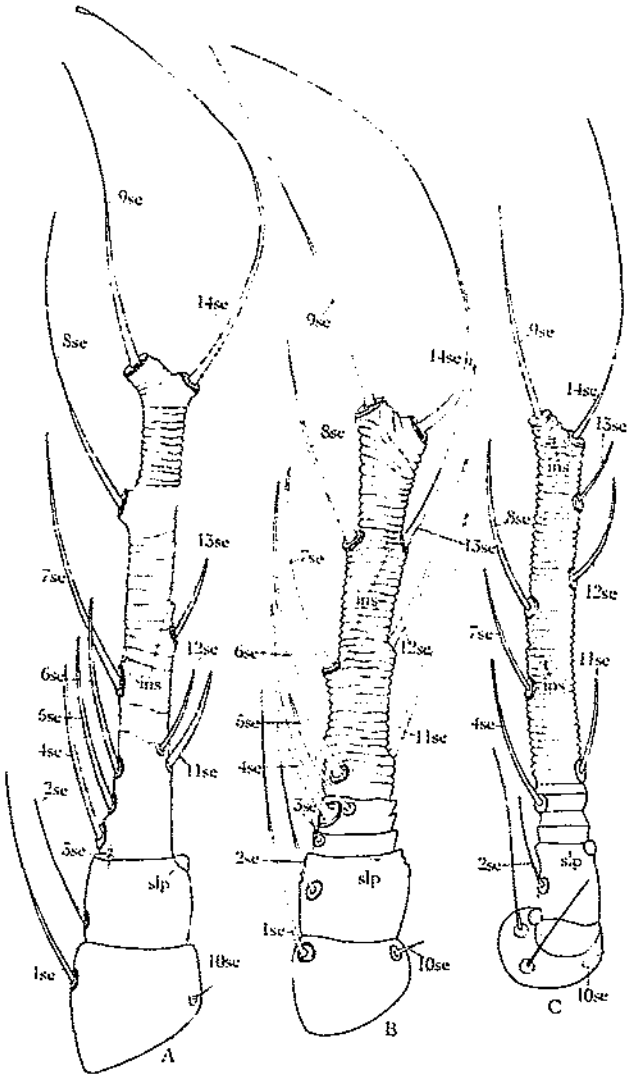

FIGURE 52.—Antennae of first-stage nymphs; *A*, *Thysanococcus pandani*; *B*, *T. chinensis*; *C*, *Aspidiotus* sp. × 1,500.

SECOND-STAGE FEMALE

(Fig. 53, *A–G*)

Body.—Moderately elliptical, with caudolateral margins very slightly concave in both young and old specimens. Marginal fringe distinctly less pronounced than in *Thysanococcus chinensis*, appearing hardly more than as fine granulations. Ventral submarginal surface coarsely granulate in irregular connected chains; dorsal surface reticulated around margins and mesally, leaving a central somewhat reniform area on each side, covered with long, slender, curving sclerotic projections. Puparium moderately sclerotic on dorsum. A typical newly molted

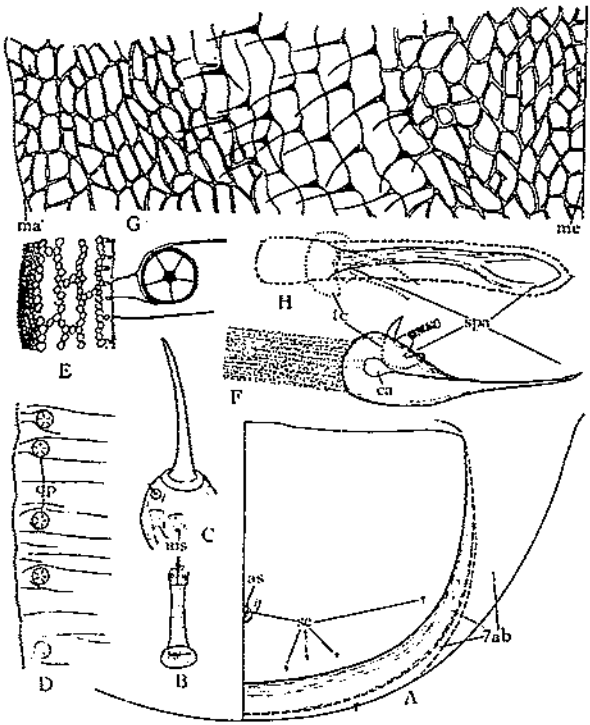

FIGURE 53.—*Thysanococcus pandani*: *A*, Second-stage female, posterior end, dorsal, × 500; *B*, same, 8-shaped pore, × 3,000; *C*, same, antenna, × 2,000; *D*, *E*, same, fringe, ventral; *D*, × 550, *E*, × 2,000; *F*, same, mesothoracic spiracle, showing only basal part of granulate invagination, × 1,000; *G*, same, section through dorsum, from margin to mesal line, × 500; *H*, second-stage male, mesothoracic spiracle, × 1,000.

specimen 0.46 mm long and 0.28 mm wide; a puparium 0.54 mm long and 0.33 mm wide.

Pores.—8-shaped pores comparatively small; of ordinary kind only; one side of a typical specimen with 2 mesal pairs on head, 1 dorsomesal pair each on fourth, fifth, and sixth abdominal segments, 13 ventrosubmarginal pairs relatively evenly spaced from head to and including sixth abdominal segment, and 2 more or less ventromesal pairs on sixth abdominal segment; in all, 20 pairs present. No quinquelocular pores associated with spiracles. On one side of a typical specimen 22 quinquelocular pores counted along margin from and including head to and including sixth abdominal segment; usually occurring singly, sometimes in pairs; rather evenly spaced.

Spiracles.—Invaginated tubes of mesothoracic spiracles extending relatively straight from latter to near body margin, against which they broadly expand; tubes finely granulate near spiracles, but coarsely granulate in their expansions near body margin, which is distinctly indented here. Mesothoracic spiraculariae larger than metathoracic pair; both pairs tapering mesally and bulbous around spiracles.

Body setae.—Essentially as in *Thysanococcus chinensis* except smaller, and ventromesal pair apparently absent from fourth abdominal segment; ventrosubmarginal setae interspersed with 8-shaped pores of this region.

Antenna.—Essentially as in *Thysanococcus chinensis* except for absence of the basal fleshy seta.

Rostralis.—With one elongate loop and the characteristic small cephalic loop, when uncoiled within body; in one specimen, 0.99 mm long.

Anal valve.—Covering tissue distinctly sclerotic, with markings obscure; pores apparently absent; with four minute pairs of setae near laterocaudal margins; anus small but with some thickened tissue around it; anal ring probably present; apparently with a pair of minute anal-ring setae.

Dried material.—Puparium dark brown at first, turning rather shiny black later; naked except for a fringe of whitish wax usually around margins; dorsum dome-shaped, sloping evenly to margin, the two surfaces meeting in a sharp line; posterior end pointed straight dorsad; first-stage exuvia covering dorsal surface.

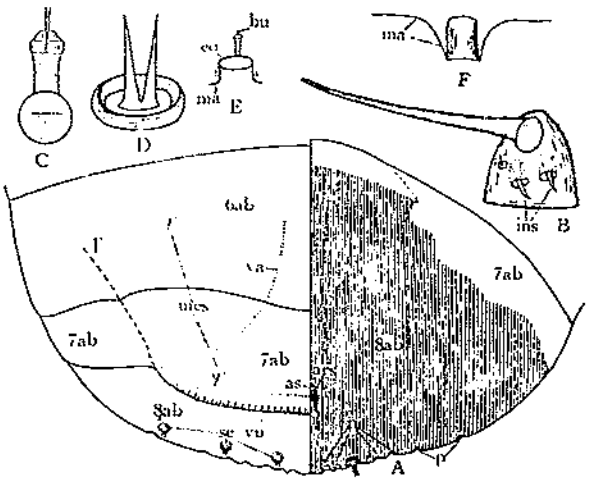

FIGURE 54.—*Thysanococcus pandani: A*, Adult female, posterior end, dorsal and ventral, × 500; *B*, same, antenna, × 2,000; *C*, same, mid-ventral 8-shaped pore, × 3,000; *D*, same, posterior marginal seta, × 3,000; *E*, same, posterior marginal 8-shaped pore, × 3,000; *F*, third-stage female, marginal tubercle, × 1,500.

THIRD-STAGE FEMALE

(Fig. 54, *F*)

Distinct; body moderately elliptical; derm membranous. A row of tubercles around margin, distributed much as in *Thysanococcus chinensis*, but in structure blunter, more or less cylindrical, and typically in pronounced depressions of body derm; 35 counted on one side of one specimen. Thin spots to accommodate 8-shaped pores of preceding instar present along ventrosubmargin. A pair of delicate spots on head, possibly extreme vestiges of antennae.

ADULT FEMALE

(Fig. 54, *A–E*)

Body.—Moderately elliptical, with posterior end projecting less than in *Thysanococcus chinensis;* segmentation on dorsum obscure, even that between seventh abdominal and anal segments; typically a pronounced suture or depression extending from meson immediately caudad of rostrum toward each mesothoracic spiracle. Dorsal sclerotization of posterior end apparently covering anal segment and much of seventh abdominal segment; indistinctly defined along its cephalic border. A typical specimen 0.48 mm long and 0.28 mm wide.

Pores.—8-shaped pores confined largely to region between mesothoracic spiracles and head skeleton; a pair usually present immediately cephalad of metathoracic spiracles; partitions apparently extending through both bars; bars distinguished apart with difficulty; external openings not on sclerotic projections, flush with surface, and much expanded; 22 counted in the cluster on one side of one specimen.

Spiracles.—Spiracularlae moderately stout; mesothoracic pair in a distinct but shallow depression and slightly larger than metathoracic pair.

Body setae.—In distribution essentially as in *Thysanococcus chinensis,* with the following variations: 3 dorsomarginal pairs on posterior abdominal segments and 1 mesal pair each on second, third, and fourth abdominal segments more frequently absent in this species; typically 2 ventromesal pairs instead of 1 on posterior section of mesothorax, and 1 ventromesal pair on corresponding section of metathorax instead of none; 4 instead of 6 pairs on anal segment; in all, 23 or 24 pairs present.

Antenna.—With 1 single long fleshy seta, 1 partially invaginated pair, and 1 minute slender surface seta.

Rostralis.—With one elongate loop and the small cephalic loop, when uncoiled within body. In one specimen, 1.3 mm long.

Anal segment.—Caudal margin slightly indented at external openings of about 6 pairs of minute pores; typically 4 pairs of short, delicate forked setae along caudal margin, 1 pair slightly more pronounced in size and sclerotization than the others.

SECOND-STAGE MALE

(Figs. 53, *H,* and 55)

Body.—Anterior and posterior ends about equally rounded; margin firm. Suture between seventh abdominal and anal segments obscure. A typical specimen 0.44 mm long and 0.25 mm wide.

Pores.—Both 8-shaped and asymmetrical pores present, intermingling and occurring more or less singly in a pronounced row entirely around the body, except possibly in mesocephalic region of head. On one side of one typical specimen with two 8-shaped pores cephalad of antenna and mesothoracic spiracle, and 1 each on posterior section of mesothorax, each section of metathorax, and second and third abdominal segments; on same side with 4 asymmetrical pores cephalad of antenna, 15 between antenna and mesothoracic spiracle, 14 between spiracles, 7 between metathoracic spiracle and second abdominal segment, 2 each on second and sixth, 1 each on third, fourth, and fifth, and 5 on the 2 posterior abdominal segments; in all, seven 8-shaped and 52 asymmetrical pores present on one side.

Spiracles.—Each mesothoracic spiracularia in a distinct but shallow depression.

Body setae.—All subequal except a marginal pair on anal segment, which are noticeably larger than the others. Typically 5 pairs on head; 1 ventromarginal pair each on prothorax, posterior section of mesothorax, and each section of metathorax; 1 ventromarginal pair each near margin of second to seventh abdominal segments, inclusive; 1 ventromesal pair each on fifth, sixth, and seventh abdominal segments; 1 dorsomarginal pair each on mesothorax, metathorax, and first, sixth, and seventh abdominal segments; 1 dorsomesal pair each on metathorax and first to sixth abdominal segments, inclusive; 5 pairs on anal segment; in all, 38 pairs present.

Antenna.—Typically with 1 large fleshy seta, 3 minute spinelike setae, and 1 pair of apparently partially invaginated setae.

Rostralis.—In one specimen, 0.58 mm long.

Legs.—Distinguishable but vestigial.

Exuviation.—Derm pushed back toward posterior end.

