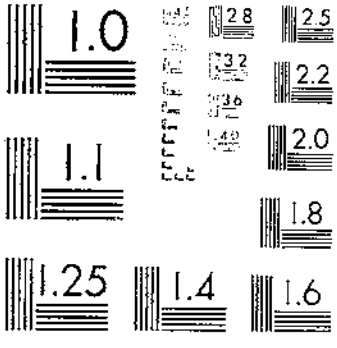
TB 421 (1934) USDA TECHNICAL BULLETINS UPDATA

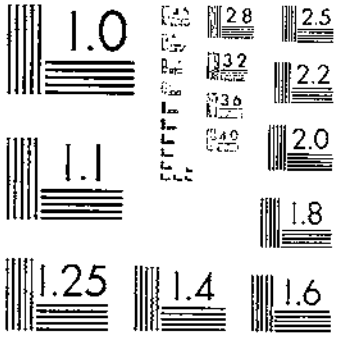
THE EXTERNAL ANATOMY OF THE PARLATORIA DATE SCALE, PARLATORIA BLANCHARDI

STICKNEY, F S. 1 OF 1

START



MICROCOPY RESOLUTION TEST CHART



MICROCOPY RESOLUTION TEST CHART

TECHNICAL BULLETIN NO. 421 JULY 1934

THE EXTERNAL ANATOMY OF THE PARLATORIA DATE SCALE, PARLATORIA BLANCHARDI TARGIONI TOZZETTI, WITH STUDIES OF THE HEAD SKELETON AND ASSOCIATED PARTS

By

F. S. STICKNEY

Associate Entomologist
Division of Fruit Insects
Bureau of Entomology
and Plant Quarantine

UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - - - - - - - - - - - Price 10 cents

Technical Bulletin No. 421 July 1934

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

THE EXTERNAL ANATOMY OF THE PARLATORIA DATE SCALE, PARLATORIA BLANCHARDI TARGIONI TOZZETTI, WITH STUDIES OF THE HEAD SKELETON AND ASSOCIATED PARTS [1]

By F. S. STICKNEY

Associate entomologist, Division of Fruit Insects, Bureau of Entomology and Plant Quarantine

CONTENTS

INTRODUCTION

Several species of palms found in the date-growing districts of the United States have been shown to be susceptible to the attacks of a scale insect which appears to be the Parlatoria date scale (*Parlatoria blanchardi* Targioni Tozzetti). This species is considered to be the most dangerous insect enemy of the date palm. An indication of the degree to which this insect may infest the fruit and leaves of the date palm is shown in plates 1 and 2. In order to determine whether the scale attacking these palms was actually *Parlatoria blanchardi* and to establish in detail, for all stages, the identity of this species, a thorough study of the external anatomy of the insect has been made.

The palms from which material was secured for use in this study were the date palm (*Phoenix dactylifera* L.), the Canary Island

[1] This work was done in the laboratory of G. F. Ferris at Stanford University, and through his kindness the writer had free access to the Stanford collection of Coccidae, which Professor Ferris has been instrumental in developing into what is probably, next to that in the National Museum at Washington, the best collection of scale insects in the United States. This privilege has proved especially valuable in giving opportunity for comparing the coccid forms collected by the writer on the various species of palms in the date-growing districts of the United States with the different species of *Parlatoria* in the collection. The writer expresses his thanks to Professor Ferris for constant interest and many valuable suggestions. Thanks are also due Dewey C. Moore, of the Government Date Garden at Indio, Calif., for the two photographs of live Parlatoria date-scale infestations, which were taken under field conditions.

palm (*P. canariensis* Hort. ex Chabaud), the Washingtonia palm (*Washingtonia filifera* Wendl.), and the doum palm (*Hyphaene thebaica* Mart.). These are the only palms, or for that matter the only species of plants, upon which the Parlatoria date scale is known to occur in this country. The date palm was imported in an infested condition. The other species have been found free from scale except where the trees were located so near to date palms as to render the source of infestation evident. The Canary Island palm, apparently, is readily attacked. A tree of this species distant 30 or more feet from date palms showed as heavy infestation as the date palms themselves. On the other hand, Washingtonia palms fully as old as the Canary Island palm, which were rubbing branches with old, heavily infested date palms, bore merely a light scattering of scales. The individuals present, however, were completing their life cycles; to what extent the generations finally succumbed and were succeeded by fresh recruits from the date palm, was not determined. The doum palms found infested were 30 feet from the nearest date palm. They were more heavily infested than were the Washingtonia palms but not so heavily attacked as were the Canary Island palms. It is highly probable that the Parlatoria date scale will infest any kind of palm if it can exist as well as it appears to do on such different genera as *Phoenix*, *Washingtonia*, and *Hyphaene*.

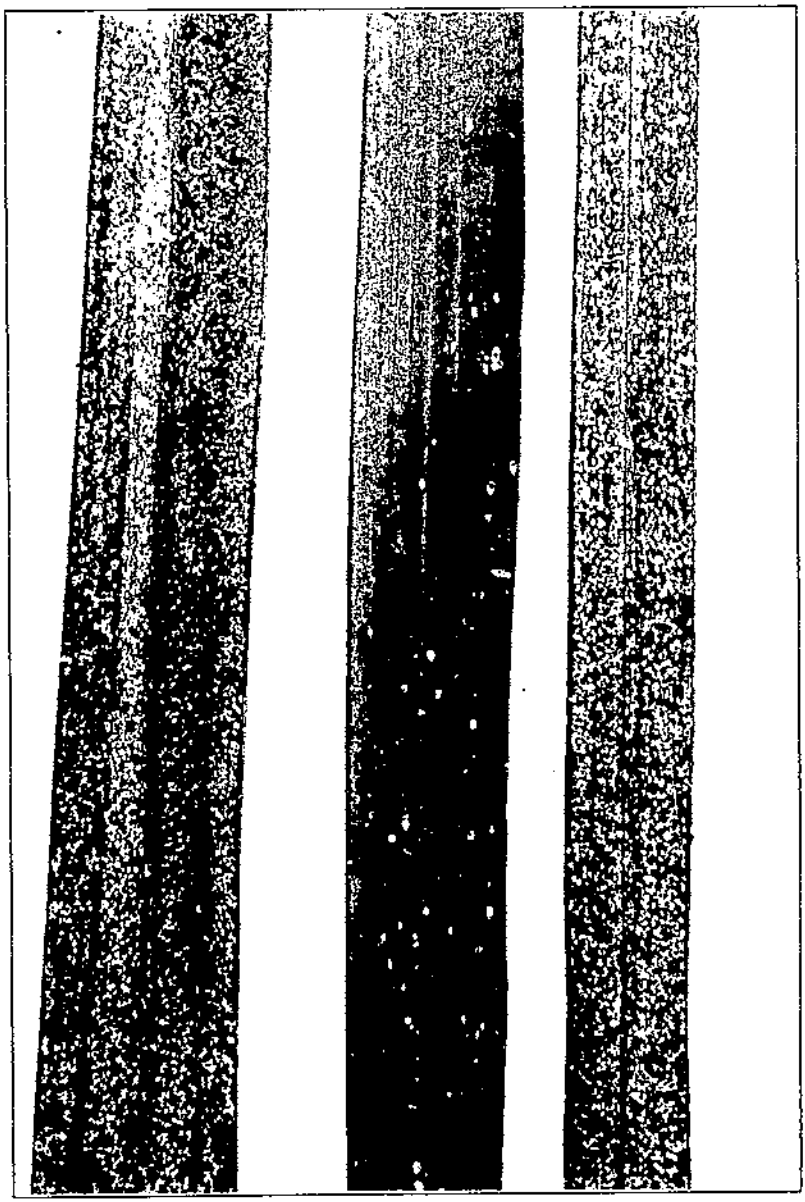
The study of every distinguishable external structure of the body in all instars of both sexes was undertaken from individuals collected from each host (except the third and fourth male instars, in which no specimens from Washingtonia palm were used), and included a critical comparison of the corresponding structures on each side of the meson of each individual. The results of this study are fully presented in the text and in illustrations.

No clear evidence was found that the insect from each species of palm was any other than *Parlatoria blanchardi*, and in consequence the description of the condition of each part of the body is based on the specimens studied from all four host palms.

The segmentation of the thorax is based on an interpretation by R. E. Snodgrass, of the Bureau of Entomology, that the spiracles are located on the anterior sections and the legs on the posterior sections of the thoracic segments. The following condition appears to prevail in all stages: On the venter, the prothorax and anterior section of the mesothorax are indistinguishably fused, and are referred to as the "mesoprothorax," the posterior section of the mesothorax and the two sections of the metathorax are distinct, and the first abdominal segment has been crowded out by the caudal migration of the thoracic parts; on the dorsum, the three primary thoracic segments appear to be neither divided nor fused, except in the adult male, and the first abdominal segment has not been obliterated.

In the divided figures, all representing particular individuals (from the date palm if not otherwise specified), the right side represents the dorsal aspect and the left side the ventral aspect; therefore, owing to the variations between the two aspects, the margins do not always precisely correspond. The bars of the pores on these figures, though located beneath the surface, are drawn solid to differ-

Date fruits and thread to which fruits were attached infested with the Parlatoria date scale (*Parlatoria blanchardi* Targioni Tozzetti)



Date leaves infested with the Parlatoria date scale (*Parlatoria blanchardi* Targioni Tozzetti).

entiate the parts clearly. Similar structures shown comparatively on a figure are drawn to the same scale. In the figures no setae or pores have been duplicated along the margins.

The endoskeleton of the head and the associated parts have also been discussed in detail and fully illustrated. The endoskeleton is represented with surface tissue removed in order to indicate its constituents the more clearly.

The terms "dextron" and "sinistron" refer to the right and left sides, respectively, of the insect from a dorsal view. Except where it seemed necessary for clearness to mention the structures on both sides of the body, the general discussion deals only with those of a single side, but in the average measurements and numbers of the parts both sides of the specimens are included, though as separate units, unless otherwise indicated. Words in common use are employed where possible to indicate particular structures or groups of structures; technical terms are used only where they seem necessary and clearly appropriate.

A segment referred to simply by number is the respective abdominal one.

In the discussion of the pores in all stages possessing them, the invaginated tubular type described for the first stage is the type referred to, unless otherwise indicated.

In the original description of (*Aonidia*) *Parlatoria blanchardi*, Targioni Tozzetti (*14*) [2] described for both sexes one more nymphal stage than the writer has observed in his investigations. A study of the structures of the bodies of individuals in process of molting has led to the conclusion that Targioni Tozzetti may have mistaken individuals of different ages of the same stage as representing separate stages, because such individuals appeared to be quite different, owing to growth, change in contour, and increase in sclerotization.

SYMBOLS USED ON ILLUSTRATIONS

a, anus.
a8ab, developing eighth abdominal segment of adult.
1ab–9ab, first to ninth abdominal segments.
9abs, marginal seta of ninth abdominal segment.
ac, antecostal suture.
aca, anal sclerotic area.
acx, precoxal bridge.
adcla, developing adult claw.
adco, developing adult coxa.
adfe, developing adult femur.
adta, developing adult tarsus.
adti, developing adult tibia.
adtr, developing adult trochanter.
alb, alar buttress.
alo, alar lobe.
amet, anterior section of metathorax.
an, antenna.
ana, anterior notal wing acetabulum.
anp, anterior notal wing process.
ap, anterior marginal plate.
ar, anal ridge.
as, antennal seta.
1as–5as, first to fifth antennal setae.
ass, anterior submarginal seta.
aw, prealar bridge.
1ax–4ax, first to fourth axillary sclerites.
axc, axillary cord.
ba, base of antenna.
bb, basal bar.
bhs, border head seta.
bmn, base of mandible.
bmx, base of maxilla.
bpen, base of penis.
bpl, base of salivary plunger.
bs, basisternum.
bu, bulla.
camr, caudal membrane articulating against rostrum.
cart, caudal rostral thickening.
cemr, cephalic membrane articulating against rostrum.
cert, cephalic rostral thickening.
cha, sclerotic area.
chs, caudal head seta.

[2] Italic numbers in parentheses refer to Literature Cited, p. 66.

cla, claw.
cls, clypeolabral suture.
co, coxa.
cru, crumena.
da, differentiated area.
db, distal bar.
dba, dorsal band.
dms, dorsal marginal seta.
8dms, *9dms*, eighth and ninth dorsal marginal setae.
dor, dorsal orifice of head skeleton for egress of rostralis.
dp, process of dorsal surface.
dpr, dorsal prominence at apex of rostrum.
dw, developing wing of subsequent stage.
e, eye.
eo, external opening.
1ep, anepisternum.
2ep, katepisternum.
epm, epimeron.
et, external tracheal thickening.
f, furca.
fe, femur.
fs, furcisternum.
gb, globular base of spinelike thickening of rostrum.
gc, genaceroris.
gsh, genital sheath.
ha, halteris.
in, invagination of alimentary tract.
ina, inferarea.
in9ab, mouth of invagination of ninth abdominal segment.
inc, infercosta.
inf, intersegmental furca.
inl, line of invagination.
inm, invagination of mandibular and maxillary bars.
inp, invagination of pharyngeal tube.
ins, invagination of mandibular sheath.
it, internal tracheal thickening.
ita, interarea.
1l–5l, first to fifth lobes.
la, line of apposition of sides of invaginated tube.
lap, lateral apodeme.
lb, lateral band.
le, leg.
lmes, lateral mesal seta.
lrs, large rostral seta.
m, median vein.
mab, marginal bulging.
mar, membranous area of scutellum.
mbp, mesal body pore.
mcr, mouth of crumena.
mea, meatus.
mes, mesal seta.
meso, mesothorax.
met, membranous tube.
meta, metathorax.
mhs, mesal head seta.
1mhs–3mhs, first to third mesal head setae.
mis, minute invaginated seta.
mn, mandible.
mnb, mandibular brace.
mnp, mandibular pocket.
mns, mandibular sheath.
mnt, mandibular tendon.
mof, mouth of furca.
mp, marginal pore.
mpl, marginal plate.
mpr, maxillary process.
mrp, marginal raised pore.
ms, marginal seta.
mx, maxilla.
mxb, maxillary brace.
mxp, maxillary pocket.
mxs, maxillary sheath.
mxt, maxillary tendon.
o, internal vaginal opening.
oe, esophagus.
p, pore.
pa, process area of ventral surface.
p9ab, developing ninth abdominal segment of fourth stage.
pbp, posterior body pore.
pc, precosta.
pcx, postcoxal bridge.
pdp, prominence of dorsal band.
pe, peritreme.
pen, penis.
ph, pharynx.
phr, phragma.
phs, pharyngeal sclerite.
pl, pleural sclerite.
pla, pleural acetabulum.
plc, pleural wing condyle.
pls, porelike structure.
plw, pharyngeal lateral wall.
pmes, posterior section of mesothorax.
pmet, posterior section of metathorax.
pna, posterior notal wing acetabulum.
pnp, posterior notal wing process.
po, pore opening.
poo, posteosta.
pos, mesothoracic postscutellum.
pp, posterior marginal plate.
pr, prothorax.
pra, third-stage antenna (male).
prl, third-stage leg (male).
prp, primary pore.
prs, suture between head and prothorax.
ps, pleural seta.
psc, mesothoracic praescutum.
pss, posterior submarginal seta.
pte, pharyngeal tube bulblike chamber.
pte, pharyngeal tendon.
ptu, pharyngeal tube.
pua, developing antenna of fourth-stage male.
puco, developing coxa of fourth-stage male.
putr, developing trochanter of fourth-stage male.
pvo, postalar bridge.
r, rostrum.
ra, raised area of head.
rad, radial vein.
rap, rudimentary anterior plate.
ro, rostral condyle.

rg, ring of genaceroris.
ri, ridge.
r5l, *r6l*, rudimentary fifth and sixth lobes.
rol, rostralis loop.
ros, rostralis.
rpp, rudimentary posterior plate.
1rsc, *2rsc*, first and second rostral sclerites.
rsg, rostral groove.
sad, salivary duct.
sap, salivary pump.
sas, small antennal seta.
1sat, *2sat*, first and second salivary tendons.
sbp, suture between maxillary brace and process.
sc, subcostal vein.
scl, mesothoracic scutellum.
sct, mesothoracic scutum.
sdc, salivary-duct bulblike chamber.
sep, secondary pore.
ses, apparent suture between sixth and seventh abdominal segments.
skc, condyle of ventral surface membrane.
slp, spinelike process.
smp, submarginal pore.
sp, spiracle.
spa, spiracularia.
spc, spiraceroris.
spl, spinelike projection.
spl, salivary plunger.
sps, spiracular submarginal seta.
spu, spur.
sr, sclerotic ring.
srp, submarginal raised pore.
srs, small rostral seta.
ss, submarginal seta.
sss, secondary submarginal seta.
st, stylus.
str, spinelike thickening of rostrum.
sua, superarea.
suc, supercosta.
sw, swellings of genital sheath.
t, trachea.
ta, tarsus.
tc, teeth.
teg, tegula.
ti, tibia.
tpl, tendon of salivary plunger.
tpw, thickening of pharyngeal wall.
tr, trochanter.
ucha, undetermined sclerotic area.
usc, undetermined sclerite.
va, vagina.
vb, ventral band.
vcha, vaginal sclerotic area.
vma, ventral membranous area.
vmcp, ventral mesal pore.
vms, ventral marginal seta.
8vms, *9vms*, eighth and ninth ventral marginal setae
vp, process on ventral surface.
vpr, ventral prominence at apex of rostrum.
vs, ventral surface.
vsr, ventral surface ridge.
vu, vulva.
vucha, vulvular sclerotic area.
w, wing or wing pad.