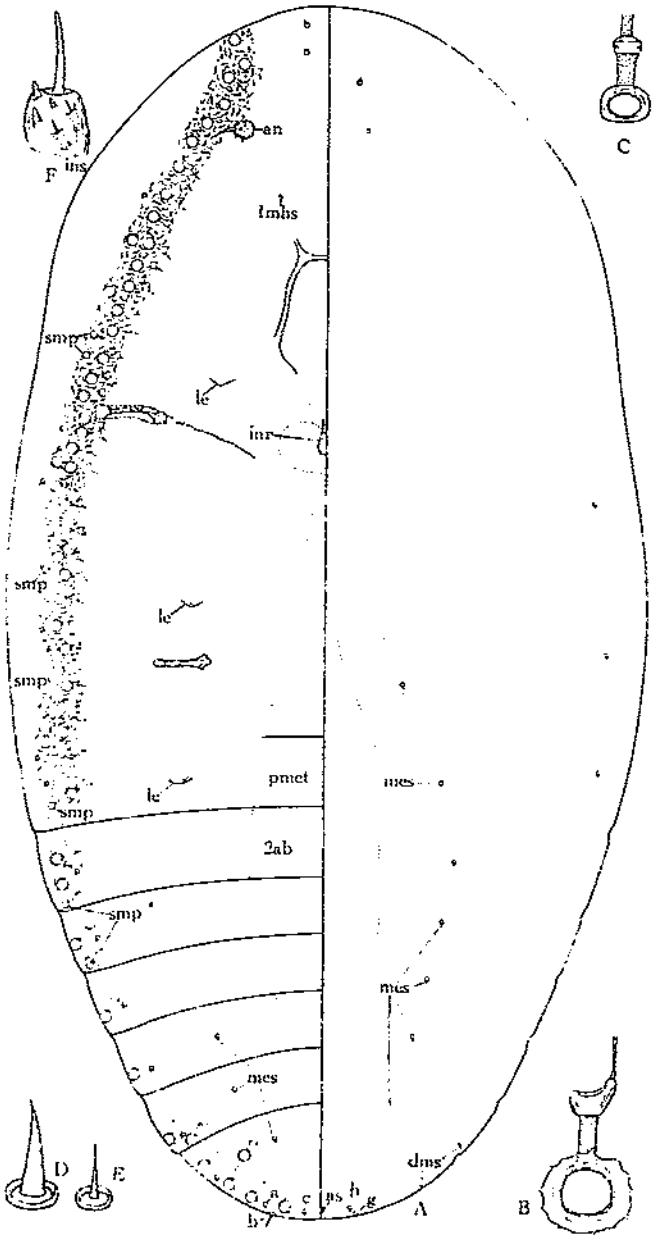

FIGURE 55.—*Thysanococcus pandani*, second-stage male: *A*, Body, dorsal and ventral, × 350; *B*, large submarginal pore (asymmetrical), × 3,000; *C*, small submarginal pore (presumably 8-shaped), × 3,000; *D*, large ventrocaudal seta, × 2,000; *E*, dorsocaudal seta, × 2,000; *F*, antenna, × 2,000.

THIRD-STAGE MALE

(Fig. 56, *H*)

Available material not in condition to distinguish many of the parts adequately, except on posterior end. Body moderately elliptical. One dorsosubmarginal pair of setae on metathorax and each abdominal segment; 1 ventrosubmarginal pair each on fifth, sixth, and seventh abdominal segments; 1 marginal pair on sixth and 2 marginal pairs on seventh abdominal segment; 5 pairs, 1 of which is fleshy and unusually prominent, on anal segment. One specimen 0.45 mm long and 0.26 mm wide.

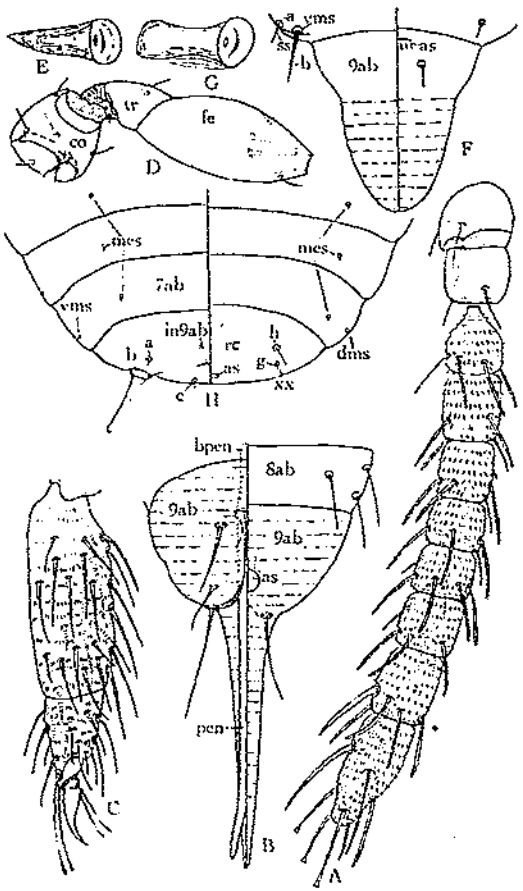

FIGURE 56.—*Thysanococcus pandani*: *A*, Adult male, antenna, × 400; *B*, same, posterior end, dorsal and ventral, × 400; *C*, same, metathoracic tibiotarsus, × 400; *D*, same, mesothoracic coxa-trochanter-femur, × 400; *E*, same, mesothoracic spiracle, × 1,000; *F*, fourth-stage male, posterior end, dorsal and ventral, × 400; *G*, same, mesothoracic spiracle, × 1,000; *H*, third-stage male, posterior end, dorsal and ventral, × 400.

FOURTH-STAGE MALE

(Fig. 56, *F* and *G*)

Available material not in condition to distinguish many of the parts clearly. Suboval, with posterior projection mildly rounded and moderately sclerotic for about two thirds of its distal surface. Spiraculariae rather elongate, moderately sclerotic, subequal. With 3 pairs of marginal or submarginal setae, 1 of which is large, spinelike, on eighth abdominal segment, and 1 dorsomesal pair on anal segment. Legs sharply elbowed. One specimen 0.44 mm long and 0.21 mm wide.

ADULT MALE

(Fig. 56, *A–E*)

Body setae.—Eighth abdominal segment with 2 marginal pairs and 1 dorsosubmarginal pair; anal segment with 2 comparatively prominent marginal pairs, 1 comparatively prominent ventromesal pair, and 1 smaller ventrosubmarginal pair.

Antenna.—Segments of club compactly joined, with all setae on each, except apical one, in a whorl near distal border; scattered on apical segment; on each segment of club from basal to distal one, in order, they number 4, 5, 5, 6, 6, 5, 6, and 8.

Legs.—Each mesothoracic leg with 5 and 1 slender setae on coxa and trochanter, respectively, and 4 slender setae and 1 fleshy seta on femur; each metathoracic tibia and tarsus with 25 and 16 scattered setae, respectively; mesothoracic and prothoracic tibiae and tarsi with setae of same character as occur on these segments of metathoracic legs, but less numerous.

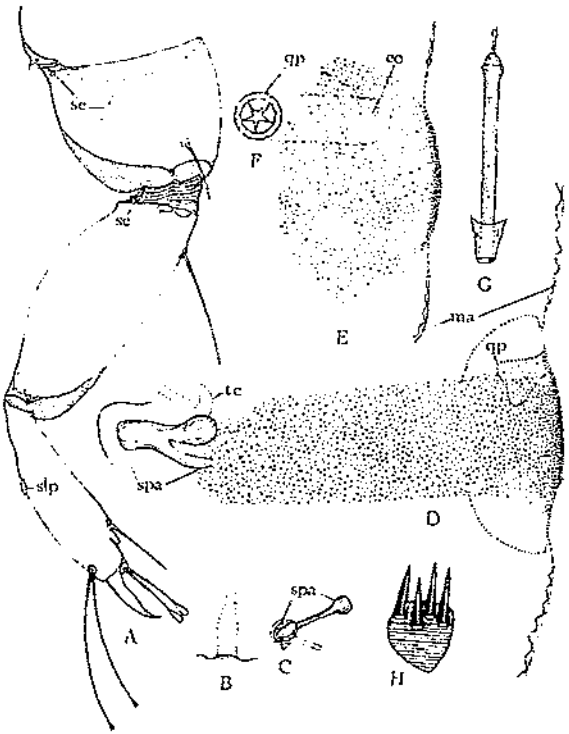

FIGURE 57.—*Thysanococcus squamulatus: A*, First-stage nymph, metathoracic leg, × 1,000; *B*, same, anus, × 1,500; *C*, same, metathoracic spiracle, × 2,000; *D*, *E*, same, mesothoracic spiracular region, ventral and dorsal, respectively, × 2,000; *F*, same, mesothoracic spiracular pore, × 2,000; *G*, same, 8-shaped pore, × 3,000; *H*, egg, spine group, × 1,500.

THYSANOCOCCUS SQUAMULATUS, new species

Two lots, United States Bureau of Entomology; one on *Calamus tetradactylus*, Canton Christian College, Kwantung, China; the other, "on palm tree", Hong Kong, China, collected by George Compere. All specimens exposed on leaves.

EGG

(Fig. 57, *H*)

Oviparous. A single group of 4 or 5 spines moderately spaced and varying but slightly in size; sclerotic body derm extending appreciably around spines.

FIRST STAGE

(Fig. 57, *A–G*)

Body.—Marginal serrations faint or obscure; segmentation about as well defined as in *Thysanococcus chinensis*. Clear area laterad of each metathoracic coxa obscure. A typical newly hatched specimen 0.46 mm long and 0.22 mm wide; a fully developed female 0.56 mm long and 0.27 mm wide.

Pores.—All 8-shaped pores approximately the same size, small, elongate; partitions extend hardly into distal bars; bars can be distinguished apart without much difficulty; bullae delicate. 8-shaped pores essentially as in *Thysanococcus chinensis*, with the following typical variations: 1 pair on head cephalad of eyes; 1 dorsomesal pair on mesothorax and on each of second, third, and sixth abdominal segments; 1 marginal pair on prothorax and first abdominal segment; in all, 19 pairs present. The quinquelocular pore associated with each mesothoracic spiracle slightly invaginated; opening on dorsum near margin immediately cephalad of external opening of invaginated tube leading to mesothoracic spiracle.

Spiracles.—The invaginated tubes leading to mesothoracic spiracles nearly straight and broader than in *Thysanococcus chinensis;* their external openings obscure. Mesothoracic spiracularlae moderately elongate, distinctly sclerotic; metathoracic pair distinctly more slender and less sclerotic than mesothoracic pair.

Body setae.—Essentially as in *Thysanococcus chinensis*, with the following typical variations: Second ventromesal pair on head not comparatively long, and 1 of marginal pairs on head cephalad of eyes absent; dorsomesal pair on prothorax absent; a single marginal pair on dorsum of metathorax, and no marginal pairs on first and second abdominal segments; 1 minute ventrosubmarginal pair each on at least the fifth, sixth, and seventh, and apparently sometimes also on the third and fourth, abdominal segments; in all, 50 pairs present. In one specimen, outer and inner long caudal setae 25 and 80 microns long, respectively.

Antenna.—Essentially as in *Thysanococcus chinensis*, with the following typical variations: Third seta apparently absent; fifth seta vestigial; sixth, seventh, and eighth setae more apical in position than in above-mentioned species.

Rostralis.—In one typical specimen, 0.71 mm long.

Legs.—Trochanter and femur, and tibia and tarsus, fused. No setae on femur or tibia; spinelike process of tarsus slightly projecting.

Anal ring.—Apparently absent.

Exuviation.—In female essentially as in *Thysanococcus pandani.*

Dried material.—Essentially as in *Thysanococcus chinensis.*

SECOND-STAGE FEMALE

(Fig. 58, *A–D*)

Body.—Moderately elliptical, with cephalic and caudal margins rounded similarly in both young and old specimens. Marginal fringe distinct; not so pronounced but of the same character as in *Thysanococcus chinensis;* extending all around cephalic margin and caudad to about fourth abdominal segment, where it terminates rather abruptly. Ventromarginal surface covered with faint papillae, of same character as in *Thysanococcus chinensis,* but considerably less pronounced; dorsal surface entirely reticulated except for a more or less bare area immediately over head skeleton. A typical young specimen 0.52 mm long and 0.22 mm wide; a puparium typically 0.63 mm long and 0.33 mm wide.

Pores.—Both ordinary and variating kinds of 8-shaped pores present. Ordinary kind of 8-shaped pore small, elongate, and delicate; external openings flush with surface; restricted to a row along ventrosubmarginal surface; typically 5 to 7 pairs on head and thorax together, and 1 pair on each abdominal segment to and including the seventh. Variating kind of 8-shaped pore moderate in size and relatively prominent, owing largely to its sclerotization; occurring along dorsomarginal surface, from and including the head to and including the fifth or sixth abdominal segment; in about 10 groups of usually 1, less frequently 2, and sometimes 3 or 4 pores in each group; also 2 to 7 pairs occurring dorsomesally on thorax or abdomen, or both; on one side of one typical specimen 16 dorsomarginal and 4 dorsomesal pores of this variating kind counted. Typically 1 quinquelocular pore associated with each mesothoracic spiracle; no others present.