Broken lines_____ Ridges (or indicating connections between different aspects of the same structure).
Cross hatching____ Space.
Dashes_____ Sclerotic parts or a solid background.
Dotted lines_____ Outlines of structures below surface.
Stippled areas____ Membranous tissue.
Wavy lines_____ Tendonous tissue.

EXTERNAL ANATOMY

EGG

The cuticle of the egg was too delicate to show any features, except a single pair of spines (fig. 1, *G*, *II*) situated near the ventrocephalic margin of the head. These spines showed slight variations in form and degree of sclerotization. They were approximately 4μ in diameter and only moderately raised above the surface.

FIRST STAGE (MALE AND FEMALE)

Twenty-eight males in process of molting, at which time the sex can be determined by the presence of the second-instar male within the first-instar cuticle, all possessed a single prominent spur (fig. 1, *A*, *spu*) on the outer margin of the tibia. This spur appears to be a stout seta, though the presence of the calyx is difficult to detect with certainty. Twenty-four specimens definitely determined to

be females showed the following conditions regarding this spur: 16 had no spur on any leg; of those with a single spur, 2 had it on the right prothoracic, 1 on the left prothoracic, and 2 on the left metathoracic leg; of the 3 individuals with 2 spurs, 1 had these on both prothoracic legs, 1 on the right prothoracic and right metathoracic legs, and 1 on the right prothoracic and right mesothoracic legs. Many other individuals were observed from time to time in which there occurred either a single spur on all 6 legs, suggesting the male, or, usually, none on any leg, suggesting the female. Occasionally 1 spur occurred on 1 leg, but rarely were there 2 on any 2 legs, again suggesting the female.

The foregoing data regarding the presence or absence of this spur indicate that there is sex differentiation in this stage. Since no other sexual characters were discovered, however, it appeared desirable to discuss the two sexes of this stage together. Two of each sex from each of the four palms, 16 in all, were studied in detail.

The contour of the body is roundly oval at first, as shown in figure 1, *A*, which represents a newly hatched male from a Canary Island palm. The average length and width of 12 males and 14 females that were newly hatched were 0.26 and 0.16 mm, respectively. In individuals ready to molt the lateral contour is somewhat more sharply oval. The average length and width, respectively, of 26 males ready to molt collected from the four host palms were 0.39 and 0.28 mm, and of 21 such females, 0.41 and 0.29 mm.

DORSAL ASPECT OF THE BODY

BODY SEGMENTS

The pygidium is considered to be composed of four segments, the sixth to the ninth abdominal, inclusive, on the basis of the number and position of the setae, pores, plates, and lobes. It is a fused piece in which the segments are indistinguishable apart except for the presence of the caudal portion of what is considered to be the suture (*ses*) between the sixth and seventh abdominal segments. There are several distinct areas in the younger nymphs, but as the individual develops the sclerotization becomes heavy and gradually covers the whole pygidium. The general size and shape of the remaining body segments are indicated in figure 1, *A*.

SETAE

Four large setae, the border head setae (*bhs*), are invariably located on each side along the margin of the head. Posterior to the two cephalic border head setae occur two smaller setae, the mesal head setae (*mhs*). Posterior to the mesal head setae is a smaller one, the caudal head seta (*chs*). All the setae on the head are situated typically as represented in figure 1. Located mesally on the thorax and abdomen is a characteristic curved row of six small setae, the mesal setae (*mes*). The cephalic one is near the meson apparently on the prothorax. The other five occur successively on the immediately following segments. In two specimens there was no seta on either side of the third abdominal segment. Nearly half way between the meson and the margin on the mesothorax and on the metathorax are setae that are slightly larger than the mesal setae and

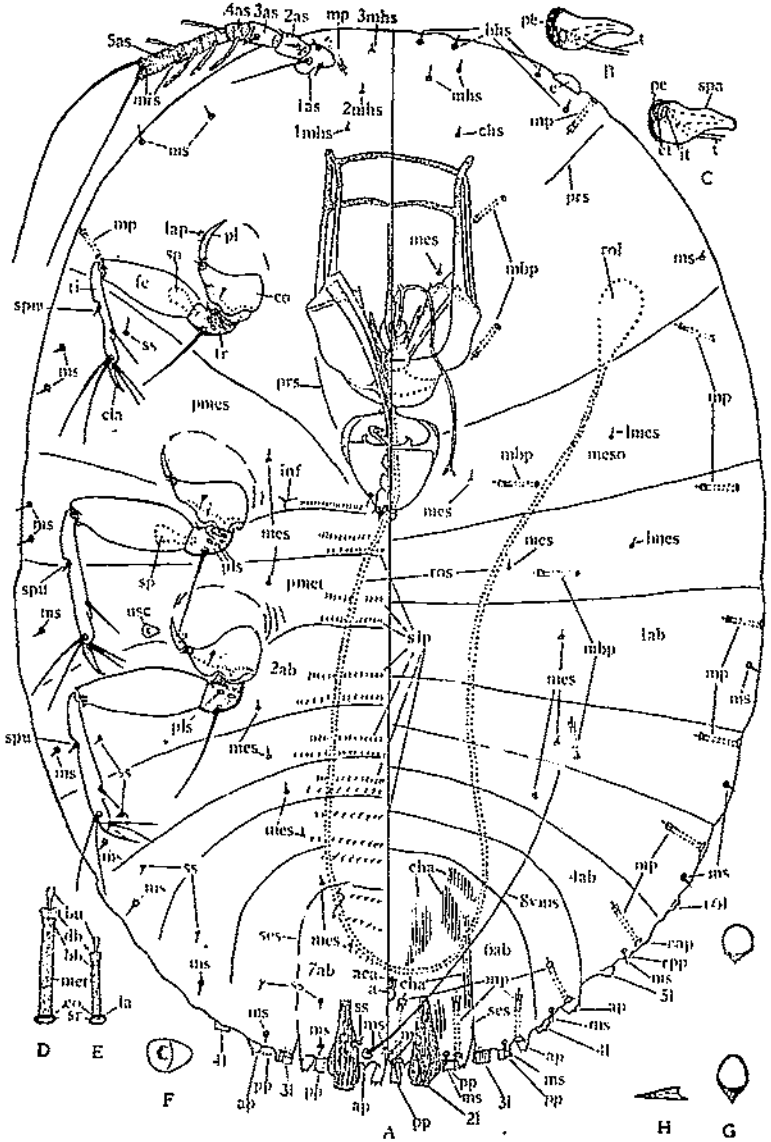


FIGURE 1.—*A*, Body, first-stage male (dorsal surface at right of observer); *B*, mesothoracic spiracle, first-stage male; *C*, metathoracic spiracle, first-stage male; *D*, marginal pore of eighth abdominal segment, first-stage male; *E*, dorsal marginal pore of head, first-stage male; *F*, undetermined sclerite lateral of metathoracic leg, first-stage male; *G*, pair of egg spines (approximate distance apart as indicated); *H*, egg spine, lateral aspect. *A*, × 540; *B*–*H*, × 1,000.

are called the lateral mesal setae (*lmes*). These two setae are constant in occurrence and almost so in position. Near the margin apparently on the prothorax and along the margin of apparently each abdominal segment at regular intervals also occurs a seta, called a marginal seta (*ms*). What is considered to be the ninth abdominal seta (fig. 2, *9abs*) is crowded beyond the margin and much reduced in size.

The average diameters, in microns, of the calyces of the various groups of dorsal setae of the head and body are as follows: Sixth, seventh, and eighth abdominal marginal, 2.3; fifth abdominal marginal, 1.9; first, second, third, and fourth abdominal marginal and anterior border head (three), 1.5; posterior border head, mesal head, prothoracic marginal, lateral mesal, 1.4; caudal head, mesal body, and ninth abdominal marginal, 1.2.

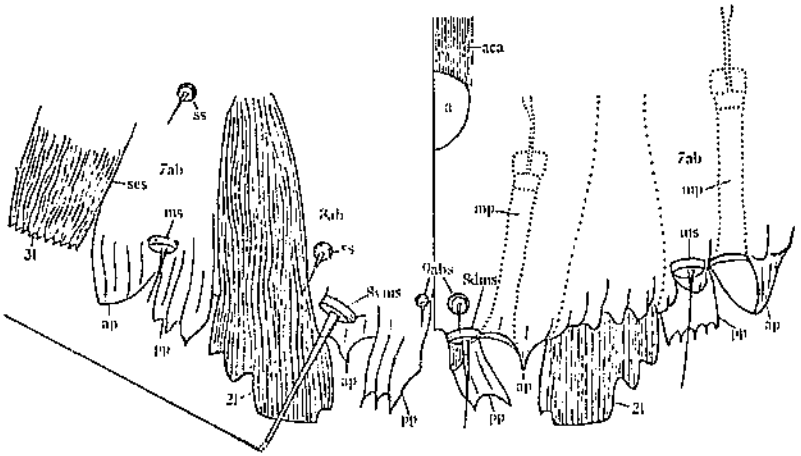


FIGURE 2.—Caudal margin of the abdomen, first-stage male. ×2,000.

EYE

The eye (*e*) is always present as a dome-shaped structure, about 8μ in diameter by 3μ in thickness, and ordinarily is situated on the margin of the body, between the two posterior border head setae.

PORES

Only one kind of pore is present (fig. 1, *D*, *E*), the invaginated tubular type having an external opening (*eo*) surrounded by a lightly sclerotic ring (*sr*) and a long delicate tube (*met*) ending in two bars. The basal bar (*bb*), which is apparently a union of what is usually considered the two bars of the pores of other diaspine species, is but little more sclerotic than the tube, and of about the same width, but it is distinctly heavier on the lateral margin. The distal bar (*db*) normally is expanded somewhat apically, more heavily sclerotic than the basal one, and capped by the "bulla" (*bu*) of MacGillivray (*8*, *p. 223*), a structure extending through the distal bar, narrow at the base and expanded apically. It is probable that the secretions pass from the wax cell through the bulla.

There is a series of pores along the margin of the body, one on each segment except the ninth abdominal one, which is too small to possess a pore (fig. 2). On the prothorax the pore is on the ventral surface. The head is peculiar in possessing two pores, the caudal pore on the dorsal surface and the cephalic one on the ventral, and known, respectively, as the ventral and dorsal marginal pores (*mp*). The largest pore is on the eighth abdominal segment, and measures uniformly about 15μ from the external opening, which is about 1.7μ wide, to the apex of the distal bar. The tube and the external opening are of practically the same width. The pores gradually decrease in size toward the head, the head pores being 9.5μ long and having a tube width of 1.2μ. The external opening does not decrease in the same proportion as the tube, and on the head the latter appears to expand somewhat on reaching the exterior. No marginal pore was ever observed to be absent. These pores are always located cephalad of the marginal setae of this surface on the two posterior segments of the thorax and on the abdomen.

Pores occur mesally on the thoracic and the second abdominal segments and are of about the same size as the marginal pores of the same segments. They always occur laterad of the mesal setae of these segments and may be called the mesal body pores (*mbp*). One of these pores is so situated that it is difficult to determine whether it is on the prothorax or the head. On two specimens of each sex the metathoracic pores were absent.

PLATES

On the pygidium are three sets of projections that may be called plates (*ap*, *pp*), the "squamulae" of Green (*4*). The cephalic half of the anterior plate of each set nearly always projects to a point and is slightly sclerotic. Its posterior margin makes a distinct curve caudad toward a pore, merging with the ring of the pore. The caudal half of each anterior plate is a little less sclerotic, and may or may not be toothed. The posterior plate of each set is characteristically broad, with a toothed distal margin, delicate and difficult to see except in well-stained specimens. At the base of each posterior plate is a dorsal marginal seta.

The plates on the eighth abdominal segment will be called the first or median set of plates, those on the seventh segment the second set of plates, and those on the sixth segment the third set of plates. On the fourth and fifth abdominal segments anterior plates may or may not be present, but usually are found on at least one side of the meson. Posterior plates of these segments seemed to be absent, or at most rudimentary, though there was occasionally a slight bulging. In figure 1 is a good example of rudimentary plates on the fourth abdominal segment (*rap*, *rpp*). The plates seem unquestionably to have arisen as bulgings from the body margin. Owing to the rudimentary condition of some of them, their exact number is sometimes doubtful. An examination of 2 male and 2 female specimens from each of the 4 host palms revealed much variation in the development of the 3 posterior pairs of these plates. The first or inner pair was sometimes absent, and the number of teeth ranged from 2 to 4, with an average of almost exactly 3. In only one specimen was the second pair of plates lacking, and the plates that were dentate had from 3 to

6 teeth, with an average of 4.7. A few of the third plates were also lacking, 2 were rudimentary only, and the remainder showed from 2 to 6 teeth, with an average of exactly 4.

LOBES

The marginal lobes (*1l* to *5l*) are also apparently outgrowths from the caudal margin of the body. When large and heavily sclerotic, they are easily recognized. The smaller and more delicate ones might be overlooked except through careful observation, especially as to their positions with regard to the neighboring setae, pores, and plates. For example, a lobe occurs immediately caudad of a marginal seta and pore on abdominal segments 5, 6, and 7, and sometimes the fourth abdominal segment appears to possess a lobe. Each one is in the same relative position with respect to the setae, pores, and plates of that segment. The first lobe is apparently absent (fig. 2). The position of the large, strongly sclerotic lobe indicates rather certainly that it is the second lobe.

The dimensions and extent of notching or dentation of these marginal lobes in 2 female and 2 male specimens from each of the 4 host palms may be summarized as follows: The second lobe varied only slightly in dimensions, the length ranging from 19 to 23μ, with the average 22μ, and the width from 6 to 7μ, with the average 6.75μ. Except in a single specimen, in which it was entire, the margin of this lobe had a distinct notch at the inner apical corner, and usually 1, but sometimes 2, comparable notches in the outer lateral edge. The lightly sclerotic and distally slightly convex third lobe ranged in length, as measured from body margin to tip, from 1 to 4μ, with the average 2.1μ, and had a width range of from 1 to 6μ, with the average 5.2μ. The width was usually more than twice the length. The apical margin was frequently minutely serrate, but more often exhibited from 3 to 7 teeth, or an average of 4.3. The nonsclerotic and variable fourth lobe may be rudimentary or lacking; when present it may be pointed or rounded at the apex or more or less truncate, and either serrate or with from 2 to 8 teeth on the outer margin. The length of the fourth lobe in the individuals showing it ranged from 1 to 4μ, with an average of 1.8μ; the width ranged from 1.5 to 8μ, with an average of 4.5μ. The fifth lobe was rarely present and resembled the fourth in its variability. Its length ranged from 1 to 2μ, with an average of 1.6μ; its width from 1 to 6μ, with an average of 3.6μ. With the exception of one side of one specimen, on which 6 teeth were found, this lobe was neither serrate nor dentate at the apex. In most of the individuals a slight bulge occurred on the third abdominal segment, which might be taken for a sixth lobe (*6l*). This slight bulge also occurred on the fourth segment in nearly every case, but in most instances it was not sufficiently differentiated from the margin to be considered a separate structure. Even the fourth lobe may sometimes be considered to be rudimentary, as when only 1 to 1.5μ in length. Indeed, only the second and third lobes would usually be observed as such. It is readily seen that in this stage the number of lobes would be practically worthless as a point in classification. The number of notches would also have to be used with caution, for the number on different individuals, and even on the lobes of the two sides of the same individual, fre-

quently differs, and there may even be no notches at all. The number of teeth of the third lobe could hardly prove of value, for not only do they vary but they may be reduced to hardly more than serrations.

ANUS

The anus (*a*) in 13 individuals averaged 6μ in diameter and was located approximately 23μ cephalad of the caudal margin of the second lobe. There was little difference in this position in young and old individuals. The position of the anus with respect to the segments could not be determined with certainty. A sclerotic area (*aca*) is always present immediately cephalad of it, and extends partly down on the sides.