Spiracles.—In structure and form mesothoracic invaginated tubes and spiraculariae of both pairs of spiracles approximately as in *Thysanococcus pandani.*

Body setae.—In occurrence and position essentially as in *Thysanococcus chinensis,* except ventromesal pair on thorax apparently absent, and apparently 2 or 3 less pairs present on anal valve.

Antenna.—With a single prominent fleshy seta and a pair of comparatively large partially invaginated setae.

Rostralis.—With 1 elongate loop, 2 large roundish loops, and the small cephalic loop, when uncoiled within body; in one typical specimen, 2.0 mm long.

Anal valve.—Posterior half of covering tissue with faint markings resembling spiny reticulations, or markings may be obscure; apparently without pores; with about 4 pairs of minute setae on or near caudal margin; anus near caudal margin; anal ring apparently absent.

Dried material.—Approximately as in *Thysanococcus chinensis,* but dorsum tapering a little more gently posteriorward.

THIRD-STAGE FEMALE

Not identified.

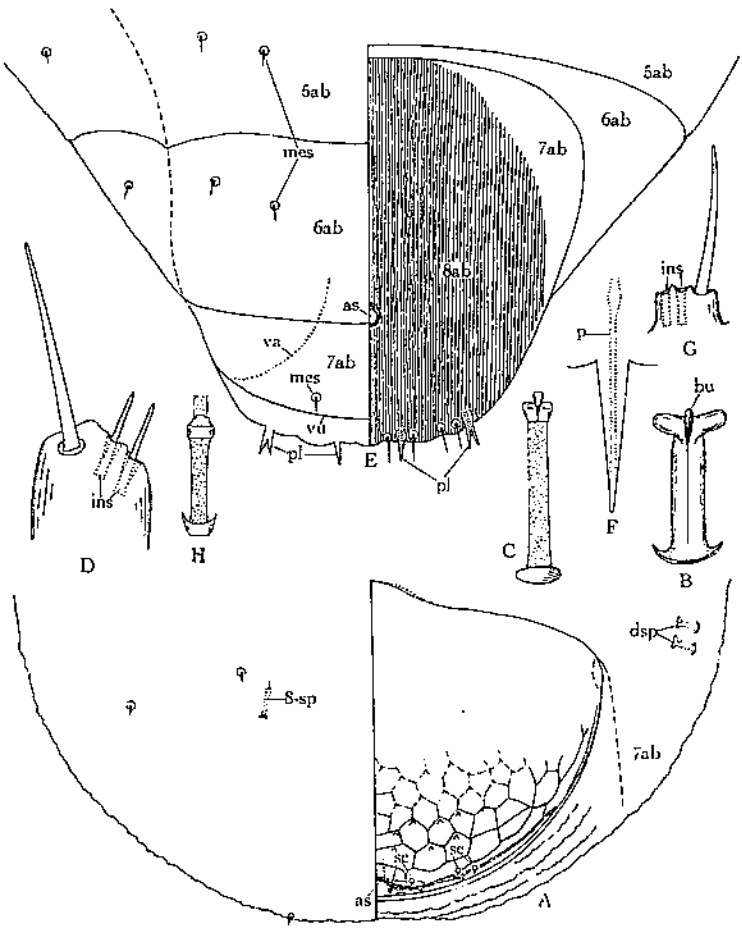

FIGURE 58.—*Thysanococcus squamulatus: A*, Second-stage female, posterior end, dorsal and ventral, × 500; *B*, same, dorsosubmarginal 8-shaped pore (variating kind), × 3,000; *C*, same, ventrosubmarginal 8-shaped pore (ordinary kind), × 3,000; *D*, same, antenna, × 2,000; *E*, adult female, posterior end, dorsal and ventral, × 500; *F*, same, caudal plate or squamula (apparently containing delicate pore), × 3,000; *G*, same, antenna, × 2,000; *H*, same, midventral 8-shaped pore, × 3,000.

ADULT FEMALE

(Fig. 58, *E–H*)

Body.—Moderately elliptical, with posterior end curving slightly mesad along its lateral margin and projecting somewhat less broadly than in *Thysanococcus chinensis;* seventh abdominal and anal segments apparently fused on dorsum; dorsal surface of sixth abdominal segment defined, that of other segments obscure; dorsal sclerotization of posterior end covering apparently all of anal segment and much of mesal region of seventh abdominal segment. A typical specimen 0.52 mm long and 0.28 mm wide.

Pores.—From 4 to 12 8-shaped pores scattered on each side of body, apparently limited to posterior section of metathorax; partitions, even into bars, apparently absent; bars can be distinguished from each other; bullae relatively broad; external openings at apices of sclerotic projections.

Spiracles.—Spiraculariae moderately elongate, subequal.

Body setae.—Essentially as in *Thysanococcus chinensis,* with the following typical variations: Apparently no dorsomarginal setae on posterior segments; no ventromesal setae on thorax, and a single pair each on second and third abdominal segments; 4 pairs, instead of 6, on anal segment; in all, 23 pairs present.

Antenna.—With one large fleshy seta and a pair of rather stout setae, moderate in size and partially invaginated.

Rostralis.—With 1 elongate loop, 2 large roundish loops, and the small cephalic loop, when uncoiled within body; in one typical specimen, 2.7 mm long.

Anal segment.—Caudal margin slightly wavy; typically with 2 or 3 pairs of small delicate plates or squamulae, which may or may not be forked, projecting from laterocaudal margin; these plates frequently appearing to possess delicate elongate pores which open externally on or near apices of plates; with 4 pairs of subequal setae along caudal margin. Anus apparently centrally located; pronounced in appearance; apparently with anal ring, but no anal-ring setae in evidence.

MALE STAGES

Not available.

THYSANOCOCCUS CALAMI, new species [13]

Material from E. E. Green; on *Calamus* sp., Buitenzorg, Java, collected by A. Zimmermann; United States Bureau of Entomology, on "rottang" ("creeper palm of the tropical forests"), Buitenzorg, Java, received through T. D. A. Cockerell, May 31, 1911. All specimens exposed on leaves.

EGG

(Fig. 59, *E*)

Apparently oviparous. With a group of 8 or 9 spines, distinctly crowded and varying in size; sclerotic body derm practically not extending beyond bases of spines.

[13] See footnote 12, p. 127.

FIRST STAGE

(Fig. 59, *A–D*)

Body.—Marginal serrations obscure; segmentation of head, prothorax, and mesothorax ill defined. Clear area laterad of each metathoracic coxa distinct. A newly hatched specimen 0.23 mm long and 0.11 mm wide; a fully developed female 0.44 mm long and 0.19 mm wide.

Pores.—All 8-shaped pores approximately uniform in size; small, with possible exception of 1 ventromarginal pair on seventh abdominal segment; confined to

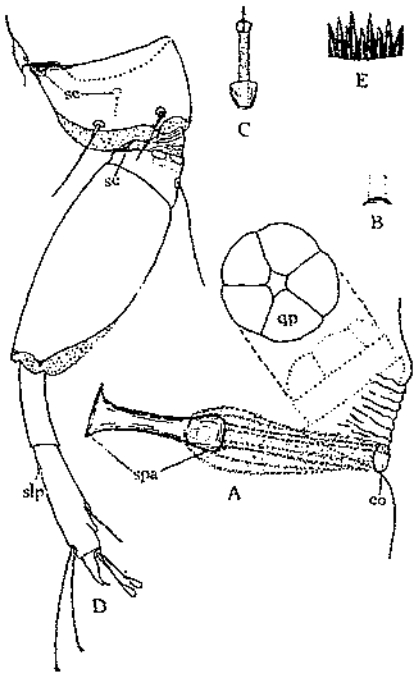

FIGURE 59.—*Thysanococcus calami: A*, First-stage nymph, mesothoracic spiracle, ventral, × 2,000; *B*, same, anus, × 1,500; *C*, same, 8-shaped pore, × 3,000; *D*, same, metathoracic leg, × 1,000; *E*, egg, spine group, × 1,500.

dorsum typically as follows: 1 pair on head, cephalad of eyes; 1 pair each near margin of prothorax, metathorax, and all abdominal segments, except possibly the third; 1 mesal pair on all thoracic segments and the second abdominal segment; in all, 15 pairs of 8-shaped pores present. The quinquelocular pore associated with each mesothoracic spiracle relatively large, emarginated, slightly invaginated, and situated cephalad of invaginated tube leading to spiracle.

Spiracles.—Invaginated tubes leading to mesothoracic spiracles straight, somewhat shorter than in *Thysanococcus chinensis*. Spiraculariae elongate, distinctly sclerotic, subequal. No differentiated area on margin near invaginated tubes leading to mesothoracic spiracles.

Body setae.—Essentially as in *Thysanococcus chinensis*, with the following additional setae: 1 minute pair on dorsal margin of apparently the anterior section of mesothorax; 1 lateromesal pair of dorsum each on mesothorax and metathorax; 1 minute ventrosubmarginal pair each on second to seventh abdominal segments, inclusive; 1 minute ventromesal pair on sixth abdominal segments; in all, 62 pairs present. In one specimen, outer and inner long caudal setae 31 and 156 microns long, respectively.

Antenna.—Approximately as in *Thysanococcus chinensis*, except for possible absence of the minute seta on third segment.

Rostralis.—In one typical specimen, 0.60 mm long.

Legs.—In essentials as in *Thysanococcus chinensis*, except femur more slender, tibia slightly longer, and spinelike process of tarsus more pronounced.

Anal ring.—Essentially as in *Thysanococcus chinensis.*
Exuviation.—Essentially as in *Thysanococcus chinensis.*
Dried material.—Light to rich brown; less flat than in *Thysanococcus chinensis;* a marginal fringe of discolored wax observed in some specimens.

SECOND-STAGE FEMALE

(Fig. 60, *C–F*)

Body.—Elongate elliptical, with cephalic margin slightly more broadly rounded than caudal margin. In structure and extent marginal fringe approximately as in *Thysanococcus chinensis;* with pronounced characteristic irregular marginal indentations, fully lined with the marginal fringe; no other noticeable dermal configuration. Puparium heavily sclerotic on dorsum; derm distinctly brittle in all prepared specimens. A typical newly molted specimen 0.35 mm long and 0.14 mm wide; a puparium 0.54 mm long and 0.23 mm wide.
Pores.—8-shaped pores rather small; of the ordinary kind only; typically 3 to 5 pairs scattered immediately caudad of metathoracic spiracles, a like number scattered dorsomesally on fifth or sixth abdominal segment, and an occasional pore elsewhere; bullae delicate, relatively broad; external openings on sclerotic conical projections. Typically 2 subequal quinquelocular pores associated with each mesothoracic spiracle. Typically about 17 groups of quinquelocular pores, each possessing from 1 to 3 pores, in a row extending entirely around body margin; 29 and 31 pores counted on single sides of two specimens.
Spiracles.—Invaginated tubes of mesothoracic spiracles extending from latter toward margin in a fairly straight line; these tubes comparatively broad and faintly granulate. A broad granulate band present along margin in immediate vicinity of external openings of mesothoracic invaginated tubes. Mesothoracic spiraculariae larger than metathoracic ones.
Body setae.—Essentially as in *Thysanococcus chinensis,* with the addition of 1 pair on cephalic margin of head, the distinct enlargement of the pair on or near caudal margin of seventh abdominal segment, and the apparent absence of 1 pair on edge of anus, but with 7 pairs on anal valve; in all, 25 pairs present.
Antenna.—With a single fleshy seta more or less apically situated, 1 minute slender surface seta, and a minute pair of wholly invaginated setae.
Rostralis.—With 1 elongate loop, 2 large roundish loops, and the small cephalic loop, when uncoiled within body; in one specimen, 1.8 mm long.
Anal valve.—Covering tissue faintly reticulated; pores apparently absent; with 7 pairs of small setae near lateral and caudal margins. Anus small, distinctly caudad in position, but not on margin; anal ring may be present; if so, narrow; anal-ring setae apparently absent.
Dried material.—Puparium dark brown to almost black; a fringe of discolored matted wax usally present around margins; body distinctly depressed but not flat; posterior end pointed nearly straight dorsad; body covered with first-stage exuvia.

THIRD-STAGE FEMALE

Present but too delicate to distinguish any parts.

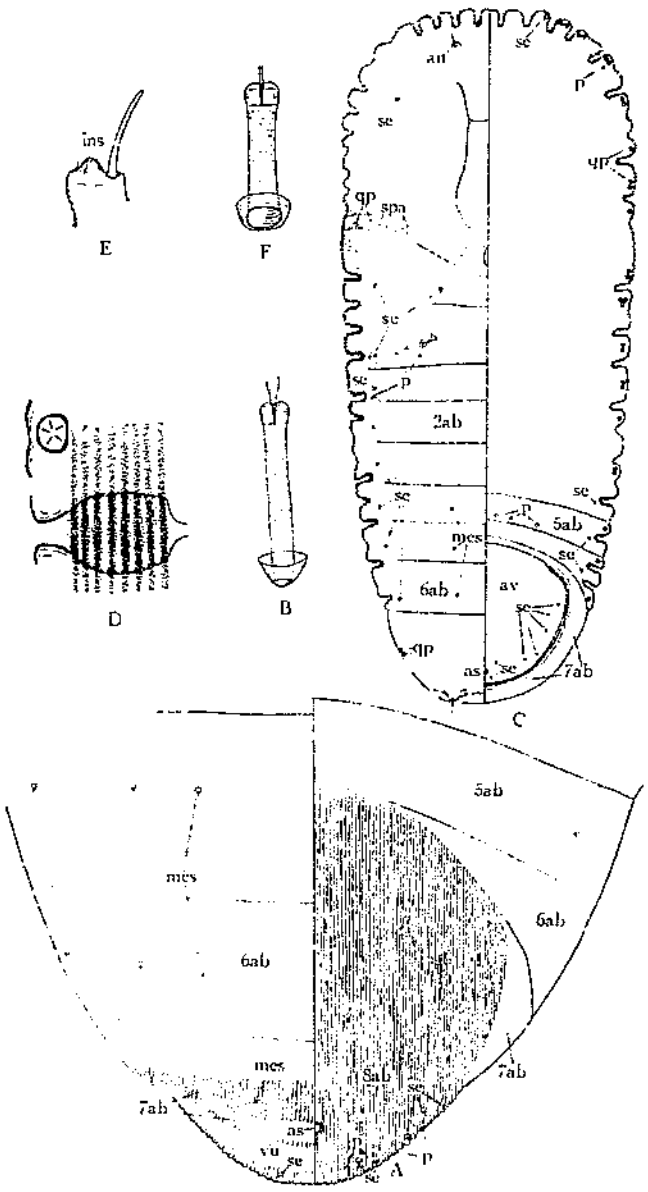

FIGURE 60.—*Thysanococcus calami*: *A*, Adult female, posterior end, dorsal and ventral, × 500; *B*, same, mid-ventral 8-shaped pore, × 3,000; *C*, second-stage female, body, dorsal and ventral, × 265; *D*, same, looking down on fringe, × 2,000; *E*, same, antenna, × 2,000; *F*, same, 8-shaped pore, × 3,000.

ADULT FEMALE

(Fig. 60, *A* and *B*)

Body.—Elongate elliptical, with posterior end projecting only slightly and less roundly than in *Thysanococcus chinensis;* seventh abdominal and anal segments fused, and mesal region of sixth apparently fused with that of seventh abdominal segment; dorsal surface of fifth abdominal segment defined; dorsal sclerotization covering all of anal segment and almost all of seventh, and possibly mesal region of sixth abdominal segment; a distinct ridged effect across ventral surface of seventh abdominal segment. A typical specimen 0.53 mm long and 0.17 mm wide.

Pores.—In structure and position 8-shaped pores essentially as in *Thysanococcus chinensis,* but clusters confined almost to posterior section of metathorax and the following (second abdominal) segment; on these 2 segments, 24 counted on one side of one specimen.

Spiracles.—Mesothoracic spiraculariae somewhat enlarged at their mesal ends, and slightly larger than metathoracic pair, which are rather elongate.

Body setae.—Essentially as in *Thysanococcus chinensis,* with the following typical variations: 2 pairs usually observed on dorsal surface of head; apparently none on prothorax; 1 pair sometimes observed on or near margin laterad of mesothoracic spiracles; 1 mesal pair on anterior section of metathorax; 3 pairs on dorsal margin near posterior end, apparently on third, fourth, and fifth abdominal segments; only 1 ventromesal pair each on second and third abdominal segments; in all, 30 pairs present.

Antenna.—With 1 large fleshy seta, 1 pair of small wholly invaginated setae, and apparently 1 minute surface seta.

Rostralis.—Not available.

Anal segment.—Caudal margin faintly crenulate; typically with 4 pairs of 8-shaped pores and 6 pairs of subequal setae along interocaudal margin; anus apparently situated caudad of center; anal ring apparently present, but anal-ring setae absent.

MALE STAGES

None at hand, except one adult in poor condition, with no vestige of thoracic wing framework or of wings, with two pairs of eyes.

RELATION TO OTHER COCCIDS

After reading the manuscript of this bulletin, G. F. Ferris made the following statement concerning the species here included in the Phoenicococcini and their relation to other coccids:

The problem of the relationships of the group of palm-infesting species here dealt with to other members of the Coccoidea (Coccidae) is a difficult one. In the first place, the general classification of the superfamily (or family) is at present only partially satisfactory, there being disagreement among authorities as to the relationship and rank of even the more clearly defined groups. And aside from such groups there exist many forms that do not fit with any of the more distinct groups and the disposal of which is a problem that has yet been but little elucidated.

The palm-infesting species here considered constitute such a problem. That they are actually related to each other seems obvious and their inclusion in some common category—whether it be called a subfamily or a family—appears adequately justified on the basis of present knowledge. But their possible connections with other groups are extremely obscure. They are most certainly not immediately connected with any of the typical and well-known groups. If their connections are to be traced at all, it must be through a study of some lesser known species in the hope that somewhere there will be found forms that may possibly serve as links with the more familiar types. The presence of the 8-shaped pores leads one naturally to a consideration of the Asterolecaniidae, and certain other features compel a consideration of some strange forms which have in the past been referred to the Diaspidae. Out of all the immense assemblage of forms in the Coccoidea these seem to offer the most promising leads for investigation.

In the search for near relatives of the Phoenicococcini, the margarodine, ortheziine, eriococcine, pseudococcine, coccine, and tarchardiine assemblages may be eliminated, since in each of these occur three or more of such characteristic features as the following, none of which are present in the Phoenicococcini: Abdominal spiracles, compound eyes or ocelli, distinctly developed antennae or legs in other than the first and three later male stages, monolocular or multilocular [14] disk pores, anal-ring pores, pronounced and well-distributed setigerous areas, dorsal ostioles, cerarii, anal clefts, anal plates, brachial plates, dorsal spines, gall formations, or resinous secretions. Of the well-known groups there remain the asterolecaniine and diaspine ones. The occurrence among most of the former of such characteristics as monolocular or multilocular [14] disk pores, more or less sessile 8-shaped pores, cribiform plates, and, in the first stage, of a markedly indented caudal margin, more or less clearly defined sclerotic anal areas, and a setigerous development in the anal region distinctly unlike that in the Phoenicococcini eliminates them from consideration. Yet two species examined, which have been assigned, apparently justly, to the asterolecaniine group, possess none of the above-mentioned characteristics, having, in fact, no structural features that seem to be widely at variance with those in the Phoenicococcini; and when it is noted that the same two general types of tubular pores occur in these two species and the latter, a relationship in one direction is indicated.

To the diaspine assemblage have been assigned a number of rather obscure forms showing varying degrees of similarity to the Phoenicococcini. One genus has at least one species remarkably like the Phoenicococcini, possessing no structural features, with the possible exception of the character of the anal valve in the second-stage female, apparently at serious variance with those in the Phoenicococcini; and since this species and at least one more in this genus clearly quite close to it show definite characteristics of being generalized diaspids, a relationship in another direction is indicated. If these relationships are valid and the species concerned belong in the groups in which they have been placed, then the asterolecaniine and diaspine groups are at least remotely connected.

The following discussion will deal first with a few asterolecaniine species and some other forms that are more or less generalized, and secondly, with a number of diaspine species, which because of certain points of similarity to the Phoenicococcini may help to throw light on the relationships of the latter. Particular attention is given to the character of the pores occurring among the various species studied, as this feature seems to be of most significance from the standpoint of relationships.

SOME ASTEROLECANIINE AND OTHER FORMS

The pores of the first stage of the asterolecaniine form *Mycetococcus ehrhorni* Cockerell (fig. 61) are limited to a normally trilocular disk and a tubular 8-shaped type. The trilocular pores are associated with each spiracle only, and the 8-shaped pores are comparable in extent of invagination, size, number, and distribution with those in this stage, for example, in *Phoenicococcus marlatti*. This tubular type of pore does not differ essentially from that occurring in the Phoeni-

[14] Used here in the sense of having more than five loculi.

cococcini, except that it seems to possess a single, only moderately sclerotic bar, a moderately sclerotic tube connecting the bar with the exterior, a partition extending completely through the bar and tube, producing a double or 8-shaped external opening, and possibly a bulla issuing from the center of the inner surface of the bar but

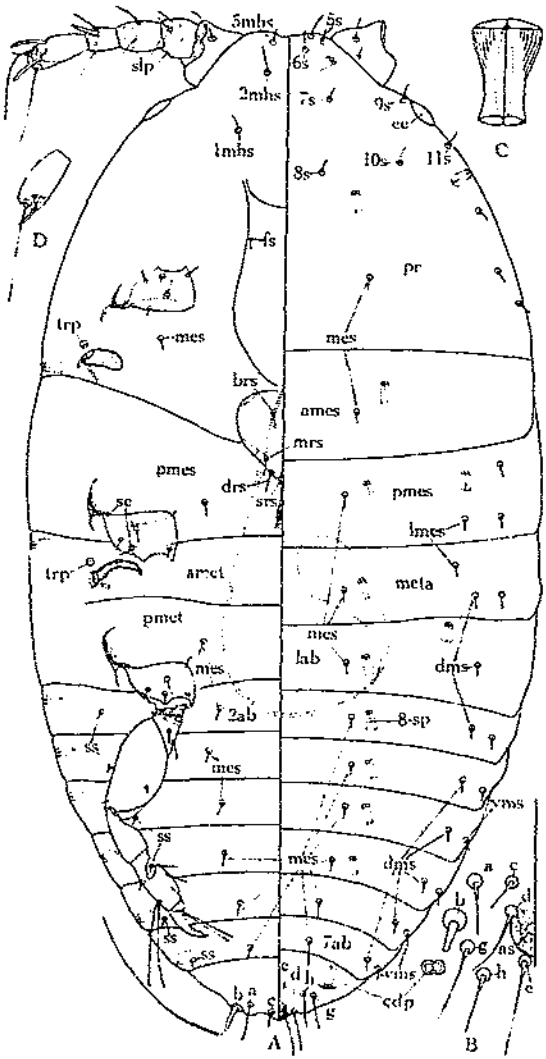

FIGURE 61.—*Mycetococcus ehrhorni*, first-stage nymph: *A*, Body, dorsal and ventral, × 500; *B*, anal region, × 1,200; *C*, tubular 8-shaped pore, × 3,000; *D*, antenna, apical segment, dorsal, × 500.

too delicate to be clearly discerned. In the possession of a single moderately sclerotic bar and a tube approximately equally sclerotic this pore of *M. ehrhorni* resembles most nearly the variating kind of 8-shaped pore occurring in the second-stage female of *Thysanococcus squamulatus* (fig. 58), the only significant difference between the two

being that in the latter species the partition is more delicate and disappears just before the external opening.

The body setae of the first stage of *Mycetococcus ehrhorni* are not essentially different from those of the Phoenicococcini except in the following respects: Only one long caudal pair is present, and the anal-ring or homologous setae are of the same general size as other setae of this region, and stable in occurrence. But these latter setae are of the same number and in the same general positions as, for example, in *Phoenicococcus marlatti* (fig. 2), and thus give every indication of being homologous with those of the latter. Since the anal-ring setae in *P. marlatti* are somewhat smaller than neighboring setae and two pairs of them are distinctly unstable in occurrence, and these are in varying degrees even less in evidence in other species of the Phoenicococcini, it appears that such setae are in process of disappearing in this tribe.