VENTRAL ASPECT OF THE BODY

BODY SEGMENTS

There is no indication of sutures between the head, prothorax, and anterior section of the mesothorax, except possibly caudomesally between the head and prothorax, but the segmentation of the remaining thoracic segments is distinguishable practically throughout. The metathoracic leg lies sufficiently caudad to bulge against the second abdominal segment. The succeeding abdominal segments to and including the sixth are distinct. This means that the pygidium, if considered to be the single inflexible caudal piece, includes for this surface three segments, the seventh, eighth, and ninth abdominal ones. There are no particular areas on the ventral surface of the pygidium, though it is more heavily sclerotic than the remainder of the surface. Its sclerotization, however, is somewhat less marked than on the dorsum. Cephalomesad on the pygidium are at least three rows of small spinelike processes (*slp*). Two rows of these little processes occur on every segment along the meson, cephalad to the mesothorax, which, however, has but one. A rather small invagination, called the intersegmental furca (*inf*), occasionally occurs between the mesothorax and the metathorax. The size of the segments is much the same as on the dorsal surface. The ninth abdominal segment is distinctly invaginated and greatly reduced in size (fig. 2).

ANTENNA

The length and width of each of the five segments of both antennae of each of the 16 individuals were measured. These measurements, in microns, were as follows: Basal, length range 8 to 11, average 9.4, width range 10 to 12, average 11; second, length range 7 to 10, average 8.3, width range 6 to 8, average 7.1; third, length range 7 to 9, average 8.5, width range 6 to 7, average 6.4; fourth, length range 4 to 6, average 5.2, width range 5 to 6, average 5.5; fifth, length range 24 to 29, average 26, width 6.

All the basal segments possessed 1 long and 2 relatively small setae; the second segments, 2 small setae; the third, 1 seta; and the fourth, 1 moderately long fleshy seta. There was no appreciable variation in the number and size of these setae on any specimen. Some variation did occur, however, on the fifth segment, where from 3 to 5 fleshy setae were found, the number present sometimes being different on the antennae of the same individuals. Their position on the segment

varies freely. Two very long and slender setae arise from the distal end of the segment. There are also two small structures, which from the resemblance to similar structures in other scale insects may be considered as minute invaginated setae (*mis*), always present on this segment as figured.

SETAE

Between the antennae are three small setae on each side (*1mhs to 3mhs*); none of these was ever observed to be absent. Eight mesal setae (*mes*) were always found on the thoracic and abdominal segments.

A pair of large setae, the marginal setae (*ms*), occur near the margin of each of the following segments: Mesoprothorax, posterior section of the mesothorax, and anterior section of the metathorax. The cephalic one of each pair is usually more mesad than the other. Sometimes one or both are almost, if not quite, on the dorsal surface. The marginal setae continue caudad, one on each of the abdominal segments. They are similar in size to the thoracic setae, except for the eighth abdominal one (*8vms*, fig. 2), which is very large and long, and the ninth abdominal one (*9abs*, fig. 2), which, in contrast to the eighth, is extremely small, in fact the smallest seta on the body. A ventral and a dorsal marginal seta of the abdomen constitute a pair in the same series with the thoracic pairs. The ventral ones are always cephalad of the dorsal ones. No seta of these pairs was ever missing.

Along the submargin of the body there is a row of small setae, one on each abdominal segment except the first and the ninth, which may be known as the ventral submarginal setae (*ss*). Each one is always present, and comparatively constant in position. On the posterior section of the mesothorax, near its cephalic border and about two thirds of the distance to the margin, is a seta which should probably be included in the submarginal series. It is larger than the other submarginal setae, but not so large as the marginal pairs.

The ventral setae may be grouped as follows according to the calyx diameters in microns: With diameter 2.7, the eighth abdominal marginal; with 1.9, the fifth, sixth, and seventh abdominal marginal; with 1.7, the thoracic marginal and the first to fourth, inclusive, abdominal marginal; with 1.5, the mesothoracic submarginal; with 1.2, the mesal head, mesal body, and remaining submarginal; with 0.8, the ninth abdominal marginal.

LEGS

The three legs are similar in every noticeable respect (except possibly size), including the number, size, and position of the setae on the sclerites; therefore, a description of one will apply to all. Distally the coxa (*co*) bears two large acetabula, and between these a large, broadly rounded condyle, articulating against two large, rather sharp pointed condyles of the trochanter, apparently allowing a limited rocking motion. At the base it is drawn out into a narrow, strongly sclerotic condyle, that articulates nearly flatly against a prominent sclerite, which MacGillivray has called the "episternum" but is termed here simply the "pleural sclerite" (*pl*). There is probably a rather limited action between the coxa and the pleural sclerite. The latter possesses an internal projection, usually stout

and rounded, designated as the "lateral apodeme" (*lap*). The trochanter (*tr*) articulates freely against the coxa. The femur (*fe*) is apparently rigidly attached to the trochanter, but articulates freely against the tibia (*ti*) by means of two small condyles, the cephalic one strongly sclerotic and the caudal one membranous. The tibia and tarsus are apparently fused. The claw (*cla*) is toothless.

The length and width of all segments of all 6 legs were measured for each of the 16 individuals. As would be expected, slight variations were noted even on different sides of the same individual. There was also a slight variation in average size of the segments, the prothoracic ones being the smallest and the mesothoracic ones next. The range and the average of the length and width of the parts of the metathoracic leg, expressed in microns, are as follows: Coxa, length range 16 to 21, average 18.4, width range 12 to 16, average 13.6; trochanter, length range 10 to 13, average 12.1, width range 8 to 10, average 9; femur, length range 29 to 35, average 32.3, width range 12 to 13, average 12.2; tibia plus tarsus, length range 28 to 35, average 32.1, width range 5 to 6, average 5.8; claw, length range 12 to 16, average 13.4, width 3.

The coxa bears 3 small setae, 1 of them on the dorsal surface. The seta situated near the basal condyle is easily overlooked. The trochanter bears 2 setae, both on the ventral surface, 1 very large, the other very small and easily missed. In addition, there are 4 porelike structures (*pls*), 2 each on opposite surfaces. The femur bears no setae. The tibia-tarsus has, besides the spur previously discussed, 1 moderately large seta on the inner surface, immediately cephalad of a notch. Two long setae occur at the distal end on the outer margin. The inner surface of the thickened base of the claw also bears a pair of setae.

SPIRACLES

In mounted material the spiracles (*sp*) are usually hidden by the legs. The spiracle proper is considered as merely the external opening, which is rather large and surrounded by a prominent sclerite, the peritreme (fig. 1, *B*, *C*, *pe*). In all specimens the peritreme appeared crescent-shaped, the ring being unrecognizable. The trachea (*t*) decreases in diameter from the spiracle. A crescent-shaped sclerotic area, the external thickening (*et*) of the trachea, occurs not far within. Somewhat farther inside occurs a ringlike sclerotic area, the internal thickening (*it*), which is of the same diameter as the trachea proper. The somewhat trumpet-shaped sclerite attached to the peritreme has been called by MacGillivray the "spiracularia" (*spa*). In this stage its small end is directed mesad. The two pairs of spiracles are nearly equal in size. The diameter of the peritreme, meaning the straight distance across the largest crescent-shaped sclerite, is typically about 6μ. The spiracularia is about 12μ long and is curved, with one or more ridges extending the length of it.

On the posterior section of the metathorax laterad of the leg is a strongly sclerotic structure (*usc*) typically of the size and shape shown in figure 1, *A*, *F*. It possesses an inner curving piece which resembles the peritreme of a spiracle. It is always present. If the segment laterad of the leg is considered to be a part of the first abdominal segment, this sclerite is in position to be a vestigial spiracle.

ROSTRALIS [3]

One structure associated with the endoskeleton of the head, the mouth-stylets bundle or rostralis (*ros, rol*), will be discussed here, as regards its position and dimensions, because of the excellent comparisons that can be made between it and other body parts. The rostralis, in issuing from the head, is always directed caudad within the body nearly to the anal opening, where it bends deeply cephalad, curving gently, first mesad and finally laterad, to the prothorax, where it forms a loop and retraces its path as far as the base of the rostrum. The length of the rostralis from the bases of the mandibles and maxillae to its tip varies with the individual. Its average length in 17 specimens was 0.64 mm, the shortest being 0.59 mm and the longest 0.77 mm.

SECOND-STAGE FEMALE

Twenty individuals, 8 from date palm and 4 each from the other 3 palms, were studied. In newly molted ones, as represented in figure 3, *A*, the contour of the body is roundly oval, somewhat sharper at the ends than in newly hatched first-stage nymphs. The average length of 15 newly molted individuals was 0.39 mm, and the average width 0.30 mm.

DORSAL ASPECT OF THE BODY

BODY SEGMENT

The pygidium is more extensive than in the first stage, for the rudiments of the suture between the sixth and seventh segments are absent. The segments of the pygidium are easily determined from the number and position of the setae, pores, plates, and lobes in this region. The ninth segment is much less reduced than in the first stage. The sclerotic areas of the pygidium are well defined in the newly molted specimens, and practically uniform in appearance. A distinctive, small, acutely oval sclerotic area is situated submarginally on the sixth abdominal segment (*ucha*). In older individuals the sclerotization spreads over the entire pygidium, obliterating any definite sclerotic areas. In the younger specimens, however, these areas can be homologized with those of the first stage. The remaining segments of the body are essentially like those in the preceding stage.

SETAE

Four large cephalic setae and one smaller caudal seta (*bhs*) are always present near the margin of the head, on each side of the meson. The exact position of each may vary somewhat, but the general position is as shown. In 3 individuals a still smaller seta was also present posterior to them, in 1 case occurring on both sides and in the other 2 on one side only. On another specimen a large seta occurred on each side, anterior to the 5 usual ones. On 5 specimens this kind of seta occurred on one side only. These were the only exceptions observed. These setae appear to be homologous with those of the first stage, and therefore may be called the border head setae.

[3] This term is used for the parts involved throughout this bulletin, the reasons for its use being given on p. 54.

The smaller posterior seta is an extra one in this stage, but is considered as belonging to this group. The pair of mesal head setae of the first stage were not observed.

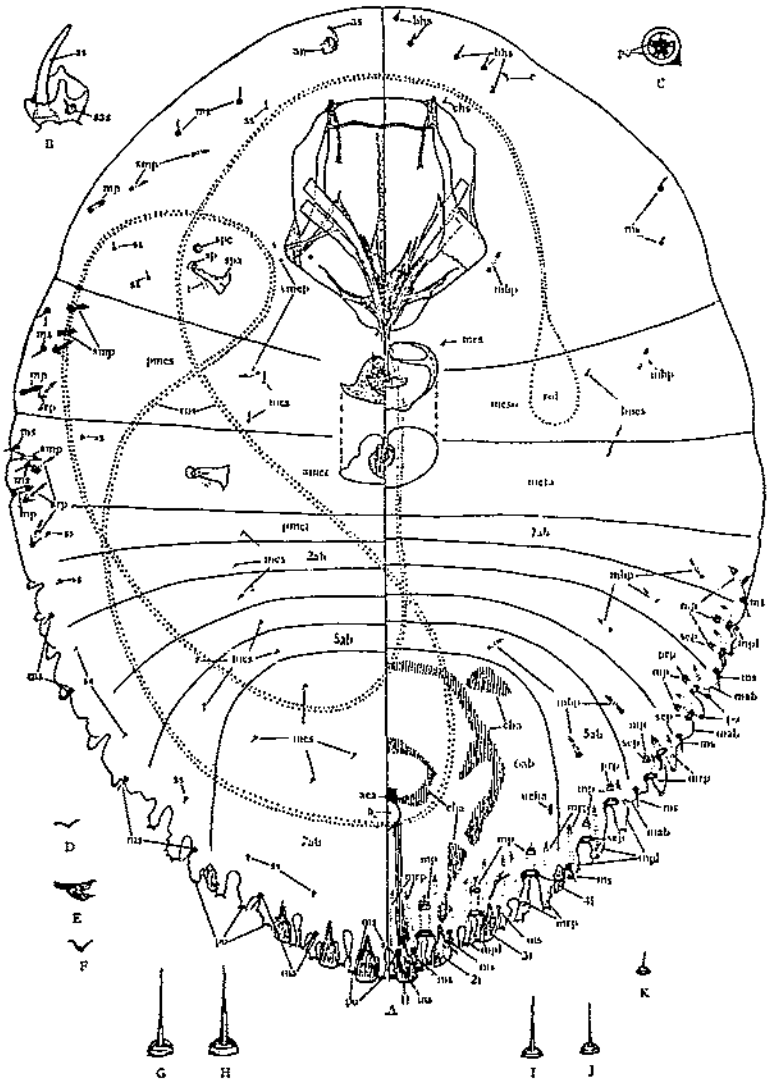


FIGURE 3.—Second-stage female: *A*, Body (dorsal surface at right of observer); *B*, antenna; *C*, spiracle ostioles; *D*, prothoracic leg; *E*, mesothoracic leg; *F*, metathoracic leg; *G*, dorsal marginal seta of first abdominal segment; *H*, large dorsal marginal seta of fifth abdominal segment; *I*, ventral marginal seta of eighth abdominal segment; *J*, mesal body seta; *K*, ventral marginal seta of ninth abdominal segment. *A*, ×320; *B-K*, ×1,025.

A small seta (*chs*) always occurs, generally cephalolaterad but sometimes immediately cephalad of the endoskeleton. It is considered to be homologous with the caudal head seta of the first stage.

The mesal setae, except what is considered to be the prothoracic one, are lacking in this stage. This seta (*mes*) does not occur in the

first stage, but occurs in the second-stage male, as well as all the other setae of this set. It was missing on both sides in two specimens; in another specimen it was absent only from one side; in all the other specimens it was present on both sides. It is evident, however, that it is not a constant structure in this stage.

Two lateral mesal setae are situated in essentially the same locations as they are in the first stage. None was ever observed to be missing.

The marginal setae are all present as in the first stage. An additional, smaller seta occurs associated with, and caudomesad of, the prothoracic marginal one. Two plates always occur between the setae on the first 4 abdominal segments, 3 plates between them on the next 3 posterior segments, and 2 between them on the eighth segment. The marginal setae are always present.

All the setae of this surface show rather closely, though not exactly, a characteristic size. For instance, no "small" seta ever occurs "large", or vice versa. These dorsal setae may be grouped as follows on the basis of measurements, in microns, of numerous calyces: With diameter 3.2, the fifth, sixth, and seventh abdominal marginal; with diameter 3, the four large border head, the eighth abdominal marginal, and the anterior prothoracic marginal; with diameter 2.3, first to fourth, inclusive, and ninth abdominal marginal; with diameter 1.9, posterior prothoracic marginal, posterior border head, and lateral mesal; with diameter 1.5, caudal head and mesal body.

EYE

The eye is nearly always distinguishable, but is evidently in a vestigial condition.

PORES

In the first stage the pores show no particular variations except that in general they are somewhat smaller anteriorward. In the second-stage female the pores show a considerable range in size, shape, and degree of sclerotization. No pores were observed on the head. In most instances a minute pore (*mbp*), rather variable in position, was noted on the prothorax and on the mesothorax. On the first abdominal segment 1 marginal pore is present, as in the first stage; on the second to fifth abdominal segments, inclusive, 2 occur; on the sixth, seventh, and eighth abdominal segments there is only 1, and on the ninth none. The marginal pores are situated at the head of prominent incisions, which are especially deep on the sixth, seventh, and eighth abdominal segments. On the segments having 2 incisions the anterior one is always the deeper. In this stage the marginal pores are shorter and broader than in the first stage, and the rings about the external openings are more strongly sclerotic. The basal bars are broader and also much more strongly sclerotic, but the distal bars are narrow and the sclerotization is relatively slight. The bulla is practically the same in the two stages. As in the first stage, the size of the pores gradually decreases cephalad. For example, a typical pore on the eighth segment, measured from the external opening to the distal border of the distal bar, was 13μ long, the width of the basal bar 5.5μ, and the width of the sclerotic

ring about the opening 8μ; in contrast, a pore of the first segment, measured over the same limits, was 8.6μ long, 3.5μ across the basal bar, and 5μ across the sclerotic ring.

Sometimes a marginal pore was absent. Of the 20 specimens studied, 7 lacked, on the dextron, the posterior pore of the fifth segment, 1 lacked, on the sinistron, the posterior pore of this segment, while 1 lacked also, on the dextron, the posterior pore of the fourth abdominal segment. Only in these instances were missing pores noted. Apparently the extra pores of these 2 segments, especially those of the fifth segment, are not so well established as those of segments 2 and 3. The fact that, where a segment normally has 2 pores, the anterior one is always present seems to indicate that it is the primary pore (*prp*), that is, the pore homologous with the one on that segment in the first stage.

The mesal pores of the first stage are probably represented in this one by a series of small pores (*mbp*) found, for the most part, along the submargin of the body. They are much smaller than those of the first stage. On the abdominal segments they are clearly distinguished from the marginal pores by their size and position. A small pore occurs typically on each of the first 5 abdominal segments, the one on the fifth being usually somewhat larger than the others, and the one on the fourth frequently so. The pore on the third abdominal segment is generally distinctly more mesad than the others. The position of these pores along the submargin varies considerably in different individuals. The size of the 2 pores on segments 4 and 5 varies considerably. Also, 1 or more of them may be lacking on one or both sides of the body. Contrariwise, there may be more pores present than the typical 5 on either or both sides, and 1 may occur on one or both sides of the sixth segment, in which case the additional pores are generally considerably mesad of the others. In short, this series of pores is decidedly unstable in character. The dimensions of the small pores, in microns, are about as follows: Length from external opening to distal border of distal bar 5, width of bars and tube 1, width of ring about opening 1.9.

The caudal margin of the body bears a series of long, narrow, delicate pores, the marginal raised pores (*mrp*), which always open at the distal ends of projections; therefore, if a projection is lacking, so is the pore. These projections are the plates subsequently discussed. The caudal pores average about 35μ in length. There is a gradual decrease until they average but 13μ in length on the first, second, and third segments. The tubes are flexible, and may curve moderately or sharply to either right or left. The bars are similar in form and sclerotization to those of the mesal body pores, but the distal ones are normally somewhat expanded. On the other hand, these distal bars may be found in a collapsed condition (fig. 5, *L*), as are occasionally any of the smaller pores of the body. The rings are little, if at all, expanded, owing undoubtedly to their confined limits on the plates.

PLATES

Typically 18 marginal plates (*mpl*) are present on each side of the body. Rarely 1 or 2 may be absent or an additional 1 may be present. They vary somewhat in size and shape, more so on ab-

dominal segments 5 and 6 than on the other segments. These plates appear to be undifferentiated projections of the margin.

The plates on the five posterior segments usually have small, sharp projections, called "teeth." A prominent distal, forked pair is nearly always present, except on the plates of abdominal segment 5. The anterior plate of this segment rarely is toothed, and the 2 posterior plates either have no teeth or a varying number up to 10, usually 5 or 6, irregular in size and position. The plates of abdominal segment 6 bear a large number of teeth, the forked distal ones and generally 3 or 4 additional lateral ones, sometimes more or less, and sometimes 1 or 2 teeth may occur on the mesal side of the plate. The plates of abdominal segments 7, 8, and 9 bear characteristically the distal forked ones and but rarely more than 1 or 2 in addition. On the anterior plates, and on the single plate on segment 9, the additional teeth are typically on the mesal sides; on the other plates, typically on the lateral sides. The teeth may be rather difficult to see, even on nicely stained specimens. They occur in all sizes, some distinct, others so infinitesimal that it is a question whether they are present at all. Furthermore, it is sometimes doubtful whether a toothlike projection is really on a plate or merely on the inner margin of the body proper.

Although the marginal raised pores never appear apart from the plates, some of the plates occasionally occur devoid of pores. The poreless plates were seen only on the fifth and sixth abdominal segments and were always in a rudimentary condition.

Structurally the marginal plates appear to be similar to the submarginal raised pores of the thoracic segments and are considered homologous with them.

LOBES

The number of lobes on each side in this stage is, rather definitely, 4. The locations for the fifth, sixth, and seventh lobes are indicated, however, by marginal bulgings (*mab*). The typical size and shape of the lobes is shown in figure 3, *A*. The measurements, in microns, of the lobes on the 20 specimens studied were as follows: First lobe, length range 14 to 21, average 17.2, width range 7 to 9, average 8.6; second lobe, length range 13 to 18, average 14.9, width range 5 to 7, average 6.1; third lobe, length range 7 to 16, average 12.2, width range 3 to 7, average 5.5; fourth lobe, length range 5 to 16, average 10.6, width range 3 to 7, average 5.2.

The first 3 pairs of lobes were always present and distinctly sclerotic, the third pair a little less so, apparently, than the preceding 2, and they showed practically no variation from the typical shape. The first 2 pairs always had even apical contours; the third pair, however, possessed a distinct lateral notch on each side of the meson in 2 specimens, and in another specimen 1 of the third pair was irregularly margined. The third pair also showed a wider range of dimensions than the other 2; in short, it was less fixed in its characteristics. The fourth pair of lobes were even less fixed than the third. In about half the individuals they were not much less sclerotic than the third pair; in other specimens little or no sclerotization was noted. In half of the individuals the apical contour of the fourth lobe was very nearly, if not quite, even. The fourth lobe had distinctly irregular apical contours on both sides of the meson

in 7 specimens, and on one side only in 2 specimens. Another individual had a typical notch on the fourth lobe on each side of the meson. The variation in size was more marked than in the third pair. In 1 individual the fourth lobe could not be distinguished on one side, and in many specimens it might easily have been overlooked by one unfamiliar with its characteristics.

ANUS

The anus averaged 10μ in diameter for the 20 individuals studied; the range was slight, from 9 to 12μ. The distance on the dorsal surface from the distal margin of the median lobes ranged from 60 to 77μ, with an average of 70μ; the difference in distance appeared to be independent of the ages of individuals. A distinctly sclerotic column extends from the base of the median lobe to the lateral margin of the anus. This column is in the position where a suture would be expected, and may indicate the division between segments 8 and 9. The anus is situated along the cephalic margin of this column, and would, therefore, apparently be either between the eighth and ninth segments or along the cephalic margin of the latter. Most morphologists, however, consider the anus as belonging to the tenth segment in other insects. In this case the tenth segment would be reduced to an indistinguishable vestige. Rather significantly, another sclerotic column extends cephalad and mesad from the second lobe, in the position for a suture between segments 7 and 8. A heavily sclerotic square area (*aca*) was present as in the first stage, immediately cephalad of the anus.

VENTRAL ASPECT OF THE BODY

BODY SEGMENTS

The segments are essentially like those of the preceding stage, except that there is no evidence of any suture between the sixth and seventh abdominal segments and the pygidium is somewhat more extensive.

ANTENNA

The antenna (*an*) is never absent. It is a tubercular structure (fig. 3, *B*) composed largely of what appear to be only 3 or usually 4 stout projections, irregular in size and position, that are frequently so smoothed out as to be scarcely, if at all, distinguishable from one another. The antenna bears a prominent seta (*as*), which is fleshy, characteristically curved, and uniformly about 12μ long. This seta was never absent. In about one fourth of the individuals a very small additional seta (*sas*) could be distinguished. This was absent, however, in the specimen figured. The positions of the setae on the antennae are not definite, owing to the irregularity of the projections on them. The antenna with its projections averages about as long as broad, that is, 7μ.

SETAE

Of the mesal head setae, only the caudal pair was ever present. In 12 individuals, including the one figured, this seta was missing; in

the remaining 8 it was present on one or both sides. It is evident that these setae have nearly disappeared from this stage.

The mesal setae differ from those of the first stage in the addition of a seta on the mesothorax, giving this segment 2, and the addition of 1 seta on each of abdominal segments 4 to 7, inclusive. The extra ones are situated laterad of the primary setae, typically as shown in the figure. The primary setae are situated similarly to those in the first stage. As would be expected, none of the primary setae was ever absent, but in 3 specimens 1 of the new setae was lacking on the seventh abdominal segment.

The marginal setae occur similarly to those in the first stage, except for the lack of one on the posterior section of the metathorax, and the great reduction in size of the one on the eighth abdominal segment, which is here just slightly smaller than the others, and the one on the ninth, which is appreciably smaller but not so small as it is in the first stage. A slight variation in size is frequently observed among the other setae of this series. Measurements of the distance separating the two members of each of the thoracic pairs of these marginal setae in the 40 cases showed much variation, as indicated by the following enumeration, given in microns: Between prothoracic pair, 7 to 14; between mesothoracic, 14 to 36; between metathoracic, 20 to 43. The marginal setae were constant in their presence.

The submarginal setae differ from those of the preceding stage by the absence of the ones on the posterior section of the mesothorax and the eighth abdominal segment, and the presence of 1 on each of the 2 sections of the metathorax and of 3 on the mesoprothorax. The position of the submarginal setae is fixed on the abdomen, but considerably less so on the thoracic segments. The typical location of each is as represented in the figure. The seta of this series on the sinistron of the metathorax was absent in 1 individual, and the more laterad of the posterior setae from the dextron of the prothorax was absent in another individual.

The ventral setae may be arranged in the following groups on the basis of measurements, in microns, of the calyx diameters: With diameter 2.7, prothoracic and mesothoracic marginal; with diameter 2.3, first to seventh, inclusive, abdominal marginal, and metathoracic marginal; with diameter 1.9, mesothoracic mesal, pygidial mesal, eighth abdominal marginal, and mesoprothoracic anterior submarginal; with diameter 1.5, all other mesal and submarginal; with diameter 1.2, ninth abdominal marginal.

PORES

No pores were observed on the head. Near the margin of the thoracic segments, except the posterior section of the metathorax, a number of pores with surface openings occur. The posterior one (*mp*) on each segment, because of its generally slightly larger size, is considered to be homologous to the marginal pores; the others are called submarginal pores (*smp*) but appear to be a continuation of the mesal body pores (*mbp*) occurring on the dorsum of the abdomen. The submarginal pores on the mesoprothorax are distinctly smaller than the other submarginal pores. On the remaining 2 segments possessing them the submarginal pores vary somewhat in

size, and on all the segments they vary in position. The marginal pores seem to be constant in number, 1 occurring on each of the thoracic segments except the posterior section of the metathorax, which apparently lacks on this surface both marginal and submarginal pores. The submarginal pores vary in number. On the 20 specimens studied they occurred as follows, those on each side of the body being counted separately: On the mesoprothorax no pores in 3 cases, 1 pore in 2 cases, 2 pores in 12 cases, 3 pores in 22 cases, 4 pores in 1 case; posterior section of the mesothorax, 1 pore in 11 cases, 2 pores in 27 cases, 3 pores in 2 cases; anterior section of the metathorax, no pores in 11 cases, 1 pore in 29 cases. A count of the marginal and submarginal pores of both surfaces of the abdomen and thorax, up to and including the marginal pore of the mesoprothorax but not the little submarginal ones of this segment, of 178 specimens from all 4 host palms showed a range on each side of the body of 15 to 20 pores, and an average of 17.4 pores.

Near the meson on the mesoprothorax is a minute pore, about 5μ long by 0.7μ wide across the bars (fig. 5, *L*). The sclerotic ring is, however, about as wide as in the average small pore. In 2 specimens no pore was observed on one side. Another pore, almost equally as small, always occurs on the posterior section of the mesothorax, in the neighborhood of the anterior mesal seta. These 2 pores are called ventral mesal pores (*vmep*). Two were present on the dextron of the posterior section of the mesothorax of 1 individual.

No mesal pores were noted on the abdomen.

On the posterior section of the metathorax there is always a single raised pore. On each of the 2 immediately anterior segments—that is, the anterior section of the metathorax and the posterior section of the mesothorax—are usually 2, occasionally only 1, and rarely 3. On the mesoprothorax 1 individual possessed 1 pore on the dextron. These raised pores are considered to be merely a continuation of the raised pores from the margin of the abdomen on the dorsum, and are in every particular like the submarginal raised pores of the anterior abdominal segments of that surface. They may therefore be called the ventral submarginal raised pores (*srp*). There appears to be no clear connecting link between the raised pores and the surface pores. The former always have tubes longer in proportion to the width than the latter (fig. 5, *M*, *N*, *O*), and there never seems to be any doubt as to whether a pore is raised or not. However, the structural details of both are apparently identical, and so there is little doubt that they are homologous.

Pores of the disk type (*spc*) occur only on the mesoprothorax, immediately cephalad of each spiracle, the "spiraceroris" of MacGillivray (*8*). This term is considered more desirable than, for instance, "spiracular pore", because it makes it possible to distinguish clearly the types by name, and to distinguish these definitely from the 1 or 2 small mesal pores which also occur near the spiracles. The spiracerores (fig. 3, *C'*) are slightly raised, doubly ringed, typically with a sharp sclerotic projection, a section of the lateral raised wall, extending from the outer ring to the body surface; and they bear from 2 to 5 pore openings, which are always located apparently at the ends of central sclerotic thickenings. In a pore with 5 openings the central thickening assumes the appearance of a star, with

the openings apparently in the apices of the rays. The spiracerores with 5 openings were all practically 4.5μ in diameter, and those with fewer pore openings were very slightly smaller, depending somewhat upon the number of openings. Occasionally the openings were too indistinct to count. The number of openings may vary on different sides of the meson of the same individual. One specimen possessed 1 pore with 5 openings on one side, and 2 pores, 1 with 5 and 1 with 3 openings, on the other side. In an examination of 195 specimens, in which each side of the body was counted separately, 3 pores occurred once and 2 pores six times; all the remaining specimens possessed 1 pore on each side.

LEGS

Certain vestigial protuberances (fig. 3, *D*, *E*, *F*), either membranous or sclerotic, or partly both, as occurs occasionally, may be considered as legs, since they are similar to larger structures in the same locations in the second-stage male which are definitely recognized as legs. Thirteen individuals had one or more of these protuberances. In one instance the protuberance, a mesothoracic one, was relatively large and somewhat sclerotic (fig. 3, *E*). Hoke (*6*) has mentioned the presence of vestigial legs in both this stage and the adult female of a leucaspid.

SPIRACLES

The spiracles (fig. 3, *A*. *sp*) differ from those of the preceding stage most noticeably in the fact that the larger ends of the spiracularlae are directed mesad, thus in opposite direction to those of the first stage. The peritreme is always ringlike in this stage. The tracheal thickenings and the ridge of the spiracularlae are present with modifications. The two pairs are subequal in size, about 20μ long, including the lateral boundary of the peritreme, by 8μ across the widest part of the spiracularia. The peritreme is almost uniformly 5μ in diameter.

ROSTRALIS

The rostralis is considerably longer in proportion to the size of the body than in the first stage. Measurements of its length in 8 specimens showed a range of from 2.31 to 2.70 mm, with an average of 2.53 mm. In the newly molted individual of this stage the rostralis is from 6 to 7 times the body length, whereas at the beginning of the first stage it is less than 3 times as long as the body. The position of the rostralis in the body of prepared specimens varies widely, no 2 individuals showing it alike. The end loop is rather definite in size, however, averaging 45μ long by 20μ wide. The rounded contour of the loop suggests its relative stiffness.

ADULT FEMALE

Thirty-two individuals, eight from each palm, were studied. The contour of the body (fig. 4, *A*) is slightly elongate oval, broadest across the base of the posterior half, from which there is a rather sharp slope caudad and a gentle slope cephalad. The body does not change in shape and increases but little in size after molting. The average for a number of older individuals is somewhat larger, but

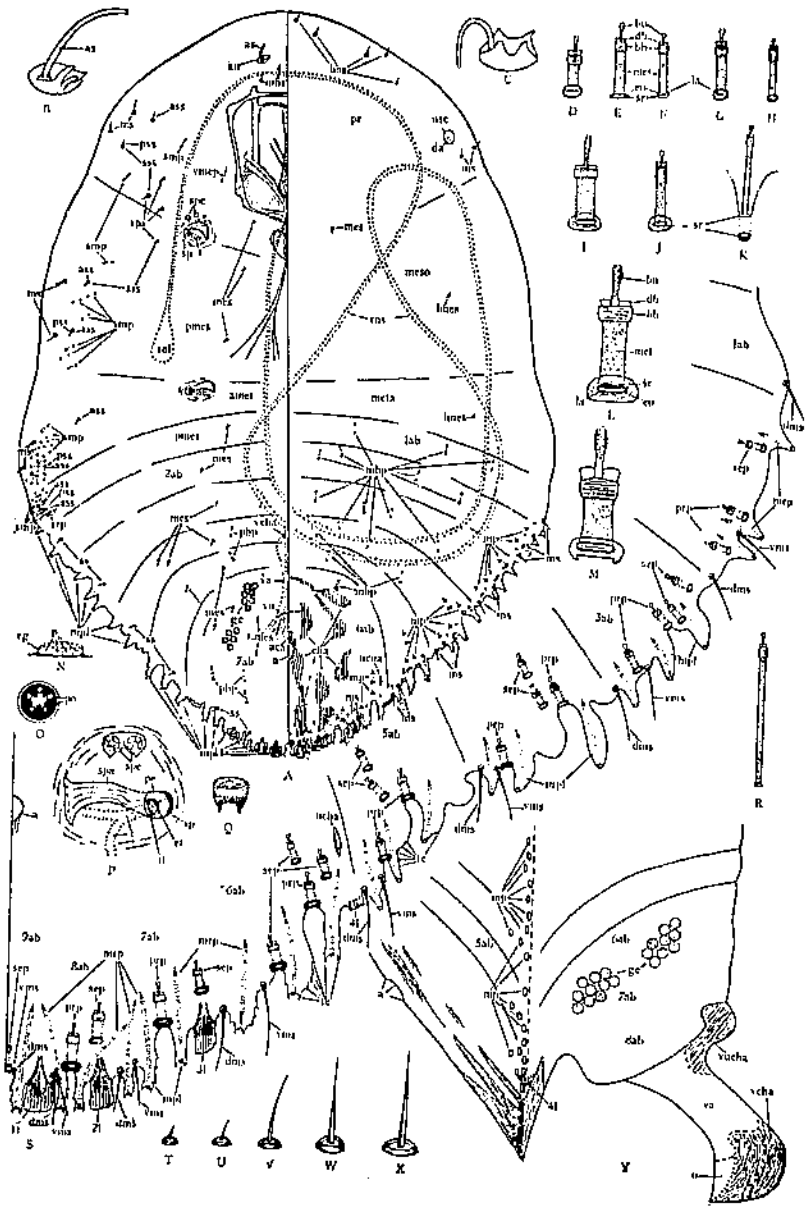


FIGURE 4.—Adult female: *A*, Body (dorsal surface at right of observer); *B*, *C*, antennæ; *D*, posterior body pore of eighth abdominal segment; *E*, posterior body pore of seventh abdominal segment; *F*, cephalic submarginal pore of mesothorax; *G*, *H*, ventral mesal mesoprothoracic pores; *I*, marginal pore of posterior section of metathorax; *J*, mesal pore of mesal body series on dorsum of sixth abdominal segment; *K*, submarginal raised pore of metathorax; *L*, marginal pore of eighth abdominal segment; *M*, marginal pore of ninth abdominal segment; *N*, lateral aspect of genaceroris; *O*, genaceroris; *P*, spiracle and associated structures; *Q*, lateral aspect of genaceroris; *R*, posterior marginal raised pore of fifth abdominal segment; *S*, abdominal marginal fringe; *T*, ventral marginal seta of ninth abdominal segment; *U*, dorsal marginal seta of ninth abdominal segment; *V*, dorsal marginal seta of first abdominal segment; *W*, dorsal marginal seta of fifth abdominal segment; *X*, large dorsal marginal seta of fifth abdominal segment; *Y*, lateral aspect of posterior part of body. *A*, × 145; *B-O*, *Q*, *R*, *T-X*, × 1,000; *P*, × 555; *S*, × 425; *Y*, × 290.

frequently an overlapping of size among the individuals of different ages has been noted. A tabulation of lengths and widths of 45 newly molted specimens and of 40 older ovipositing specimens showed much variation throughout; it may be summarized as follows: Newly molted individuals, length 0.52 to 0.85 mm, average 0.7 mm, width 0.4 to 0.66 mm, average 0.53 mm; older ovipositing individuals, length 0.61 to 0.84 mm, average 0.74 mm, width 0.5 to 0.68 mm, average 0.59 mm.