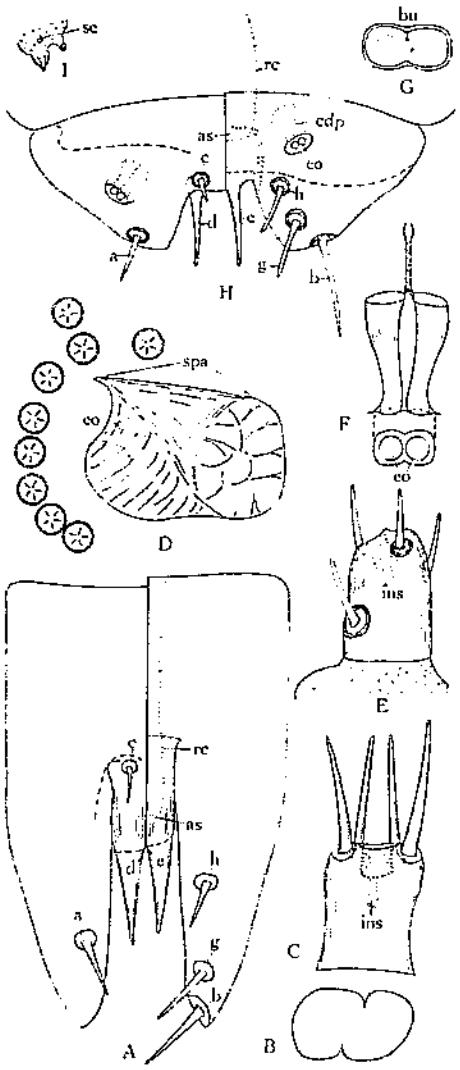

FIGURE 62.—*Mycetococcus ehrhorni*: *A*, Adult female, posterior end, dorsal and ventral, × 400; *B*, same looking down on inner end of 8-shaped pore, × 3,000; *C*, same, antenna, × 1,000; *D*, same, mesothoracic spiracle, × 1,000; *E*, second-stage female, antenna, × 1,000; *F*, same, tubular 8-shaped pore, × 3,000; *G*, same, looking down on inner end of tubular pore, × 3,000; *H*, same, posterior end, dorsal and ventral, × 400; *I*, same, metathoracic leg, × 1,500.

As regards the remainder of the body in the first stage, there is apparently no more difference between *Mycetococcus ehrhorni* and a species in the Phoenicococcini than there may be between two species of the latter, except that the antenna is only 5-segmented and has a slightly enlarged apical segment, which possesses a larger number of slender setae than are present in the 6-segmented type of the Phoenicococcini; yet the 6-segmented type of antenna differs more from the annulated type in this tribe than from the antenna in *M. ehrhorni*.

In the second and adult female stages of *Mycetococcus ehrhorni* (fig. 62) the pores are limited to quinquelocular and trilocular disk types and a tubular 8-shaped type. The quinquelocular pores are associated with the spiracles and the trilocular pores are situated laterad of the head skeleton. The 8-shaped pores are distributed generally

over the body in both these stages and are plainly double throughout except for a single centrally located distinct bulla to each pore. They are in no essentials different from the first-stage tubular pores, except that the bullae are not distinct in the latter. A twisted 8-shaped effect was frequently observable across the inner surface of the bar of a tubular pore, especially in the adult stage. This effect is probably due to distortion from the flattening out of the rotund bodies on slides, for the normal 8-shaped effect was also noted.

The anus is noticeably invaginated in the second-stage female of *Mycetococcus ehrhorni* and more so in the adult stage, with stouter setae around it in both stages than are present in the first stage of this species, or in the Phoenicococcini; but these anal setae are apparently homologous with those in the first stage of this species and of the latter. All other parts of the body in these two female stages are not greatly dissimilar to the corresponding parts in the Phoenicococcini.

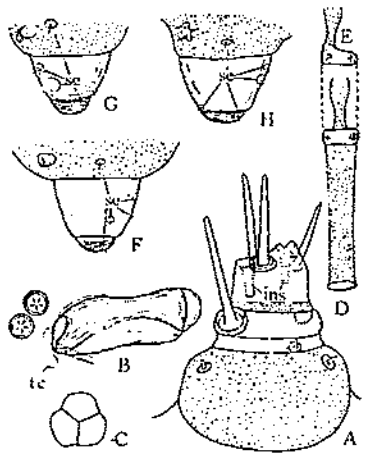

FIGURE 63.—*Mycetococcus ehrhorni*, second-stage male: *A*, Antenna, × 1,000; *B*, mesothoracic spiracle, × 1,000; *C*, trilocular pore interad of head skeleton, × 2,000; *D*, tubular pore, × 3,000; *E*, same pore, turned partly around, × 3,000; *F*, metathoracic leg, × 1,500; *G*, mesothoracic leg, × 1,500; *H*, prothoracic leg, ×1,500.

The second-stage male of *Mycetococcus ehrhorni* (fig. 63) has the same disk types of pores, and these are situated as in the female stages. The tubular pores appear significant. The typical ones have delicate tubes, also distinctly sclerotic, seemingly single bars, and bullae arising from the sides of the bars; thus, as far as can be judged, these pores are essentially like the asymmetrical ones occurring in this stage of *Halimococcus thebaicae* (fig. 35) and *Thysanococcus pandani* (fig. 55). They are distributed generally over the body. In some specimens apparently the identical kind of 8-shaped pore occurring in the female stages is sparsely scattered over the body. It resembles a union of two of the usual type, the bars and tubes simply coming into juxtaposition but the bullae completely fusing. The two posterior segments are like those of the second-stage female except for the above-mentioned difference in pore structure and in the possession of one mesal pore on each surface of each segment. Legs are present and distinct though vestigial, and the antenna is tuberculate but plainly segmented; thus in these particulars, as well as in all others, this stage is apparently essentially like that in the Phoenicococcini.

The adult male of *Mycetococcus ehrhorni* is strikingly similar to males of the Phoenicococcini in that it has a closely joined head and thorax, no vestige of wings or of thoracic wing framework, a pair of simple eyes, setae of the same general character, and a single rapierlike posterior projection which is slightly stout, being much like that in *Phoenicococcus marlatti* (fig. 9). Unfortunately, the apical part of each antenna was lost in the specimens at hand; so no observations on this structure were possible.

The 8-shaped pores of the Phoenicococcini might be considered as having been derived from such a type as those of *Mycetococcus ehrhorni*, since in the former the partition is apparently present in all degrees, from being complete nearly to the external opening to entirely disappearing in the tubes. Furthermore, since the Phoenicococcini possess a variating kind noticeably like the typical 8-shaped type in *M. ehrhorni*, apparently the same kind of asymmetrical tubular pores and only the same other pore types as this species, and since no serious structural differences seem to exist in the corresponding stages, and there is no apparent difference in the character of the waxy secretions of each, it seems reasonable to believe that *Mycetococcus ehrhorni* and the Phoenicococcini are related.

The first stage of the asterolecaniine form *Capulinia sallei* Sign. (fig. 64) has quinquelocular-disk pores associated with the spiracles instead of trilocular ones as in this stage of *Mycetococcus ehrhorni*. The only other pores present are of the double tubular type, which are essentially like those of *M. ehrhorni* except for the following modifications: The two component parts of a pore are less closely joined, there being a distinct separation of parts of the tubes and more or less of the bar, which is perhaps more sharply sclerotic, the tubes membranous, and the single bulla distinct though delicate. The antenna is of the same type as in *M. ehrhorni* but has 6 segments instead of 5. All body setae, including those of the posterior end, though largely much more developed, can apparently be readily homologized with those of *M. ehrhorni* and the Phoenicococcini. This stage of *C. sallei* is unusual in the possession of two pairs of long caudal setae. The importance of this fact should be judged with caution owing to the modified development of other setae in this region and elsewhere. The extent of the anal ring is obscure owing to much sclerotization around the anus. This makes it difficult to determine whether or not the anal ring is present at all, for unless it stands out rather sharply its use as a systematic factor may prove misleading. The anus is somewhat evaginated, instead of invaginated as in *M. ehrhorni*, and more or less flush with the surface as in the Phoenicococcini. No parts of the body, however, are considered to be at great variance with those in *M. ehrhorni* and the Phoenicococcini.

In the second and adult female stages of *Capulinia sallei* (fig. 64) the double and single types of tubular pores, essentially of the same character as are found in the female and second male stages, respectively, in *Mycetococcus ehrhorni*, occur together, with a preponderance of the single type present, especially in the adult female. The double pores are approximately twice the size of the single ones, are loosely joined as in the first stage of this species, and strongly suggest that each has resulted from a coalescence of two of the single ones.

Capulinia sallei possesses no pore types not present in some stage of *Mycetococcus ehrhorni* and, except perhaps for the presence of one or more pairs of vestigial legs, no structures apparently exist in the female stages of this species which differ greatly from those of *M. ehrhorni;* also the waxy secretions of both are essentially of the same character, being cottony in texture as in the Phoenicococcini. But the adult male of *C. sallei* has a well-developed thoracic wing framework (though the wings are apparently rather vestigial or absent), a pronounced constriction between the head and the thorax, setigerous areas, and two pairs of simple eyes.

With so many characteristics in common it seems reasonable to believe that *Mycetococcus ehrhorni* and *Capulinia sallei* are definitely related; and, likewise, that the latter species is related to the Phoenicococcini, but probably less so than is *M. ehrhorni*, chiefly because of the more loosely joined character of the 8-shaped tubular pores, the presence of the asymmetrical type of tubular pore in the female stages, and the more distinguishing differences in the adult male.

The double or 8-shaped type of pore of a more typical asterolecaniine species may be tubular as in *Callococcus pulchellus* Maskell (fig. 65, *F*), virtually sessile as in *Asterolecanium pustulans* Cockerell (fig. 65, *G*), in a slight invagination as in *Lecaniodiaspis tessellata* Cockerell (fig. 65, *C*, *D*), or in a more pronounced invagination as in *Pollinia ovoides* Cockerell (fig. 65, *E*). The type in *C. pulchellus* appears to be essentially like that in *Mycetococcus ehrhorni* and in *Capulinia sallei*, but to be nearer the sessile condition. In *L. tessellata*, from the appearance of the 8-shaped parts, which apparently conform strictly to the condition in the sessile type of pore, the slight invagination present, apparently no more than a mere indentation in the body wall, is considered to be a later development from the sessile type. The situation of the 8-shaped pore in *P. ovoides* would apparently be simply a step further. Incidentally, in later female stages of the latter the 8-shaped pores are almost sessile. Thus the types of 8-shaped pores in all the above-mentioned asterolecaniine forms appear to bear a fundamental relation to one another. If this is so, then on the basis of the discussion already given, the 8-shaped

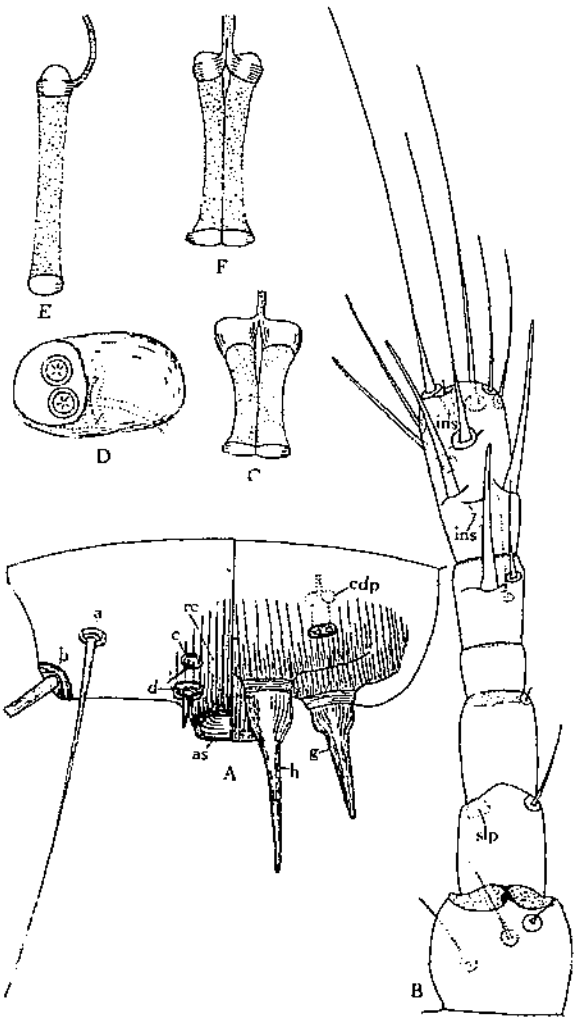

FIGURE 64.—*Capulinia sallei*: *A*, First-stage nymph, posterior end, dorsal and ventral, × 1,000; *B*, same, antenna, × 1,000; *C*, same, tubular 8-shaped pore, × 3,000; *D*, same, mesothoracic spiracle, × 1,000; *E*, adult female, tubular asymmetrical pore, × 3,000; *F*, same, tubular double pore, × 3,000.

pores of the Phoenicococcini would be connected with those of the typical asterolecaniine forms through the type occurring in such species as *M. ehrhorni* and *C. sallei*. Also, in later stages of all these more typical asterolecaniine species occurs a long membranous tubular type of pore, with the bulla issuing from one side, apparently identical with the asymmetrical tubular type occurring in *Mycetococcus ehrhorni*, *Capulinia sallei*, and the Phoenicococcini. But owing to the absence of the features previously mentioned as occurring among typical asterolecaniine species, *M. ehrhorni* and *Capulinia sallei* appear not to be typical members of the group. However, since these two species have so many points in common with the typical asterolecaniine species, such as apparently related 8-shaped pores and essentially the same type of asymmetrical tubular pores, and possess no structures that seem to justify removing them from the general asterolecaniine group, it is suggested that they be placed in a separate tribe of this group.

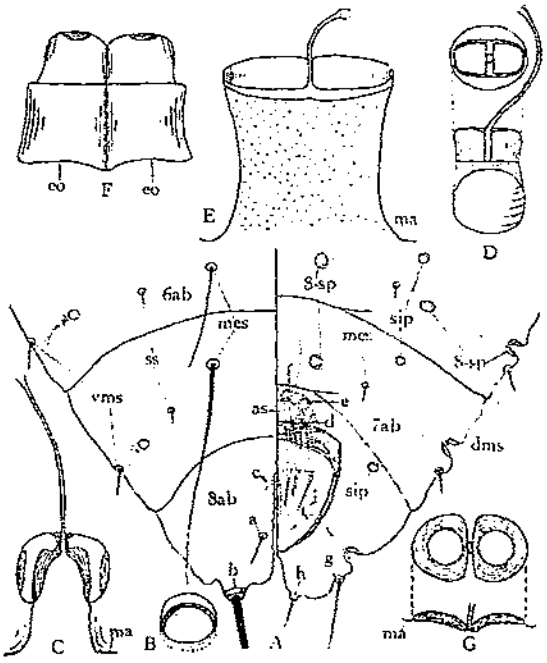

FIGURE 65.—*A–D*, *Lecaniodiaspis tessellata*, first-stage nymph: *A*, Posterior end, dorsal and ventral, × 500; *B*, slightly invaginated simple pore, dorsal, × 3,000; *C*, 8-shaped marginal pore, dorsal, × 3,000; *D*, 8-shaped submarginal pore, ventral, × 3,000. *E*, *Pollinia ocoides*, first-stage nymph, 8-shaped tubular pore, × 3,000. *F*, *Callococcus pulchellus*, first-stage nymph, tubular 8-shaped pore, × 3,000. *G*, *Asterolecanium pustulans*, first-stage nymph, marginal 8-shaped pore, × 3,000.

The posterior end of *Lecaniodiaspis tessellata* (fig. 65, *A*) is figured to show the character of the pores and to indicate the probable homologies of the parts occurring here of a typical asterolecaniine as compared with this region in other coccid species treated in this bulletin.

That the tubular type of 8-shaped pore is not restricted to a narrow range is indicated by the fact that along the ventrosubmarginal surface of the abdomen in the second and adult female stages of the obscure form *Kuwanina parvus* Maskell (fig. 66, *C* and *D*) occur a few small delicate 8-shaped pores, essentially of the type in the Phoenicococcini and resembling especially the 8-shaped pores occurring in the genera *Phoenicococcus* and *Palmaricoccus*. The only other type seen was the quinquelocular-disk one, the pores of which were either rather large and scattered over the body or comparatively small and mostly localized in the midventral region. The two above-mentioned stages possess eyes, segmented but much reduced

antennae, all three pairs of legs, though in vestigial form, a faintly segmented rostrum, but a posterior end not greatly unlike that in the first stage of *Phoenicococcus marlatti*, though with eight pairs of well-developed setae. In the first stage of *K. parrus* (fig. 66, *G–I*) a few rather large quinquelocular pores are scattered over the body, with no other pore type observed except an irregular band of apparently anal-ring pores. Excluding these differences and that of an extra pair of setae and of only one prominent caudal pair, the posterior end in this stage is approximately like that in *P. marlatti*. It appears not unlikely that *K. parrus* may be a distant relative of the Phoenicococcini, but it does not seem to fit in well with any recognized group of coccids.

In another obscure form, *Stictococcus multispinosus* Newstead (fig. 66, *A*), tubular 8-shaped pores occur around the ventral margin and submargin of what is presumably the adult female. The pores are fairly large, have broad bullae, two more or less sclerotic bars, a membranous tube, and a double external opening. Except for the last-mentioned characteristic, they resemble the 8-shaped pores of the Phoenicococcini more than those of other coccids mentioned above. Tubular 8-shaped pores also occur in several margarodine genera.

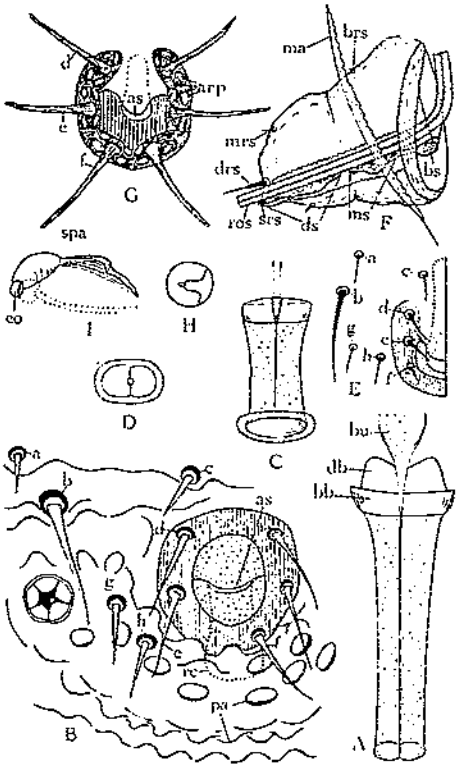

FIGURE 66.—*A*, *Stictococcus multispinosus*, adult female (?): Tubular 8-shaped pore, × 3,000. *Kuwanina parous*: *B*, Adult female, anal region, × 1,000; *C*, same, tubular 8-shaped pore, × 3,000; *D*, same, looking down on inner end of 8-shaped tubular pore, × 3,000; *E*, second-stage female, anal region, × 1,000; *F*, same, lateral aspect of rostrum, × 1,000; *G*, first-stage nymph, anal ring, × 1,000; *H*, same, clear area lateral of metathoracic coxa, × 3,000; *I*, same, mesothoracic spiracle, × 1,000.

SOME DIASPINE FORMS

A single type of pore only is observed through the various stages of *Ancepaspis edentata* Ferris, an invaginated 8-shaped one with a centrally located bulla, 2 bars, and a membranous tube. The partition extends through both bars but apparently not into the tube. As far as can be seen, this type of pore is like that in the Phoenicococcini. The only features in the first stage (fig. 67) by which this species can be well separated from the Phoenicococcini are the presence of a pair of rudimentary diaspid lobes and the absence of one pair of long caudal setae. Even the antennae are essentially like those of the Phoenicococcini. The second-stage female of *A. edentata*

is puparial (fig. 68), with an apparently functional anal valve on the dorsal surface. This valve differs from that in the Phoenicococcini in that it apparently embraces, besides the eighth, the dorsal surface of the seventh and sixth abdominal segments, is not depressed below the surrounding region, and has its laterocaudal margins not sharply defined, appearing in fact to be in process of coalescing with the bordering tissue; whereas in the Phoenicococcini the anal valve includes apparently no more than the eighth abdominal segment,

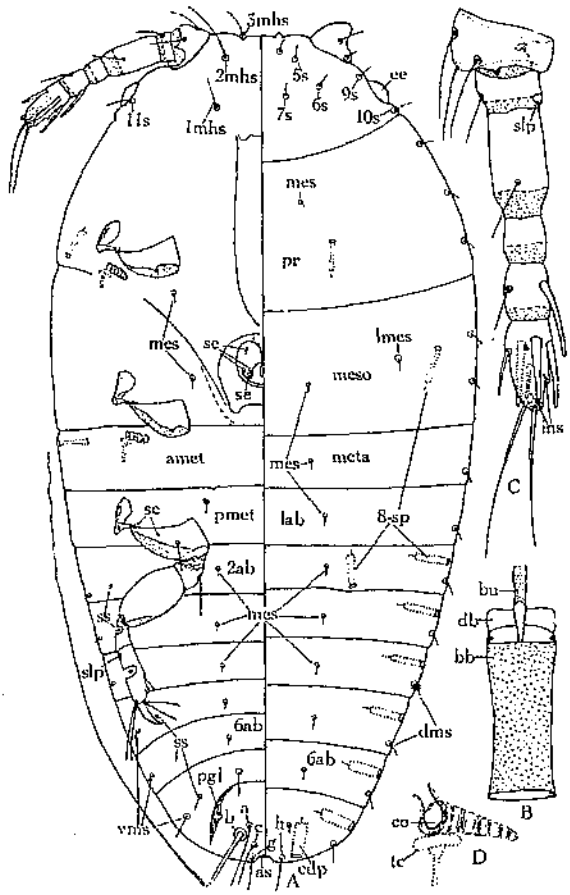

FIGURE 67.—*Ancepaspis edentata*, first-stage nymph: *A*, Body, dorsal and ventral, × 500; *B*, 8-shaped pore, × 3,000; *C*, antenna, ventral, × 1,000; *D*, mesothoracic spiracle, × 2,000.

although it may extend sufficiently cephalad practically to crowd out the dorsomesal part of the seventh or perhaps even the sixth abdominal segment (fig. 48), is always more or less depressed below the surrounding surface, and has its laterocaudal margins sharply defined. With these differences and the apparent presence of one pair of pygidial lobes and possibly the beginnings of a second pair, no other characteristics in this stage of *A. edentata* appear to be noticeably at variance with those in the Phoenicococcini. The adult female of *A. edentata* (figs. 69 and 70) apparently has no characteristics that clearly distinguish it from the Phoenicococcini.

In the related species *Ancepaspis tridentata* (fig. 71), also, the only type of pore observed in the first stage and in the second and adult female stages is the 8-shaped tubular one, which apparently is of the same character as that occurring in *A. edentata* and the Phoenicococcini. In these stages *A. tridentata* differs chiefly from *A. edentata* as follows: First stage with two pairs of anal lobes; second-

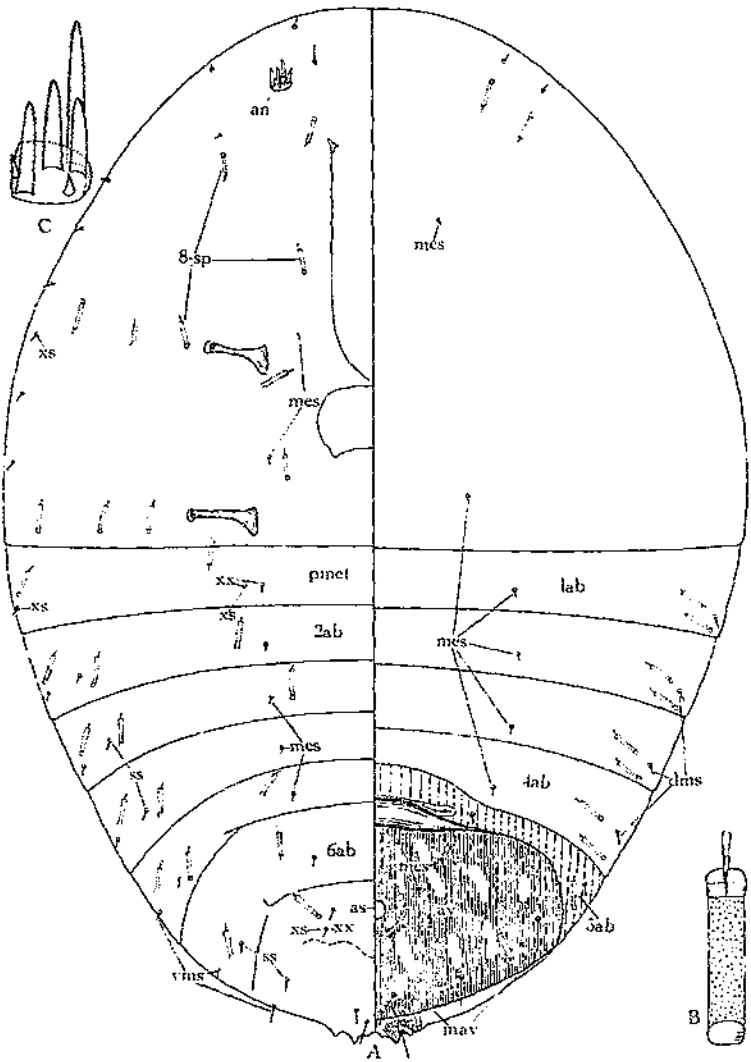

FIGURE 68.—*Ancepaspis edentata*, second-stage female: *A*, Body, dorsal and ventral, × 300; *B*, 8-shaped pore, × 3,000; *C*, antenna, × 2,000.

stage female with a distinct pygidium as far as sclerotization, pores, and setae go, but having no evident lobes or plates, though the undifferentiated caudal end projects to some extent, and no definite anal valve, the region corresponding to the boundaries of this in *A. edentata* having entirely disappeared in this stage, though apparently for egress of the subsequent generation of nymphs an irregular

rupture of the tissue takes place near the laterocaudal margin of the pygidium; adult female having a modification of the posterior end resulting in a pygidium with a characteristic 3-pronged caudal projection.