DORSAL ASPECT OF THE BODY

BODY SEGMENTS

The segments of the pygidium are differentiated in essentially the same way as in the preceding stages. The sclerotic areas of the pygidium are characteristic in the newer forms, gradually becoming indistinguishable as sclerotization spreads over the entire pygidium. These areas can be readily homologized with those of the second stage. The remaining segments of the body can be detected in newly molted individuals, but are less distinct than in the immature instars.

SETAE

On the anterior part of the head are 5 setae which are apparently homologous with the border head setae of the preceding stages. They are rather constant in presence, comparatively so in size, and less so in exact position. In only 2 out of the 64 groups examined were any setae absent. On the dextron of 2 individuals the most anterior seta of the group was missing, but an extra posterior seta was present on one side in 3 specimens and on both sides in 1 specimen.

The caudal head seta is absent in this stage.

The mesal seta of the prothorax and the 2 lateral mesal setae of the preceding stage are present.

The marginal setae occur essentially as in the preceding stage. The ventral marginal setae of the abdomen occur practically on the dorsal surface. The ventral setae are always cephalad of the dorsal ones. The relation of the setae to the neighboring plates is noteworthy. Typically 2 plates occur between the pairs on abdominal segments 2 to 8, and 1 plate between the setae of each pair on segments 2 to 7, inclusive. This is, however, by no means a fixed condition. No plate ever occurs between the setae of the pairs on the eighth and ninth segments, and only 1 plate between these 2 pairs. A single seta, the dorsal one, which is never missing, is borne by the first segment. Of nearly 800 segments examined, 21 showed 1 marginal seta absent and in 4 cases both were absent.

The setae (excluding the ventral abdominal marginal setae) may be segregated into several groups on the basis of the diameter, in microns, of their calyces, as follows: With diameter 4.2, fifth, sixth, and seventh abdominal marginal; with diameter 4.0, the four anterior border head and the eighth abdominal marginal; with diameter 3.6, cephalolateral prothoracic marginal and the first to fourth, inclusive, abdominal marginal; with diameter 3.2, posterior border head and caudomesal prothoracic marginal; with diameter 2.8, mesal, lateral mesal, and ninth abdominal marginal.

EYE

The only structure observed that might be taken for the eye was a prominent, well-sclerotized, rounded tubercle, which occurs cephalolaterad of the anterior spiracle near the dorsal margin of the body. Berlese (*1, v. 4*) indicates the presence of an eye, even to showing the optic nerve leading to it, in a related species. Yet the writer considers that here this tubercular structure might not be an eye, for reasons given below. It appears to be distinctly more caudally situated than what is taken to be the eye in other stages of this species, occurring near the first pair of marginal setae cephalad of the posterior section of the mesothorax, and in some specimens even as far caudad as one of these setae and may be almost touching one of them. If this pair of setae is a continuation cephalad of the series of marginal setae, then one or both of them may be expected to occur either on the anterior section of the mesothorax or on the prothorax. It hardly seems likely that both of these segments may be reduced nearly to the vanishing point in the vicinity of the tubercle. Also the eye, though pronounced in the first-stage female, appears to be vestigial in the second stage, but the tubercle is large and strongly developed in the adult. Moreover, in other species of *Parlatoria* (eight examined) no structure that might be clearly taken for the eye was discernible in the adult female, though in this stage of one species (*P. ziziphus* Lucas) occurs a structure that probably has no relation to the eye but gives evidence, as will be indicated in the following section, of being homologous with the tubercle in *P. blanchardi*. Whether or not the tubercle under discussion is an eye can probably best be settled by tracing the optic nerve, a task not possible with the writer's material.

PORES

In other species of *Parlatoria* typically 1 to 3 or 4 raised pores occur on the ventrolateral surface of the body cephalolaterad of the anterior spiracle and apparently on the thorax. These pores vary considerably in location, but in no case was one noted definitely on the dorsal surface. Usually the rim around the external opening of a pore is very large and heavily sclerotic, as compared with the remainder of the pore. In general aspect a rim resembles the tubercle mentioned in the preceding section, suggesting that the latter might possibly be homologous with these raised pores by a small modification in position from the ventral to the dorsal margin, and in structure through the disappearance of all parts of a pore except the rim. In the adult female of *Parlatoria ziziphus*, as well as in that of *P. blanchardi*, the raised type of pore was not seen cephalad of the anterior spiracle, but in *P. ziziphus* laterad of the anterior spiracle on the margin of the body occurs a prominent, rounded knob, which may be sclerotic distally but membranous basally. This knob may or may not bear a seta, apparently one of the pairs homologous with the pair occurring near the tubercle in *P. blanchardi*. If this is so, then the latter would seem to be homologous with at least part of the knob. Until a better understanding of this tubercle is obtained, it is considered simply as an undetermined sclerite (*use*). Close observation of the tubercle will usually reveal

a faint differential area (*da*) in it. The tubercle ranges from 12 to 18μ in diameter and from 10 to 12μ in height. It was present in all but 2 individuals, being absent from both sides in 1 specimen and from the sinistron in another. No more than 1 of these structures occurred on a side in the 32 individuals studied in detail, but among some other specimens 1 possessed on one side 2 well-developed and well-separated tubercles.

No pores of any kind were definitely recognized on the thorax of the 32 specimens studied in detail, but it is likely that one or more very minute, invaginated surface pores may have been present, for such appeared to be the case in some other specimens.

Two kinds of marginal pores are distinguished on the abdomen, primary pores and secondary pores (fig. 4, *S*, *prp*, *sep*). The primary pores, or the pores considered homologous to those similarly situated in the second-stage female, are apparently constant in occurrence. The first segment lacks 1 pore; their presence on the remaining segments agrees with that in the preceding stage. Those on segments 2 and 3 may vary a little in position, and usually are situated within the margin; those on the other segments are practically fixed in position and occur characteristically at the head of certain definite incisions. The secondary pores, or the extra ones found in this stage, are generally located somewhat within the margin, except on the sixth and ninth segments. On the 32 individuals studied, anywhere from 0 to 5 of these secondary pores occurred on any one segment from the second to the sixth; on the seventh and eighth there were 0, 1, or 2. In a special count of 1,040 margins of specimens from all 4 host palms the range in number of primary and secondary pores on each side of the body was from 12 to 39, and the average 25.1.

The structure of the marginal pores of this stage is essentially like that of those of the second stage, and here again they gradually increase in size posteriorward, with an accompanying increase in sclerotization of the rings about the external openings. There is little increase in size of the pores of this stage over those of the preceding stage. The pores of the last segment or so generally appear larger, with hardly any more sclerotization about the rings, but with broader tubes and bars; and the parts of the pores may vary somewhat in proportions.

Within the pore opening a black line (*la*) is frequently seen (fig. 4, *L*, *M*). Hoke (*5*) states that the clear area about the line represents a membrane stretched across the opening, and that the black line itself is a slit in the membrane, the actual opening into the pore. Sometimes this slit cannot be located, either open or closed (fig. 4, *I*, *J*). Occasionally, with a pore in just the right position, by racking the fine adjustment of the microscope, the slit can be made apparently to move from the opening a distance down the tube. Furthermore, the slit does not always occur in the center of the opening, and it can be made to move across the ring by racking the microscope either up or down. These facts make it almost conclusive that the slit (*la*) is simply the line of apposition of the sides of the tube when it is in a collapsed condition, and that when the slit cannot be found the tube either is not collapsed or is curved so that a sharp line cannot be detected. Usually the pores, wherever they occur on the body (of

this and other stages also), are in a collapsed condition in prepared material, and the black lines are generally distinct.

In this stage the mesal pores are scattered rather promiscuously over the segments of the abdomen, the arrangement shown in the figure being typical. The range in number on a side is from 4 to 18. The number on different sides of the meson of a single individual may vary as greatly as between individuals. On all segments except the sixth abdominal segment these pores are small. Nearly all those on the sixth segment were of medium size, the few exceptions noted being small. The following is a summary of the numbers of these pores found in the 32 individuals, those on each side of the body being counted separately: First abdominal segment, range 0 to 3, average, when present, 1.5, wholly lacking in 75 percent of cases; second abdominal segment, range 0 to 4, average, when present, 2.2, wholly lacking in 23 percent of cases; third abdominal segment, range 1 to 6, average 2.9; fourth abdominal segment, range 0 to 5, average, when present, 2.55, lacking in a single case; fifth abdominal segment, range 1 to 4, average 1.94; sixth abdominal segment, range 1 to 2, average, when present, 1.2, lacking in only 6 percent of the cases; total number present on one side of body 4 to 18, average 10.6.

The marginal raised pores are essentially like those of the preceding stage, in both structure and size. In this stage the characteristic number is 21, as compared with 18 in the preceding one, owing to the increase in number of plates, outside of which a pore is never found. Plates were frequently absent on the more anterior abdominal segments, which meant that the accompanying pores were absent as well.

PLATES

The plates are similar to those of the second stage in structure and contour. On abdominal segments 2, 3, and 4 they are subtriangular and without teeth, but they may vary considerably in size. The anterior plate of abdominal segment 4 is characteristically long. The plates on abdominal segment 5 are decidedly variable in outline, but on the whole broad and toothed. Those of abdominal segment 6 are predominantly broad and toothed also, and the anterior one of this segment is comparatively long. Occasionally a plate on abdominal segment 5 or 6 was much reduced in size, as in the second stage. The pore accompanying the plate was present unless the plate was actually rudimentary. The remaining 6 plates are always long, narrow, and toothed. Abdominal segments 2 to 7, inclusive, bear 3 plates each; segment 8, 2; and segment 9, 1 (fig. 4, *S*). No plates were ever absent from the pygidium, i. e., on segments 6 to 9, inclusive, but on any other segments 1 was commonly missing, and occasionally 2, while even 3 were lacking in 2 cases. In both of these cases the plates were missing on the sinistron of the third abdominal segment. From 2 to 3 extra plates were sometimes found on each margin of the second abdominal segment, and 1 extra plate sometimes on one or both margins of the fourth abdominal segment.

The total number of abdominal plates present on one side of any of the 32 specimens was found to range from 14 to 25, with an average of 20.

The teeth of the plates are essentially the same in number, size, and position as in the second stage.

LOBES

The first, second, and third lobes average very slightly larger than in the second stage. The contours are essentially the same, except that the third lobes are more frequently notched on the lateral sides. In many of the 32 individuals it was found that this notch either was lacking or was indistinct or replaced by three smaller notches.

The fourth lobe is considerably more rudimentary in this stage than in the preceding one. In more than half of the 64 cases in the 32 specimens this lobe was lacking or rudimentary or small and membranous and obscurely defined. In other specimens it ranged from being only faintly sclerotic along its distal margin to being apparently capable of definition and as large as 5 by 5μ. The apical margin in these larger examples was often toothed, the number of teeth ranging from 2 to 8.

ANUS

The anus is essentially in the same location as in the second stage. It is, however, farther removed from the distal border of the median lobe, averaging for the 32 specimens 103μ, with a range of from 85 to 115μ. The diameter averaged 14μ. The heavily sclerotic square area of the second stage, immediately cephalad of the anus, is also present in this stage.

VENTRAL ASPECT OF THE BODY

BODY SEGMENTS

The parts are essentially like those of the second-stage female, except that the sutures are less distinct.

ANTENNA

The antenna is essentially the same as that of the preceding stage, but is slightly larger, averaging 8μ in length and width. The fleshy seta is uniformly about 18μ long.

SETAE

A mesal head seta reappears in this stage. The two mesal head setae are more nearly constant than the one of the second stage.

A mesal seta, apparently not present in the preceding stage, occurs here immediately caudad of the head skeleton. There is here, as in the preceding stage, a pair of mesal setae on the mesothorax. There is also an additional mesal seta on each of abdominal segments 3 to 7, inclusive. They occur characteristically as shown. Three specimens lacked setae homologous with the ones of the second stage, while in 32 cases out of 640 the new setae were absent in this stage. It happened that the specimen figured did not possess one of the new setae on the dextron of the third and fifth abdominal segments.

The thoracic marginal setae occur similarly as in the preceding stage except for some variation in position. The two anterior pairs

are spaced typically about 35μ apart, and the posterior pair about 18μ apart. Frequent variation, however, is shown in this particular. The ventral marginal seta of the posterior section of the metathorax is missing here, as in the second stage.

An increase in submarginal setae takes place on the thorax, there being generally 2 and sometimes 3 on the mesoprothorax, 3 on the posterior section of the mesothorax, and 1 on each of the 2 sections of the metathorax. What are considered to be the new setae are so labeled (*sss*) in the figure. All the submarginal setae are characteristically small, except the 3 most lateral ones of the mesoprothorax, which are of moderate size. A pair of submarginal setae appear to be associated with each pair of marginal setae on the thoracic segments. There is also a pair on the posterior section of the metathorax, which may be considered as associated with the dorsal marginal seta of the first abdominal segment. These paired setae of the submarginal series may be called the anterior and posterior submarginal setae (*ass*, *pss*). This leaves several setae near the anterior spiracle in a separate grouping, the spiracular submarginal setae (*sps*). The pairs of submarginal setae, as well as all those posterior to these, are relatively constant in position, but those of the spiracular group are rather variable, and usually one or more are at a moderate distance from the spiracle. The anterior and posterior submarginal setae on the prothorax and on the posterior section of the metathorax were each missing once, and the anterior one of the mesothorax twice; none of the others was ever absent. In the spiracular group a moderate-sized one was present in all but 5 instances, while 3 small setae were present in 12 instances, 4 in 45 instances, and 5 in 7 instances out of the total of 64. The submarginal setae of the abdominal segments are similar in number and position to those of the second stage. On the abdomen 11 submarginal setae out of a possible 384 were missing. The setae on the ventral surface (including ventral abdominal marginal) may be arranged in several groups on the basis of the diameter, in microns, of the calyx cup, as follows: With diameter 4.0, mesoprothoracic marginal; with diameter 3.6, mesothoracic marginal; with diameter 3.2, metathoracic marginal, second to seventh, inclusive, abdominal marginal, and mesoprothoracic submarginal paired; with diameter 2.8, mesal head, eighth abdominal marginal, mesoprothoracic medium-sized spiracular and mesothoracic submarginal; with diameter 2.3, mesal setae and all remaining submarginal and spiracular; with diameter 1.6, ninth abdominal marginal.

PORES

There are usually 1 or 2 small pores on the mesoprothorax, both laterad in position but somewhat away from the border. A few scattered pores are present near the border on the mesothorax, which are on the average slightly larger than the mesoprothoracic pores. On both sections of the metathorax, distinctly near the border, is a rather closely bunched group of pores, which are considered to be a combination of the marginal and submarginal pores of the preceding stage. The two types cannot be separated on any of these segments. It has already been mentioned that the marginal pores of the abdomen gradually decrease in size anteriorward. This decrease continues until the pores on the mesoprothorax resemble any of the small

pores of the body, such as the dorsal mesal pores (*mbp*) of the abdomen. For convenience all pores discussed above on the ventral surface will be called simply the submarginal pores. From a tabulation of the numbers of these ventral submarginal pores, based on the 32 individuals under discussion, the following summary has been drawn: Mesoprothoracic pores, range 0 to 2, lacking in 37 percent of cases considered, average, when present, 1.5; mesothoracic, range 1 to 14, average 6; anterior section of metathoracic, range 5 to 24, average 12; posterior section of metathorax, range 1 to 14, average 6.6.