Both *Ancepaspis edentata* and *A. tridentata* produce a covering of waxy filaments of the same general texture and color as is produced

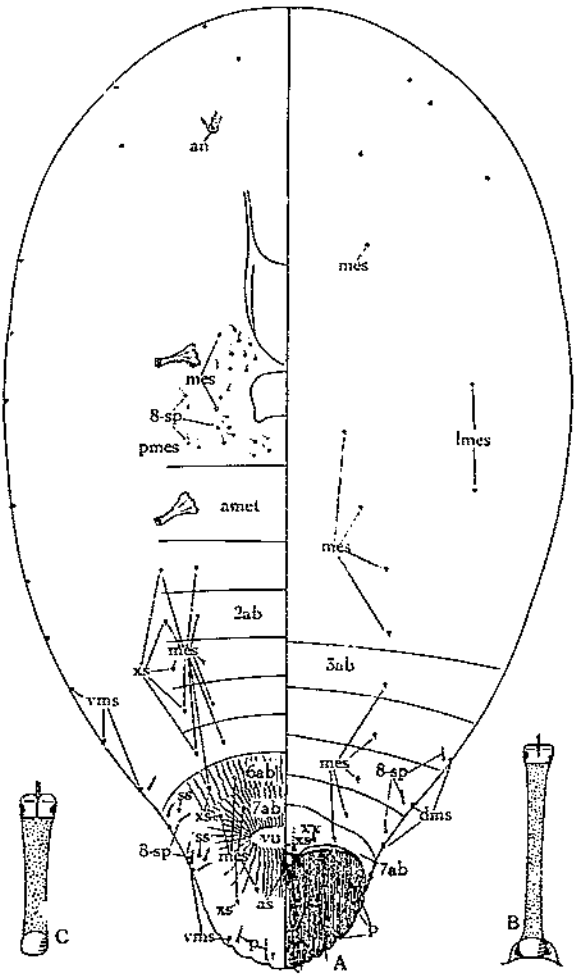

FIGURE 69.—*Ancepaspis edentata*, adult female: *A*, Body, dorsal and ventral, × 250; *B*, marginal 8-shaped pore, × 3,000; *C*, midventral 8-shaped pore, × 3,000.

in the Phoenicococcini; also the adult male of *A. tridentata* (fig. 72) (that of *A. edentata* was unavailable) is strikingly like those of the Phoenicococcini in that it develops in a definite first-stage puparium, has no vestige of wings or thoracic wing framework, and has a pronounced antennal club, stocky legs, and a rapierlike posterior projection. No specimens of the second-stage male of either *A. edentata* or *A. tridentata* were available.

In the second and adult female stages of *Protodiaspis lagunae* Ferris and *P. agrifoliae* Essig the pores are distinctly 8-shaped, numerous, scattered, all small, and structurally of the types (except in size and shape) figured for the second-stage male of *P. lagunae* (fig. 73, *A*, *B*, *D*, *E*). Apparently the only real structural difference between these pores and those in *Ancepaspis edentata* is that a sufficient sclerotization of what is apparently a section of the upper ends of the membranous tube has produced a third bar. The pores of the second-stage male of these two species are numerous, mostly of the small type figured for *P. lagunae*, but in the latter there are five pairs of large, very broad, heavily sclerotic pores along the posterior margin, of the type of the large pore figured, and in *P. agrifoliae* there are only three pairs of these large pores in this stage. In *Ancepaspis anomala* Green (fig. 73, *G*) this large, heavy type of pore is numerous posteriorly and around the margin in the second-stage male, but does not occur in any other stage. In the first stage and in the second and adult female stages of *A. anomala* the only pores present are structurally (except in size and shape) on the order of the large type figured for the first stage of *Chionaspis etrusca* Leon. (fig. 76, *B*), but all are small, numerous, and scattered in the two later female stages mentioned, as in *P. lagunae* and *P. agrifoliae*. In *C. etrusca* (fig. 76, *C* and *E*) a large heavy pore is in evidence, not only in the second-stage male, but in the second and adult female stages. It is a characteristic type in the corresponding stages of all typical diaspids. Viewed endways, these large heavy pores exhibit a typical twisted 8-shaped effect. The only other pore types present in any stage of *P. lagunae*, *P. agrifoliae*, and *A. anomala* are trilocular or quinquelocular disk ones, the pores of which are

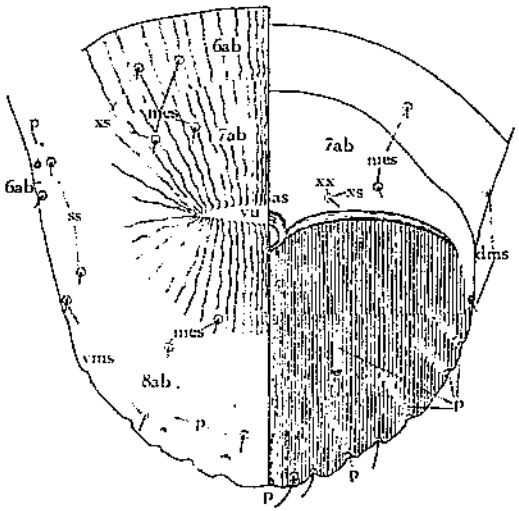

FIGURE 70.—*Ancepaspis edentata*, adult female, posterior end, dorsal and ventral, × 550.

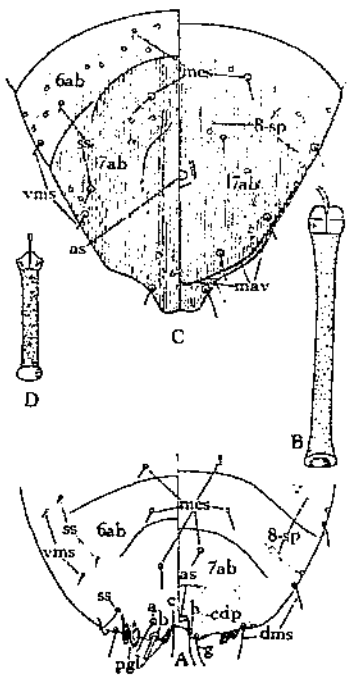

FIGURE 71.—*Ancepaspis tridentata*: *A*, First-stage nymph, posterior end, dorsal and ventral, × 500; *B*, same, marginal 8-shaped pore, × 3,000; *C*, second-stage female, posterior end, dorsal and ventral, × 500; *D*, adult female, 8-shaped pore, × 3,000.

associated with one or both pairs of spiracles only. *P. lagunae* is of further interest in that its adult male is noticeably like those in *Ancepaspis tridentata* and the Phoenicococcini, the antenna being about half way between being clubbed and filiform and there being no vestige of wings or of thoracic wing framework.

In the first stage of *Ancepaspis anomala* the posterior end is distinctly pygidial, the anus being well up on the dorsal surface, which is plainly sclerotic, and at least one pair of pygidial lobes is present. The second-stage female becomes a puparium, but the caudal valve, which is better defined than in *A. edentata*, is entirely on the ventral surface though the anus remains normal in position on the dorsum. Both the anus and the valve are apparently restricted to the eighth abdominal segment, as they are in the Phoenicococcini. The adult male of *A. anomala* has a long filiform antenna and well-developed thoracic wing framework and wings. These features, taken in conjunction with the typical diaspid type of tubular pore in the first stage and the second and adult female stages, indicate this species to be quite different from *A. edentata* and *A. tridentata*.

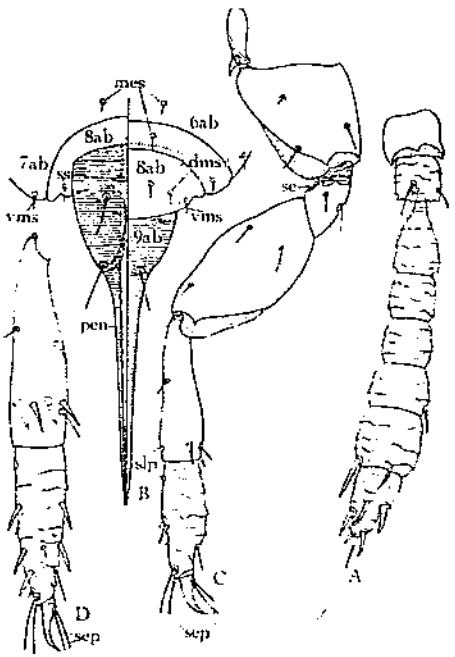

FIGURE 72.—*Ancepaspis tridentata*, adult male: *A*, Antenna; *B*, posterior end, dorsal and ventral; *C*, mesothoracic leg; *D*, tibiotarsus of metathoracic leg. ×500.

Full figures are given for the first stage and the second-stage female of *Chionaspis etrusca* (figs. 74 and 75) in order to show the structural parts in a typical diaspid. In both stages most of the body parts can apparently be readily homologized with the corresponding ones in the Phoenicococcini. The tubular pores are 8-shaped, with the partition extending only through the distal bar; they are of two kinds (fig. 76, *A* and *B*), one with a wholly membranous tube, the other having apparently developed a sclerotic bar in the upper part of the tube. The smaller tubular pore and also the heavy type of tubular pore in the adult female of *C. etrusca* (fig. 76, *D* and *E*) appear to be fundamentally like those in the adult female and second-stage male, respectively, of species in *Protodiaspis* mentioned above. The pores of the second and adult female stages of *C. etrusca* are essentially alike.

The antenna of the first stage of *C. etrusca* has only five segments and one slender seta on the distal segment, but otherwise it bears a near resemblance to the 6-segmented type in the Phoenicococcini. In an aspidiotine form the only noteworthy differences between its annulated type of antenna and that present in a genus of the Phoenicococcini (fig. 52) are the presence of an additional seta on the

basal segment, the absence of 2 or 3 setae on the annulated part, and possibly the sharper outlines of the third and fourth segments.

The dried material of *Xanthophthalma concinnum* Cockerell and Parr resembles that of the diaspid type. The adult female, for example, possesses two naked exuviae attached to a thin waxy shell entirely covering the body. The first stage and the adult female stage of *X. concinnum* (figs. 77 and 78) apparently possess only one type of pore, the 8-shaped tubular one, which seems to have the essential characteristics of that type in the Phoenicococcini except that a slight sclerotization, apparently of the membranous tube, just below the bar can be distinguished in at least the first stage. This pore is apparently not essentially different from a type occurring in the second-stage male of *Ancepaspis anomala* Green (fig. 73, *H*), or even in a more typical diaspine form (fig. 73, *I* and *K*). *X. concinnum* is included in this discussion because it shows some definite diaspid characteristics such as those mentioned above but has some others not so definitely diaspidlike, for example, an ill-defined pygidium, if this structure can be considered as present at all, in both of the above-mentioned stages, in which segmentation is complete through to the eighth abdominal segment, no clear-cut sclerotic piece or pygidial lobes or plates, and no accumulation of distinctly specialized pores in the posterior region.

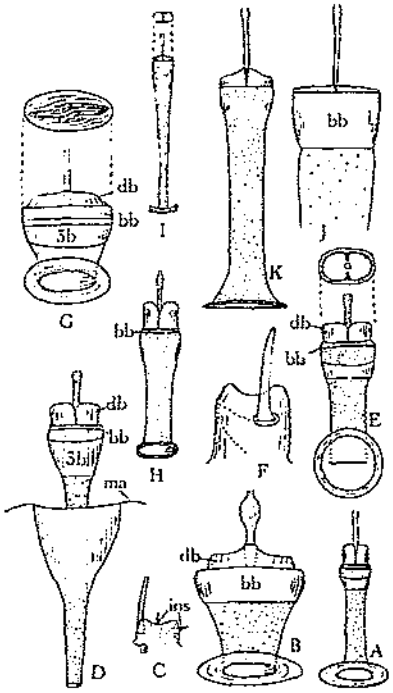

FIGURE 73.—*A–F, Protodiaspis lagunae: A*, Second-stage male, smaller pore, × 3,000; *B*, same, heavy posterior marginal pore, × 3,000; *C*, same, antenna, × 2,000; *D*, adult female, raised pore, × 3,000; *E*, same, pore, × 3,000; *F*, same, antenna, × 2,000. *G* and *H*, *Ancepaspis anomala: G*, Second-stage male, heavy posterior marginal pore, × 3,000; *H*, same, cephalic marginal pore, × 3,000. *I–K*, *Aspidiotus* sp.: *I*, First-stage nymph, 8-shaped pore, × 3,000; *J*, adult female, section of very long caudal pore, × 3,000; *K*, same, moderate-sized marginal pore, × 3,000.