The small ventral mesal pore (*vmep*) of the preceding stage laterad of the head skeleton is present in this one, too.

The fourth and fifth abdominal segments may each bear a small pore in the neighborhood of the mesal setae. The sixth and seventh abdominal segments usually have 1 or 2 similar small pores each, rather posterior in position. In 5 cases there was also a pore on the eighth segment. None of these abdominal pores were present in the preceding stages. They are called the posterior body pores (*pbp*). A summary of a tabulation of the number and occurrence of these posterior body pores on each side of the body in the 32 individuals studied gave the following results for the fourth to eighth abdominal segments, inclusive: Fourth, range 0 to 1, lacking in 45 percent of cases; fifth, range 0 to 1, lacking in 45 percent of cases; sixth, range 0 to 3, average, when present, 1.4, lacking in 14 percent of cases; seventh, range 0 to 2, average, when present, 1.3, lacking in only 3 percent of cases; eighth, range 0 to 1, lacking in 92 percent of cases.

The raised pores are in structure essentially like those of the second stage, and similarly placed. The mesoprothorax never showed a raised pore; it will be remembered that in but a single instance did one occur there in the preceding stage. The mesothorax rarely has a raised pore, in contrast to the 1, 2, or 3 which were the rule in the preceding stage. The anterior section of the metathorax, on the other hand, has them in nearly equal numbers in the two stages, but the posterior section of the metathorax possesses generally from 1 to 4, whereas in the preceding stage no more than 1 was ever found on this segment. The numbers of raised submarginal pores, counting those from each side of the body separately, in the 32 specimens studied, were as follows: Mesothorax, range 0 to 3, average, when present, 1.3, lacking in 90 percent of cases; anterior section of the metathorax, range 0 to 3, average, when present, 1.6, lacking in 30 percent of cases; posterior section of the metathorax, range 0 to 4, average, when present, 1.9, lacking in 16 percent of cases.

The spiracerores are similar in all respects, including size, to those of the second stage. In a count of 2,378 groups on specimens from all 4 host palms the range in number of pores in each group was from 0 to 5, and the average 2.1. The number of openings in each pore was usually 5, sometimes 4, occasionally only 3, and in one instance 7.

Of the same type of pore, and essentially like the spiracerores, are two groups occurring on each side of the meson on the pygidium, near the vagina, probably on the sixth abdominal segment. These are the "genacerores" (*gc*) of MacGillivray (*8*); they are commonly

termed the "circumgenital" or "paragenital" pores, but the writer prefers the more technical word, both because they are of a different type from the usual pores and because this term clearly distinguishes them from the posterior body pores which also occur near the genital opening. The genacerores are larger than the spiracerores, being almost uniformly 5.5μ in diameter; also they are somewhat more strongly sclerotic. A part of the outer ring of this type of pore can be seen in the genacerores better than in the spiracerores. A side view shows the ring to be distinctly raised above the pore openings, the parts on each side, in focus, appearing as sharp curving lines (fig. 4, *N*). By focusing either up or down, the curving lines can be made to extend over and meet, forming a dome over the openings. A casual glance suggests that these are covered by a dome-shaped membrane, but a careful examination shows that what is seen is merely the edge of the ring on the more elevated side of the pore. (The openings are indicated by the dotted line in the figure.) A perfect side view would, of course, not show the dome. Occasionally an individual is found with 1 and even 2 genacerores on the median line, clearly separated from the others. The pores of the groups are occasionally so scattered or so bunched together that it is difficult, if not impossible, to separate the groups.

An enumeration of the genacerores included in each group in 1,091 specimens selected at random from the four host palms gave a range of from 1 to 14 and an average of 8.1 for each anterior group, and a range of from 0 to 10 and an average of 5.8 for each posterior group.

LEGS

The legs are apparently absent.

SPIRACLES

Both pairs of spiraculariae are directed laterad. The anterior pair were on the average slightly shorter, but a little wider, than the posterior pair. The range in length of the former was from 21 to 30μ, with an average length of 27μ; of the latter from 27 to 36μ, with an average of 28μ. The spiracularia of the former averaged in width 18μ; of the latter, 17μ. The spiracle itself was approximately 9μ in diameter for both pairs.

VAGINA

Before egg deposition begins the vagina is always shaped as shown in figure 4, *A*. The walls appear to be rather thick, the actual free tube being the area limited by the mesal dotted line. At the anterior end is a characteristic and distinct sclerotic area (fig. 4, *Y*, *vcha*). When egg deposition begins, the vagina is either ruptured to a shapeless piece or is evaginated (fig. 4, *Y*), sometimes both. In length the vagina averaged, for 50 specimens, 77μ from the external opening to the anterior sclerotic area, the range being from 68 to 90μ. On the same number of specimens the vulva (*vu*) averaged 20μ cephalad of the anus, the range being from 11 to 36μ. The vulva is located probably between the seventh and the eighth abdominal segments.

ROSTRALIS

In length the rostralis averages about the same in proportion to the length of the body as in the second stage. From a tabulation of the lengths of the body in relation to the lengths of the corresponding rostralis it is evident that the two are not directly proportional. In 25 specimens examined in this respect the general average ratio between length of body and length of rostralis was 1 to 6.25; the lowest ratio noted was 1 to 4.6, the highest 1 to 9.3; the average length of the rostralis in these specimens was 4.18 mm, the range from 3.07 to 4.92 mm; the average length of the body was 0.67 mm, the range from 0.49 to 0.84 mm.

The position of the rostralis within the body is irregular in prepared specimens, but the end loop is characteristic in shape, and averaged 59μ long by 18μ wide.

SECOND-STAGE MALE

Twenty-four individuals, 8 each from the date and Canary Island palms and 4 each from the Washingtonia and doum palms, were studied. The newly molted individuals (fig. 5, *A*) average very slightly smaller than the second-stage females, although the sizes overlap freely. The average dimensions for 40 newly molted individuals of this stage were 0.36 mm long and 0.28 mm wide; the length range was from 0.35 to 0.37 mm, the width range from 0.27 to 0.29 mm. When newly molted the two sexes cannot be distinguished by contour, but in time the body of the male becomes elongate-oval, in contrast to the more roundly oval body of the female. Seventeen fully matured examples of this stage just ready to molt showed an average length of 0.61 mm and an average width of 0.33 mm.

DORSAL ASPECT OF THE BODY

BODY SEGMENTS

The segments are similar to those of the second-stage female.

SETAE

The border head setae are similar in number and size, and practically so in occurrence, to those of the second-stage female. The only variation from the normal 4 large ones and 1 medium one was in 1 specimen that possessed an extra large cephalic seta on the dextron.

The mesal head setae of the first stage are retained in this stage. As a rule they are slightly smaller than the larger border head setae. In no instance was one missing.

The caudal head seta of the first stage and of the second-stage female is also present here in moderate size. There is an additional seta in the series, a very small one generally, caudolaterad of the other. The primary seta was never missing, but the new seta was missing four times from one side and twice from both sides, in the 24 individuals studied.

The thoracic and abdominal mesal setae of the first stage are all retained, also the prothoracic mesal seta of the second-stage female.

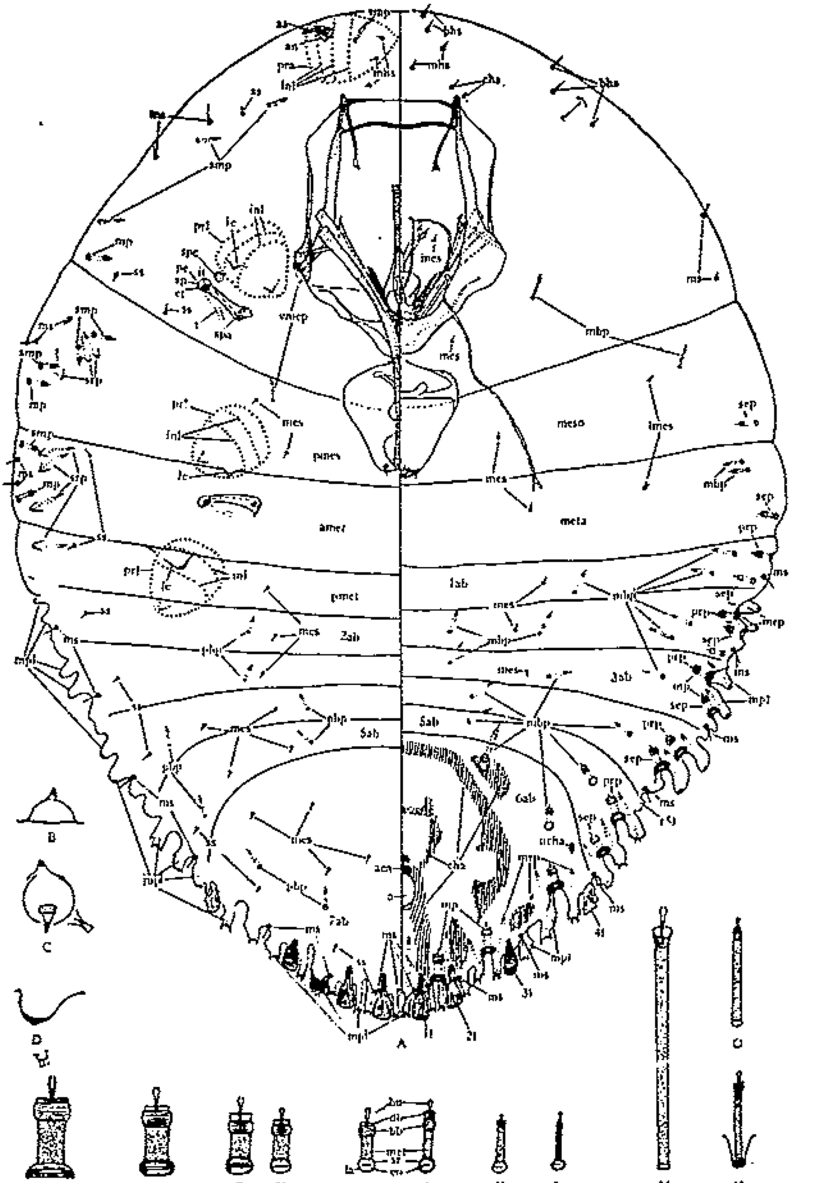


FIGURE 5.—Second-stage male: *A*, Body (dorsal surface at right of observer); *B*, prothoracic leg; *C*, mesothoracic leg; *D*, metathoracic leg; *E*, marginal pore of eighth abdominal segment; *F*, marginal pore of first abdominal segment; *G*, marginal pore of metathorax; *H*, marginal pore of mesoprothorax; *I*, *J*, mesal body pores of sixth abdominal segment; *K*, mesal body pore; *L*, ventral mesal pore of mesoprothorax; *M*, marginal raised pore of ninth abdominal segment; *N*, posterior marginal raised pore of fourth abdominal segment; *O*, submarginal raised pore of metathorax. *A*, ×365; *B-O*, ×1,040.

33818°—34——5

All these setae are small, their calyces approximately 1.9μ in diameter. The position of these setae is characteristic, similar to that in the first stage, except that the second abdominal one is usually situated distinctly mesad of the neighboring ones. The posterior prothoracic one was absent once from the sinistron.

The lateral mesal and marginal setae are similar to those of the second-stage female in number, position, size, and occurrence. The caudal one of the marginal series on the prothorax was absent once on the sinistron of one specimen.

EYE

The eye is nearly always recognized, usually distinct and rather well developed, but occasionally it appears to be hardly more than vestigial.

PORES

The marginal pores are essentially like those of the second-stage female, except that characteristically an extra pore may be present on one or more of the following segments: Mesothorax, metathorax, and first and second abdominal segments. These extra pores are included in the secondary pore series. The secondary pores on the first and second abdominal segments may be reduced in size or absent; also on the fourth and fifth abdominal segments they may be absent. The single marginal pores on the mesothorax and the metathorax were considered as belonging to the secondary pore series because of their positions and generally stouter proportions than those of the neighboring pores of this surface.

The pores corresponding to the mesal body pores of the second-stage female are present in this stage in greater numbers, mainly toward the meson, and the posterior ones average larger in size. There is, however, no fundamental difference between them. A distinctive lateral row of the pores occurs here, as in the second-stage female, with the addition of 1 or 2 pores near the margin on the metathorax. A typical example of the number and position of pores on the segments is shown for the individual figured. The sizes, in microns, of the mesal body pores on the abdomens of the 24 specimens, together with a comparison of the sizes of these pores among themselves, have been summarized as follows: First abdominal segment, range 1 to 5, average 3.14, with 83.5 percent of the 151 individual pores small, 14.5 percent medium, and 2 percent large medium; second abdominal segment, range 1 to 4, average 3.0, with all the pores small; third abdominal segment, range 1 to 3, average 2.9, with 84 percent of the 137 pores small, 9.5 percent medium, and 6.5 large medium; fourth abdominal segment, range 1 to 4, average 2.3, with 60 percent of the 112 pores small, 12.5 percent medium, 23 percent large medium, and 4.5 percent large; fifth abdominal segment, range 1 to 3, average 2.0, with 42 percent of the 95 pores small, 10.5 percent medium, 33 percent large medium, and 14.5 percent large; sixth abdominal segment, range 1 to 3, average 2.0, with 9.5 percent of the 95 pores small, 33 percent medium, 9.5 percent large medium, and 48 percent large.

The marginal raised pores are in all essentials similar to the corresponding ones of the second-stage female, with approximately the same variations of occurrence.

PLATES, LOBES, AND ANUS

These structures also are similar in every noticeable particular, including occurrence, to those in the second-stage female.

VENTRAL ASPECT OF THE BODY

BODY SEGMENTS

The segmentation of the body appears to be similar in all respects to that of the second-stage female.

ANTENNA

The antenna resembles that of the second-stage female except that its largest projection is somewhat more elongate.

SETAE

The three mesal head setae of the first stage are all present. The mesal and the marginal setae are similar to those of the second-stage female. The ventral marginal seta of the eighth abdominal segment is, however, distinctly smaller than the one in the second-stage female. The submarginal setae are similar to those of the second-stage female, except that the eighth abdominal one is retained and there is occasionally an extra one on the mesoprothorax and one on the posterior section of the mesothorax. All the setae of this surface, excluding the extra ones near the margin of the mesothorax, are constant in occurrence.

PORES

The marginal pores on the posterior section of the mesothorax and the anterior section of the metathorax are difficult to distinguish from the submarginal pores. From their position it is interpreted that the caudal one on each of these segments is the true marginal and primary pore. As in the second-stage female, the caudal pore of the mesoprothorax is distinctly larger than the more cephalic ones, and is considered to be a marginal pore. As compared with the second-stage female, an extra submarginal pore frequently occurs on the posterior section of the mesothorax and the anterior section of the metathorax. The submarginal pores are slightly larger and more sclerotic than those of the second-stage female. A small submarginal pore was occasionally observed on the head, usually mesad of the antenna. A count of the marginal and submarginal pores of both surfaces, up to and including the marginal pore of the mesoprothorax but not the little submarginal pores of this segment, on 25 specimens from all 4 host palms, showed a range of from 18 to 27 pores, and an average of 21.2 pores, on each side of the body.

The mesal pores (*vmep*) of the thorax occur as in the second-stage female, except that the one on the posterior section of the mesothorax appears to be frequently absent.

A single small pore is always found on the submargin of each of the fourth to seventh abdominal segments, and one is usually present near the meson of each of the second to sixth abdominal segments. All these may be known as the posterior body pores (*pbp*). None, it

will be remembered, appeared in the second-stage female, but, as has been mentioned, the adult female does have some pores on the posterior part of the abdomen similar in every respect to the pores here.

In contrast to the single occurrence of a raised pore on the mesoprothorax in the second-stage female, this pore was observed 13 times in this stage. Also 2 raised pores on the posterior section of the metathorax were observed 4 times in this stage, but not once in the second-stage female.

The spiraceroris is essentially like that of the second-stage female. From an examination of 218 specimens, considering each side independently, 2 pores occurred once, no pores 4 times, and a single pore in all the remaining cases.

LEGS

The legs are in most instances distinct on all three segments as very small protuberances, which are generally somewhat sclerotic at the tips. They are frequently plainly separated into segments (fig. 5, *B*, *C*). Though always considered as present, they are undoubtedly in a vestigial condition, but not so much so as in the second-stage female. The dotted areas about the legs in figure 5, *A*, represent the developing third-stage legs, which do not actually appear in an individual as young as the one represented. This also holds true for the dotted area about the antenna, representing the developing third-stage antenna. These areas are placed here as a matter of convenience, being in fact the only extraneous structures shown on the figure.