A word as to the anal valve. Between its type in the Phoenicococcini and that in *Ancepaspis edentata* there would seem to exist a gulf, owing to the larger number of segments embraced by the anal valve in the latter. Yet in *A. anomala*, a species that has more typical diaspid characteristics than its congener *A. edentata*, and, for example, in *Gymnaspis ramakrishnae* Green, a rather definite diaspid, the valve embraces no more segments than in species of the Phoenicococcini, and is, moreover, entirely on the ventral surface, thus being decidedly different in this particular from *A. edentata* and the Phoenicococcini. On the other hand, from the type of anal valve in *A. edentata* to the lack of one in *A. tridentata*, in which species, however, the tissue eventually ruptures along a rather definite, though irregular line, appears to be only a simple step, and continuing to the pygidium of the corresponding stage of a typical diaspid, as, for example, *Chionaspis*

etrusca Leon. (fig. 75), appears to be only another step. However, it must not be assumed that the pygidium necessarily developed in this manner, since a pygidium, or at least a posterior rather clearly

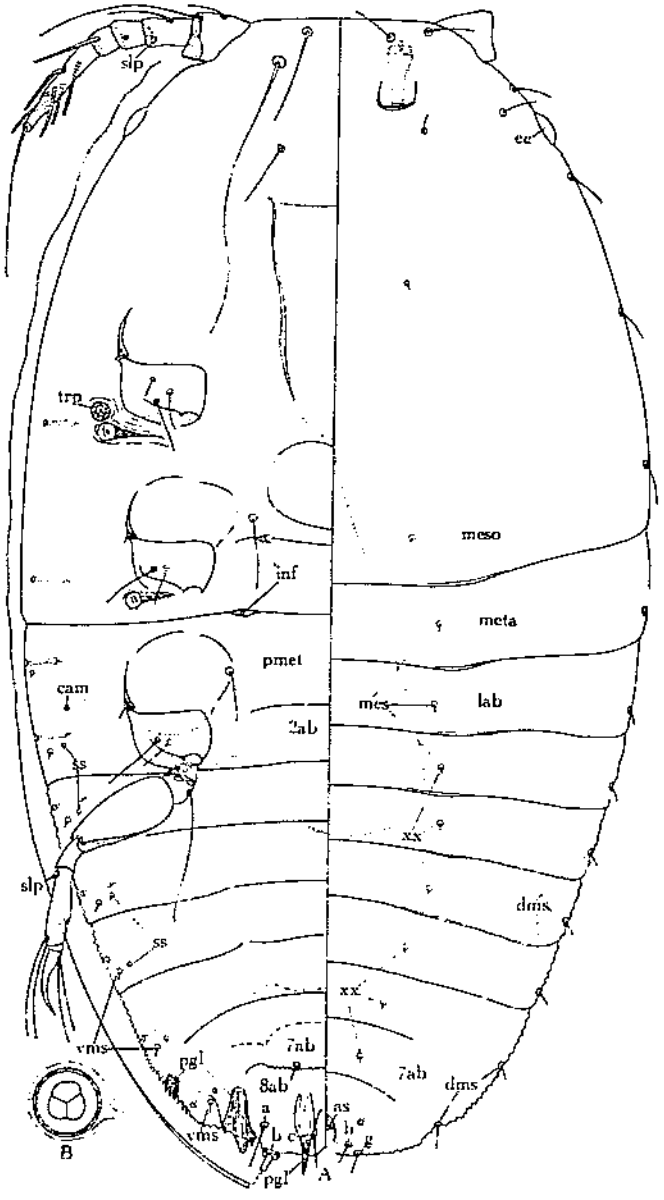

FIGURE 74.—*Chionaspis etrusca*, first-stage nymph: *A*, Body, dorsal and ventral, ×600; *B*, trilocular mesothoracic pore, × 2,000.

defined sclerotic dorsocaudal area possessing pores, setae, and the anus, and in one species pygidial plates as well, is present in the adult female of members of the Phoenicococcini. In some species of this

tribe, also in *A. edentata* and *A. tridentata*, the pygidium appears to include no more than the dorsum of the eighth abdominal segment, but in other species (figs. 54 and 60) it appears to embrace or crowd out, also, at least parts of the dorsum of the seventh and even the sixth abdominal segment, thus approaching the condition in typical

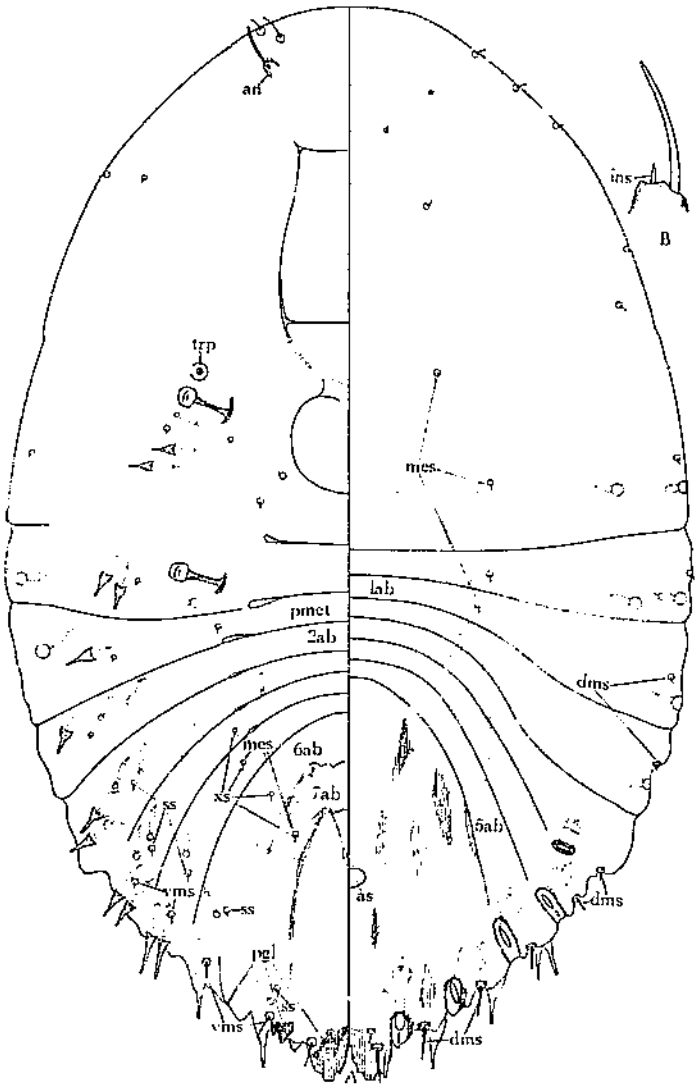

FIGURE 75.—*Chionaspis etrusca*, second-stage female: *A*, Body, dorsal and ventral, × 500; *B*, antenna, × 2,000.

diaspids, in which this structure is considered to embrace ordinarily all of the eighth, seventh, and sixth abdominal segments. Since the characteristics exhibited by the valve and the pygidium are shown to be independently variable, even among definitely related species, it would seem that differences in the value between such a species as

A. edentata and the Phoenicococcini should not be considered of serious moment.

A theory of the evolution of the 8-shaped tubular pore occurring among the more typical diaspids may be presented very briefly as follows: At first (as in *Ancepaspis edentata* and *A. tridentata*) the pores are subequal and moderate in size in all stages. They possess two bars, a bulla, and a regular 8-shaped effect, and have the partition extending no more than through the distal bar. In short, they are in general character like the more delicate pores occurring in members of the Phoenicococcini. Eventually certain modifications arise. An apparent third bar begins to form in some pores, either out of the basal bar or out of the upper part of the membranous tube. This third bar may or may not become strongly sclerotic and well defined. At the same time a tendency may or may not develop for the pores, especially the marginal ones, to increase in size and sclerotization, becoming the heavy pores mentioned above as present in various diaspids, including the typical one, *Chionaspis etrusca*, represented here.

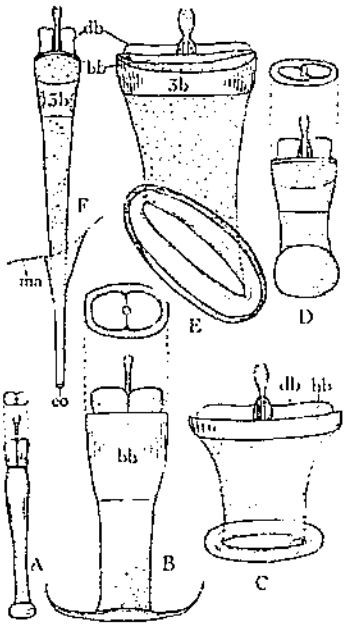

FIGURE 76.—*Chionaspis etrusca*: *A*, First-stage nymph. 8-shaped pore; *B*, same, large head pore; *C*, second-stage male, heavy posterior marginal pore; *D*, adult female, smaller pore; *E*, same, heavy posterior marginal pore; *F*, same, raised pore, ×3,000.

Ancepaspis edentata, as has been brought out, shows more characteristics in common with the Phoenicococcini than does any other species studied. With differences between its anal valve and those of the Phoenicococcini indicated as being unimportant, this species is sufficiently similar to the Phoenicococcini in its general characteristics to be considered as related to this tribe. *A. tridentata*, without doubt congeneric with *A. edentata*, reveals only a little less in common with the Phoenicococcini than does *A. edentata*. Since these two species have definite diaspine features, such as pygidial lobes in the first stage and a pygidial posterior end in both the second stage female and the adult female, and have, moreover, no characteristics that would eliminate them from the diaspine assemblage, there seems to be sufficient justification for not only allying the Phoenicococcini with the diaspines but even including them within that assemblage.

Since *Ancepaspis edentata* and *A. tridentata* show possibly more characters in common with the Phoenicococcini than they do with any other species studied, it seems reasonable to suggest that these two species might properly be placed in a separate tribe to be included in the new subfamily Phoenicococcinae. Were this done, the definition of this subfamily as given herein would naturally have to be revised. However, no more than a suggestion for this classification

of these two species will be made in this bulletin, and no suggestions will be offered toward the segregation of other diaspid species studied.

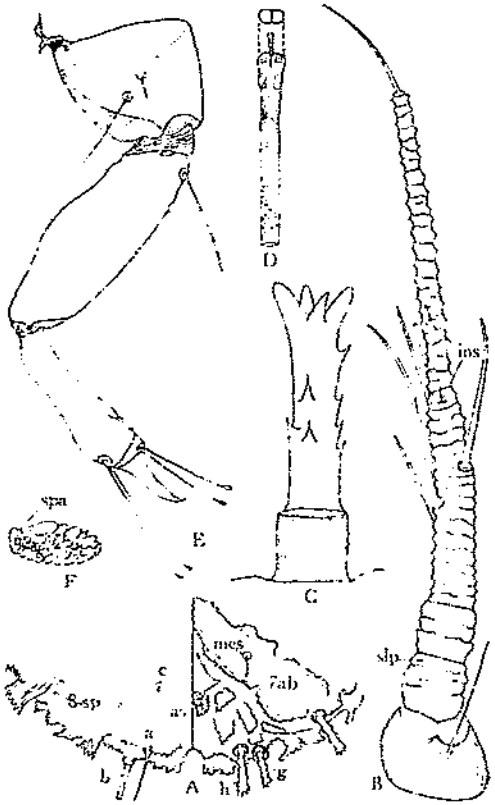

FIGURE 77.—*Xanthophthalma coccinnum*, first-stage nymph: *A*, Posterior end, dorsal and ventral, × 500; *B*, antenna, × 1,000; *C*, branched marginal seta, × 2,000; *D*, 8-shaped pore, × 3,000; *E*, metathoracic leg, × 1,000; *F*, mesothoracic spiracle, × 1,000.

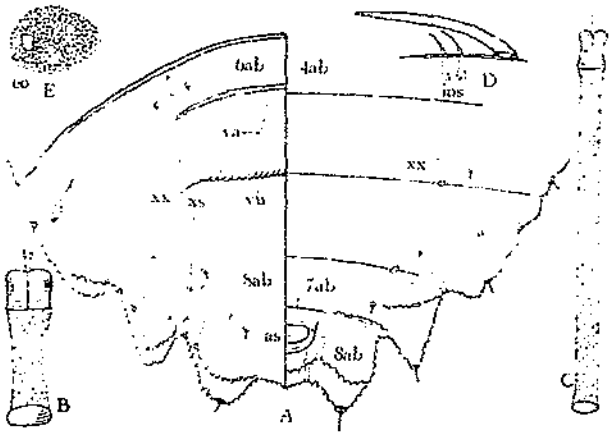

FIGURE 78.—*Xanthophthalma coccinnum*, adult female: *A*, Posterior end, dorsal and ventral, × 500; *B*, shorter 8-shaped pore, × 3,000; *C*, elongated posterior marginal 8-shaped pore, × 3,000; *D*, antenna, × 2,000; *E*, mesothoracic spiracle, × 500.

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