SPIRACLES

The spiracles are essentially like those of the second-stage female.

ROSTRALIS

The rostralis does not differ in any noticeable particular from that of the second-stage female, and is not shown in the figure.

THIRD-STAGE MALE

Seven specimens, 4 from the date palm, 2 from the doum palm, and 1 from the Canary Island palm, were studied. The body is elongate-oval (fig. 6, *A*), and the average length and width of 6 of the specimens was 0.59 and 0.29 mm, respectively. The figure shows the typical condition of the various structures.

All pores, plates, and lobes, as well as the eye and the pygidium, are absent. The spiracles show no unusual features, and will not be discussed.

DORSAL ASPECT OF THE BODY

BODY SEGMENTS

A part of the suture (*prs*) between the head and the prothorax can be detected only with difficulty. All the other segments are distinct except the ninth abdominal one, which is much reduced but apparently can be at least partially differentiated by an indentation in the body margin.

SETAE

Four setae along the submargin of the head are considered to be the border head setae. The 2 anterior ones are comparatively large

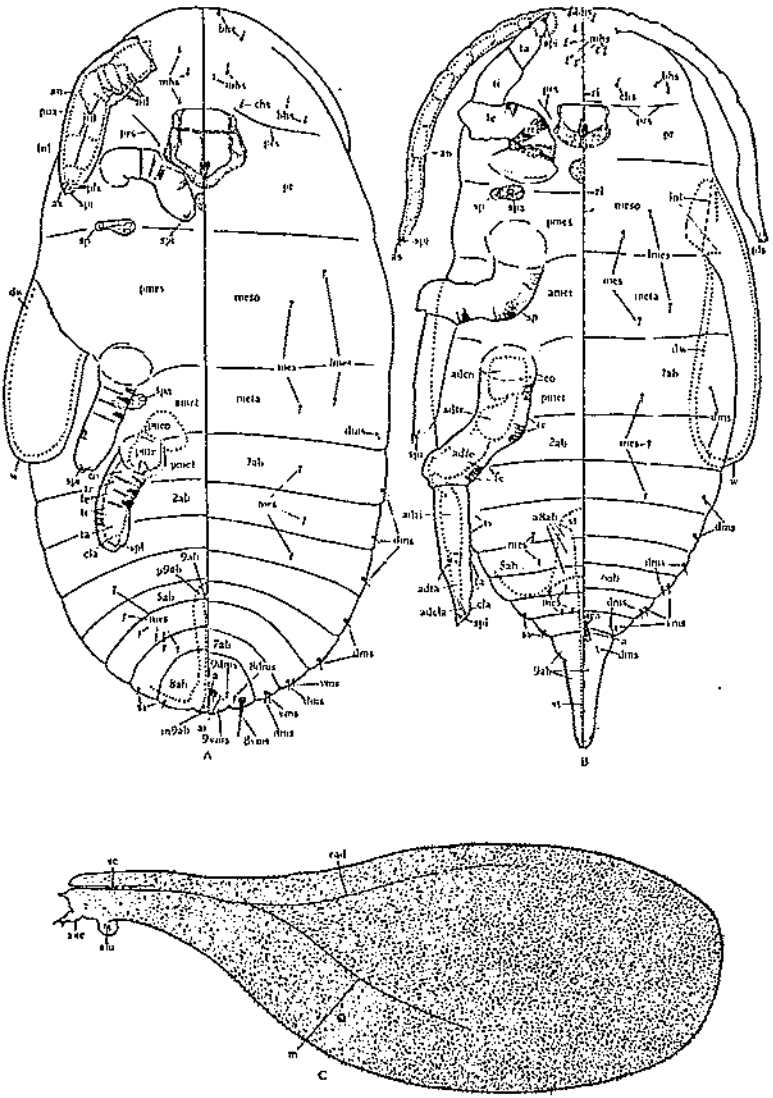


FIGURE 6.—*A*, Third-stage male (dorsal surface at right of observer), × 155; *B*, fourth-stage male (dorsal surface at right of observer), × 135; *C*, adult wing, × 140.

and always present; the 2 posterior ones are always small, and 1 of them was missing in 3 instances.

The large and small setae close together near the meson of the head are interpreted as the mesal head setae. Each one may be either large or small; neither was ever missing.

The seta cephalolaterad of the anterior margin of the endoskeleton is considered to be the caudal head seta. It is variable in size, and was absent 4 times out of a possible 14.

The mesal setae are present on the mesothorax, the metathorax, and the first three abdominal segments. They are constant in presence and position.

Both lateral mesal setae of the preceding stages are present here. They were never missing and were always in the same relative positions.

The dorsal marginal setae are limited to the metathorax and the abdomen, one occurring on each segment. The metathoracic seta is small, and was absent from both sides on four specimens. All the setae on the abdomen were always present, and were nearly uniform in size and position.

The ventral marginal setae occur very near the margin, and it is usually a question as to whether the anterior ones are on the ventral or the dorsal surface. In the figure they are shown on the dorsal surface. They are usually somewhat smaller than the dorsal setae and, except on the ninth segment, are always situated cephalad of the latter. With a single exception, they were always found on abdominal segments 6 to 9; one specimen lacked one seta on the sinistron of the sixth abdominal segment. The eighth abdominal seta (*8vms*) is unusually large.

ANUS

The anus is located about 15μ from the caudal margin of the body, and is 9μ in diameter. It is narrowly sclerotic. A characteristic ridge (*ar*) curves caudolaterad from it.

VENTRAL ASPECT OF THE BODY

BODY SEGMENT

The ninth abdominal segment (*9ab*) over much its greater extent is very long and narrow. All except the very base is invaginated, represented in the figure by the mesal dotted area. The outer dotted area (*p9ab*) represents the ninth abdominal segment of the fourth instar in a similarly invaginated condition, developing around it.

SETAE

The 3 mesal head setae were present in every instance but 3; the cephalic one was missing from both sides in 1 specimen and from one side in another.

A mesal seta occurred on the fourth and fifth abdominal segments, and a pair of them on the sixth and seventh abdominal segments. One of these was absent from the sinistron of the fifth and sixth abdominal segments of a single specimen. One specimen showed 2 setae on a side on all 4 of these segments and, in addition, a very small seta on each side of the third segment. Another specimen showed 2 setae on the dextral side of the fourth abdominal segment, and a third specimen had 2 on the dextron of the fourth and fifth abdominal segments. A ventral submarginal seta always occurred on the eighth abdominal segment, and was present in 7 instances on the seventh and in 2 on the sixth.

In this stage the measurements of the setae from both surfaces have been considered together. They may be grouped as follows, according to the diameters, in microns, of their calyces: With diameter 4.7, the eighth abdominal ventral marginal; with diameter 2.4, two cephalic border head, outer dorsal mesal head, and first to seventh, inclusive, abdominal dorsal marginal; with diameter 2.1, inner dorsal mesal head, caudal head, lateral mesal, dorsal mesal of thorax, dorsal marginal of metathorax, and eighth abdominal dorsal marginal, remaining ventral abdominal marginal, and the ventral mesal head; with diameter 1.9, two posterior border head, ventral mesal of abdomen, submarginal; with diameter 1.6, ninth abdominal dorsal marginal; with diameter 1.4, antennal.

ANTENNA

The antenna develops within the body of the second-stage male (fig. 5, *A*) in a telescoped condition, the cross dots in the figure representing the lines of the major invaginations. Three segments of the antenna are generally recognized, two short basal ones directed caudolaterad and a long distal segment bent more caudad. The antenna is typically about 360μ long by 160μ wide. It possesses no noticeable structures except near the tip, where it generally bears a very small seta (*as*), a short spinelike projection (*spi*), and 2 or 3 small clear areas (*pls*) which are probably sensory in nature. In the older individuals the fourth-stage antenna is visible within as a partially invaginated structure, owing to its much greater length. It is in a decidedly crumpled-up condition near the bend, on account of its crowded quarters, and folds are present in it nearer the tip.

LEGS

The segments are in part distinctly sclerotic. A characteristic spinelike projection is present near the tip of each leg. The developing fourth-stage leg is plainly visible in the older individuals. It is so much longer than the third-stage leg that the coxa appears to have been crowded entirely out of the leg into the body proper.

WING PADS

The wing pads (*w*), when present, arise on the lateral margins of this surface, typically as shown, and are always well developed. From an examination of 49 males of this stage obtained from all the host palms considered, the wing pads were absent in 55 percent of the specimens.

FOURTH-STAGE MALE

Nine specimens, 4 each from the date and Canary Island palms and 1 from the doum palm, were studied. The body is approximately the same size as in the third stage, though it averages somewhat longer from tip to tip, owing to the extended position of the ninth abdominal segment (fig. 6, *B*). The average length and width of the body, for the specimens studied, were 0.72 and 0.26 mm, respectively.

As in the third-stage male, all pores, plates, and lobes, as well as the eyes and the pygidium, are absent. The spiracles are well developed but appear to possess no features worthy of discussion.

DORSAL ASPECT OF THE BODY

BODY SEGMENTS

The extended caudal piece is readily seen to be simply the ninth abdominal segment. The characteristic segmentation is as figured. A distinct ridge (*ri*) extends along the meson from near the posterior margin of the head to the middle of the mesothorax. In emerging, the adult splits the skin along the meson from the cephalic border just to the caudal end of this ridge, which evidently has something to do with the molting process. The lateral split takes place along the submargin of the head, between the posterior border head setae, as far as the prothorax. The position and extent of the splitting of the third-stage skin correspond to those of the fourth.

SETAE

All the setae of this surface are essentially like those of the third stage in size, position, and occurrence, except that the marginal metathoracic one was not observed and the eighth ventral abdominal marginal seta is similar in size to the other marginal setae in this stage; also the cephalic border head seta appears to be situated nearly, if not quite, on the ventral surface.

WING PADS

The wing pads arise from the submargin of the mesothorax on this surface. They fold over onto the ventral aspect, about half of the wing pad occurring on each surface, typically as represented. The adult wing developing within the fourth-stage one, being somewhat longer than the latter, is a little folded near the base, as indicated by the short dotted lines. When present the wing pads always appear well developed. In this stage they were absent in 40 percent of 99 specimens examined from all the host palms.

ANUS

This structure is apparently situated on the ninth abdominal segment, just caudad of the anterior margin. Its distance from the caudal tip of the segment averaged, for all individuals, 104μ, the approximate length of the segment. The diameter of the anus averaged 12μ.

VENTRAL ASPECT OF THE BODY

BODY SEGMENTS

A noticeable feature of older individuals is the developing ninth abdominal segment, or the stylus (*st*), of the adult within the body. The stylus is so long that only about half of it can come within the fourth-stage projection. The base of the stylus extends cephalad nearly to the third abdominal segment of the fourth instar, and in consequence the eighth abdominal segment of the adult is forced forward to this extent.

SETAE

Four head setae, apparently belonging to the mesal group, are present in this stage, in contrast to the three present in all the preceding male stages. One seta was absent in a single instance. The mesal and the submarginal setae occur essentially as in the preceding stage.

ANTENNA

This structure averaged, for the nine specimens, 280μ long by 24μ wide. Indentations along the outer basal half are the only distinct segmental indications. In older individuals the adult antenna is plainly discernible within the fourth stage. There is sufficient room for it to develop entirely within the latter, without such folding as takes place within the third stage. A short spinelike projection always occurs at the apex of the antenna; a very small seta (*as*) and 1 or 2 small, apparently sensory structures (*pls*) are generally present also.

LEGS

The segmentation can be made out more readily than in the third instar. The outer margin of a leg projects characteristically about half the distance between the base and the tip. This bulging is to accommodate parts of the adult femur and tibia (*adfe*, *adti*). The legs of the fourth instar also have the short spine (*spi*) at their apices.

ADULT MALE

Sixteen individuals, four from each palm, were studied. The average length and width of 15 individuals were 0.80 and 0.20 mm, respectively. Their size varied considerably, from one individual measuring 0.64 mm long by 0.16 mm wide, to one measuring 0.86 mm long by 0.22 mm wide. These wide variations were noted in other specimens, not only of the adult, but of the third and fourth instars as well. The specimen figured (fig. 7, *A*) represents an individual from the doum palm.

There are no pores present that can definitely be recognized as such; plates and lobes are also absent.

DORSAL ASPECT OF THE BODY

BODY SEGMENTS

A narrow sclerotic area (*cha*) extends caudolaterally across the meson of the head, and may limit its caudomesal margin. The anterior margin of this area projects some distance from the meson cephalolaterad, decreasing rapidly to a line, and then curving sharply cephalomesad near the mesal margin of the eye, producing within a distinctly raised area (*ra*) that always bears four of the head setae.

The strongly sclerotic framework covering the central part of the body is considered to embrace the mesothorax. Between the mesothorax and the sclerotic area (*cha*) and a lateral indentation, that is, in position to be the prothoracic suture (*prs*), lies the prothorax.

The sclerites of the mesothorax may be defined as follows: The praescutum (*psc*), appearing from the dorsum as a narrow, curving, strongly sclerotic band along the mesocephalic margin and a broader

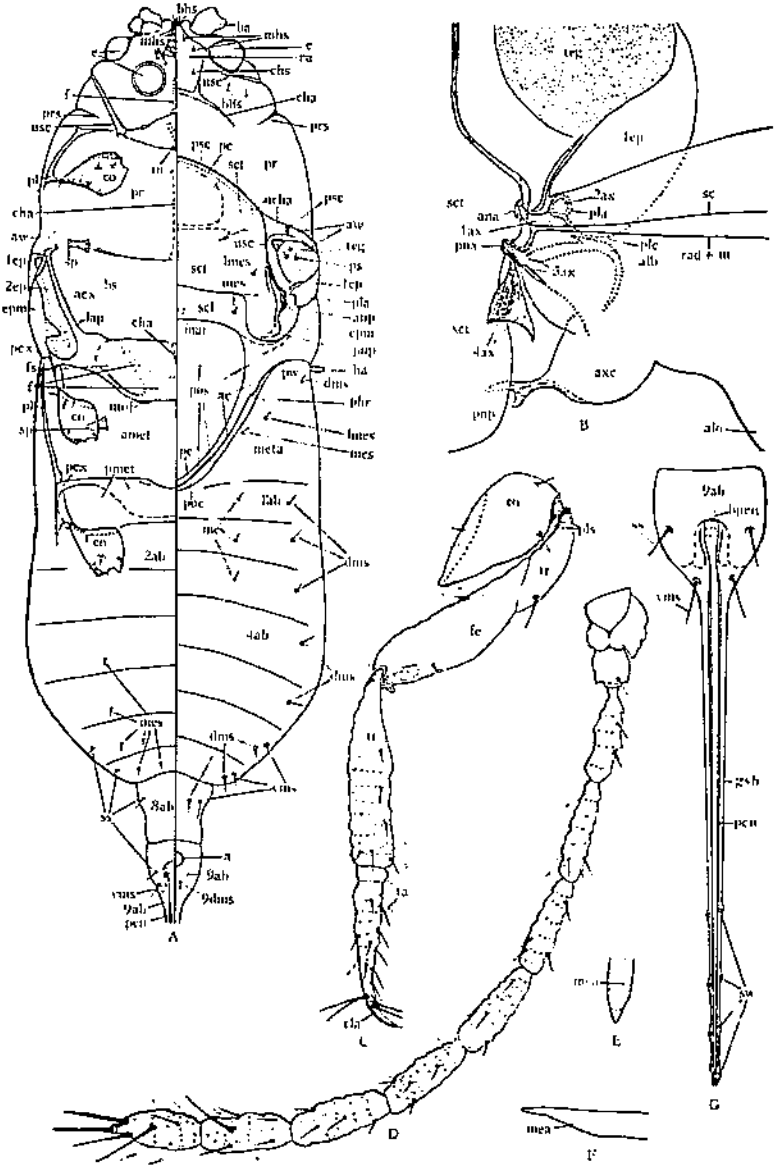


FIGURE 7.—Adult male: *A*, Body (dorsal surface at right of observer), × 195; *B*, articulation of wing, × 875; *C*, mesothoracic leg, × 350; *D*, ventral surface of antenna, × 350; *E*, ventral aspect of tip of penis, × 2,630; *F*, lateral aspect of tip of penis, × 2,630; *G*, genital armature, × 350.

extension laterally; a wide, more or less membranous area immediately caudad of the praescutum and extending to the articulation of the wing, the scutum (*scl*); a sclerotic band in the center of the framework, the scutellum (*scl*); a broad membranous area immediately caudad of the scutellum, followed by a narrower, curving, strongly sclerotic band, both parts constituting the postscutellum (*pos*). Berlese (*1, v. 4, pp. 101–102, 161*) gives the postscutellum as belonging to the metathorax.

Below the cephalic margin of the praescutum and attached to it is a sclerotic band, the precosta (*pc*).[4] Laterad of the precosta, and below the praescutum, is an undetermined sclerotic area (*ucha*) which may be inconspicuous or developed as shown in the figure. Laterad of this sclerotic area, and also below the praescutum, is a sclerotic piece, of characteristic form, which is in position to be the prealar wing process (*awp*). A differentiated area (*mar*), usually membranous, and varying to some extent in size and contour, is located on the meson of the scutellum. The strongly sclerotic caudal section of the postscutellum is divided by a distinct suture, considered to be the antecostal suture (*ac*), into an anterior part, designated the precosta (*pc*), and a posterior part, designated the postcosta (*poc*). The postscutellum extends, without any apparent interruption, onto the pleuron, but is considered to be separated from the latter by the postalar bridge (*pw*).

The metathorax is quite broad laterally, but on the meson is sharply reduced to hardly more than a line by the posterior projection of the mesothorax.

The abdomen is clearly differentiated into 9 segments. The first 7 are of the usual form, the eighth is narrowed, and the ninth is composed of a swollen base and a long, rapierlike distal portion.

SETAE

There are 4 border head setae, as in the third and fourth stages. The 2 cephalic ones are on the cephalomesal margin, 1 on the ventral surface and 1 on the dorsal. These were never absent. The 2 posterior ones are near the caudolateral margin. One or both of these were absent in 5 instances.

The usual 2 mesal head setae and the caudal head seta are present on the raised area. The caudal head seta and a posterior seta of the mesal head pair were absent from the sinistron of 1 individual.

The mesal and lateral mesal setae are present here as in the two preceding stages. From 1 to 3 additional setae occur on the pleuron, cephalolaterad of the anterior lateral mesal seta. They are called the pleural setae (*ps*).

The marginal setae occur essentially as in the two preceding stages. The ventral marginal setae appeared to be placed on this surface, and occurred on either one side or the other, or both, on the fifth abdominal segment 12 times, and on the fourth segment 7 times, out of a possible 32.

The setae may be grouped as follows according to the approximate diameter, in microns, of their calyces: With diameter 2.4, all marginal setae on dorsum, except ninth abdominal one; with diam-

[4] Many of the terms used to describe the parts of the thorax on both the dorsum and the venter are those used by Snodgrass (*13*).

eter 2.0, all head, mesal, and lateral mesal; with diameter 1.6, ninth abdominal.

EYES

An eye is present on the dorsolateral margin, dome-shaped, and about 27μ in diameter and 22μ in thickness. The eye is never absent, though occasionally it is somewhat reduced in size.

WINGS

Targioni Tozzetti (*14*) states that this species is wingless; yet the writer has found the winged individuals to predominate. Not uncommonly, however, the wings were observed to be only partially developed. Of 186 adult males from all the host palms considered, it was found that only 25 percent were wholly wingless, 56 percent had fully developed wings, and in 19 percent the wings were present in various degrees of development, 11 percent having them less than half size. In all specimens the thoracic wing framework was fully developed.

The fully developed wing (fig. 6, *C*) is about 0.64 mm long by 0.24 mm wide, shaped typically as shown in the figure. It bears numerous spinulae scattered evenly over its surface, and has two prominent veins, which are united for most of their proximal halves. Comstock (*2, p. 290*) quotes Patch (*11*) as indicating that the anterior vein is the radius (*rad*) and the posterior one the median vein (*m*). At the base of the wing, cephalad of the coalesced veins, occurs a short, delicate line, called by Patch the subcostal vein (*sc*). A prominent lobe, the alar lobe (*alo*), occurs near the posterior proximal margin. The articulation of the wing to the thorax (fig. 7, *B*) agrees apparently with what Snodgrass (*13*) found to be the condition for the general insect wing. Two points of articulation occur on the notum, the anterior notal wing process (fig. 7, *A*, *anp*) on the lateral margin of the scutum and the posterior notal wing process (*pnp*) on the scutum and near its caudal border. These two processes are borne by membranous tissue, and considerable flexibility appears to be possible. The margin of the anterior process, however, is strongly sclerotic, this sclerotization continuing cephalad as a very narrow band. Two distinct indentations occur in the anterior process, the anterior notal wing acetabulum (*ana*) and the posterior notal wing acetabulum (*pna*). These are actually the articulating points of the anterior process. Into the former fits a curving, heavy sclerite, closely attached to the wing, the first axillary sclerite (*1ax*); into it, above, a heavy, narrow, roundly curving sclerite, the third axillary (*3ax*), which is deeply indented by a projection of the base of the wing. The third axillary appears to be joined so firmly to this projection as to seem almost a part of it. Below, the third axillary sclerite apparently rotates on the distal knob of a heavy sclerite, the fourth axillary (*4ax*), which articulates beneath the third also with the posterior wing acetabulum. The fourth axillary is broadly and concavely expanded at its base, which apparently rocks about the cephalic part of the rounding margin of the posterior notal wing process. The fourth axillary sclerite is so thickened on its mesal half that this region resembles a stout projection. From its shape and position it

probably acts in part as a brace to the backward movement of the wing. The strongest brace of the wing, however, is probably the axillary cord (*axc*), a swollen clublike projection from the posterior margin of the base of the wing. The proximal end, which is emarginate and strongly sclerotic, fits around the posterior notal process, and also appears capable of a rocking motion. The second axillary sclerite (*2ax*) is situated below the wing. It is globular and articulates proximally against the first axillary and distally against the pleural wing acetabulum (*pla*).

The wing articulates against one process on the pleuron, which is composed of two elements, the pleural wing acetabulum and the pleural wing condyle (*plc*), against which abuts a sclerotic thickening on the under surface of the wing, the alar buttress (*alb*). This is a crescent-shaped structure, convex, facing the condyle, with a special projection from its margin as the articulating surface. The sclerite bearing the pleural wing process is thought to be the anepisternum (*aep*) of Crampton (*3*). It curves laterocephalad onto the ventral surface. A membranous piece is situated cephalad of the latter, and is in position to be the tegula (*teg*). It bears the pleural setae. An undetermined subtriangular sclerite (*usc*) borders the mesocephalic margin of the tegula. From its position and shape this sclerite appears to serve as a buttress against the forward movement of the wing, in much the same manner that the axillary cord acts as a brace against the backward movement of the wing.

The part along the body margin and connected to the postscutellum by the postalar bridge is designated the epimeron (*epm*). It is distinct from the anepisternum, and apparently possesses no wing-articulating points.

The halteris (*ha*) was present occasionally as a projection from the cephalolateral margin of the metathorax. In some individuals it was difficult to decide whether this structure was actually present or not. Except when vestigial, occurring as hardly more than slight bulgings from the body, even the smaller ones appeared in contour surprisingly like the fully developed wings, being neither threadlike nor knoblike. This structure was found to be present in only 17 percent of the 184 adult males from all the host palms examined. When the halteris was present it was always found on both sides, but there was sometimes a noticeable difference in size on the two sides. The size also varied greatly from individual to individual. The range in length was from 36μ down to 2μ. The halteris possessed no distinguishable secondary structures, though prominent distal setae are borne by other species of *Parlatoria*.

ANUS

The anus, which is subcircular in outline, appears to be situated on the ninth abdominal segment. It is about 12μ in diameter.

VENTRAL ASPECT OF THE BODY

BODY SEGMENTS

The homologies of the segments were determined mainly from the positions of the legs, spiracles, and sutures.

A delicate structure (*in*), apparently an invagination, occurs on the meson immediately cephalad of the prothoracic leg. This is considered to be the entrance to the alimentary tract. An internal projecting structure (*f*) occurs on the meson cephalad of the above-mentioned invagination. At first glance it might be thought to be a part of the alimentary tract, but it is strongly sclerotic, and is of a definite length, ending abruptly, and is interpreted as a furca of the head. The caudal margin of the head is delimited by a delicate suture extending from the invagination of the alimentary tract toward an indentation in the body margin. A narrow, undetermined sclerotic piece (*usc*) extends laterocephalad from this suture onto the dorsum of the head.

On the meson, in the suture separating the anterior from the posterior section of the mesothorax, a long sclerotic piece (*cha*) occurs. It appears to be on the surface, and for this reason is not considered to be a furca. The posterior section of the mesothorax is apparently composed of two parts, a basisternum (*bs*) and a furcisternum (*fs*). Laterally the basisternum is bounded by a narrow sclerotic piece, the precoxal bridge (*acx*). The precoxal bridge extends cephalolaterad, turns dorsad near the prealar wing process, abuts against the latter, and then, apparently, turns caudad to extend along the mesal margin of the anepisternum. It is probable that this caudal extension can be considered as no more than a differentiated part of the katepisternum (mentioned below). The furcisternum is connected with the pleuron by a bridge, the postcoxal bridge (*pcx*). It may seem questionable to call this bridge "postcoxal" when it is situated cephalad of the coxa. However, the coxa has been drawn noticeably caudad, and in consequence has thrown the neighboring parts out of their usual alinement. Shepard (*12*) indicates the lateral extension of the furcisternum in some typical Lepidoptera as being cephalad of the coxa. Between the basisternum and the furcisternum a small sclerotic area (*cha*) is located, As it also appears to be on the surface, it is not considered to be a furca. Along the caudal margin of the furcisternum a prominent pronged furca having a broad base arises.

As herein interpreted and indicated, the anepisternum extends onto the venter as a narrow curving piece that joins the caudal extension of the precoxal bridge. Posterior to the anepisternum, and plainly separated from it, are two sclerites. Between these, along a distinct suture, is a prominent apodeme (*lap*). The mesal sclerite (*2ep*) appears to be homologous to the katepisternum of Crampton; the lateral sclerite is a continuation of the epimeron of the dorsal surface. No definite division of the epimeron could be distinguished. Below the line of the invagination of the apodeme is an elongate sclerotic piece, against the caudal extension of which the coxa articulates. Whether it belongs wholly to the epimeron, or partly also to the katepisternum, could not be determined. The elongate sclerotic pieces on the prothorax and metathorax, against which the coxae articulate, are called simply the pleural sclerites (*pl*).

The metathorax is composed of two sections. A bridge (*pcx*), corresponding to the mesothoracic postcoxal bridge, connects the posterior section of this segment to the pleural sclerite.

Except for the apparent obliteration of the first abdominal segment, all the remaining abdominal segments are similar to those of the dorsal surface.

ANTENNA

The antennae (fig. 7, *D*) may vary considerably in size, but the relative lengths of the segments are fairly constant. The average length measurements, in microns, for each segment of 15 antennae were: Basal 22.4, second 16.9, third 37.0, fourth 39.2, fifth 38.0, sixth 36.3, seventh 36.8, eighth 35.8, ninth 38.4, tenth 31.8.

Every antennal segment bears 1 or more setae, which range from small on the basal segments to relatively large on the apical ones. There is much variation in the numbers of these present on the different segments, a tabulation of the numbers on 16 antennae giving the following range: Basal 1, second 1, third 1 to 2, fourth 1 to 9, fifth 1 to 7, sixth 6 to 10, seventh 4 to 13, eighth 7 to 12, ninth 2 to 13, tenth 5 to 9. Each segment from the third to the tenth bears from 4 to 6 irregular transverse rows of minute spines.

SETAE

There are 7 mesal head setae, 5 on the meson of a small raised area and a pair caudolaterad of the others. There were never any more than this, and on 5 individuals the posterior seta on the meson was absent. The mesal one of the paired caudolateral setae was absent on one side in each of 2 individuals.

The mesal setae of the abdomen and the submarginal setae are present essentially in the same numbers, positions, and occurrences as in the two preceding stages, except for the addition of a submarginal one on the ninth abdominal segment, which also has a marginal seta.

All the setae of this surface are small, their calyces about 2μ in diameter, except the lateral one of the pair on the head, which is somewhat larger.

EYE

The eye is almost circular, approximately 20μ in diameter, and is situated well toward the meson.

LEGS

The prothoracic legs are the smallest, the mesothoracic ones slightly larger, and the metathoracic ones a little larger still. The tibia and tarsus are distinctly separate, in contrast to their fusion in the first stage. The tarsus is probably one-segmented, though it is distinctly constricted near its base, giving that part the appearance of being a separate sclerite. Slight variations in the dimensions of the segments, not worthy of note, were observed, but the following measurements, in microns, of the lengths of the parts of a prothoracic leg may be taken as approximately characteristic for all the legs: Coxa 47, trochanter 47, femur 90, tibia 90, tarsus 60, claw 18.

Each segment of the legs (fig. 7, *C*) bears 2 or more setae. On 7 specimens representing all the host palms considered, the parts of

the legs were found to bear setae as follows: Coxa 5, trochanter 2, femur 3 to 7, tibia 10 to 17, tarsus 16 to 20, claw 2.

The setae on the coxa are in characteristic locations, as represented in the figure. The 2 caudal setae on the upper surface, near the articulation of the coxa to the trochanter, are generally somewhat larger than the others. The trochanter possesses a very minute seta near its proximal end, on the margin, facing the coxa; on the opposite margin, near its distal end, is a much larger one. These setae are thus situated on all the legs. The setae on the femur are somewhat variable in position. There is, however, always 1 on the margin facing the coxa, and there are 2 or more near the distal end. Those on the tibia and tarsus occur irregularly around these segments, on the distal two thirds. The tarsus always bears the larger number, usually 3 or 4 more. The 2 long setae on the distal end of the tarsus and the 2 moderate-sized setae at the base of the claw are never absent.

As in the first-stage nymphal leg, 4 distinct but small porelike spots occur, 2 each on opposite sides, near the proximal end of the trochanter.

The tibia and the tarsus possess apparently the same sort of minute spines as are present on the antenna.

STYLUS

The stylus (fig. 7, *G*), if it is considered as constituting the ninth abdominal segment, excluding its enlarged base, consists of two fundamental parts, the genital sheath (*gsh*), which composes the outer parts of the long caudal projection and is deeply depressed along the ventromeson, and the penis (*pen*), a slender rapierlike organ extending the length of the sheath and surrounded by it. The sheath has a number of swellings (*sw*) near its distal end along each side. Usually there are 4 on a side, and occasionally 3 or 5. Each contains a dark spot or nucleus. These swellings are probably tactile in function. The penis arises within the swollen basal part of the ninth abdominal segment, and is strongly sclerotic proximally, but gradually becomes less so till it is almost membranous distally. Within the sheath the penis apparently is a round tube, which slowly decreases in diameter towards the tip, where it becomes suddenly pointed (fig. 7, *E*, *F*), with the external opening, the meatus (*mea*) (represented by the dotted lines), on the under or dorsal surface. Distally the penis is but loosely clasped by the sheath.

SCALES[6]

The scale of the first instar is subcircular, approximately 0.4 mm in diameter at the time of the first molt, thus just covering the exuvia caudocephalad. At this time a comparatively thick mass of wax is present, which tapers toward the margins, but the darker exuvia is plainly discernible beneath.

The color of the first exuvia of both sexes beneath the secretions is rather uniform for any one specimen, but for different specimens, even those close together on a single leaf, it grades from light brown

[6] Descriptions based on dried material.

to almost black. There appear to be more of the darker forms on the date palm, but much gradation of color is noted among the specimens from all four palms.

When fully developed, the scale of the second-stage female is subcircular, approximately 0.7 mm in diameter, with the first exuvia projecting beyond the anterior margin at varying angles but in a general cephalic direction. At the time of the second molt the scale extends about 0.5 mm caudad of the first exuvia.

The adult female scale, when fully developed, is oval, more sharply so anteriorward, approximately 1.3 mm long by 0.7 mm wide. The secretion extends around the anterior margin as a very narrow band. Posteriorward this band increases in width, extending 0.3 to 0.35 mm beyond the caudal margin of the second exuvia. The first exuvia continues to project beyond the anterior margin of the scale, in a generally cephalic direction. The second exuvia appears orange colored beneath the scale, usually with a darker central area of varying proportions. This darker area appears black beneath the scale but greenish black when the scale is removed. It may almost cover the exuvia, or it may be reduced to a small central arrow-shaped area, the long point directed caudad. Sometimes it is lacking entirely, the exuvia appearing uniformly orange colored. Another specimen, almost touching one lacking the dark area on the exuvia, may, on the other hand, have the exuvia practically covered with the dark area. The date-palm material in the writer's collection has a larger number of specimens with comparatively extensive dark areas on the exuviae; yet here, as well as in the material from the other palms, all gradations in extent of the dark area on the exuviae occur.

The exuviae of the second, third, and fourth instars of the male are too delicate to show through the heavy scale covering secreted by the second instar. When fully developed, the scale covering is elongate-oval, the anterior end being somewhat sharp in contour, approximately 1.0 mm long by 0.4 mm wide. The first exuvia projects beyond the anterior margin in a general cephalic direction. It ranges from light brown to nearly black in color, each individual exuvia, however, being practically all the same shade. Here, too, there are more specimens with the darker exuvia in the date-palm material.

In color the scale coverings of all the stages from all four palms are white or nearly so. The older male specimens appear somewhat more yellow than the females, probably because of the denser secretions. In size there is some slight variation among the specimens of each stage, but none distinctive for those from any particular palm.

In molting, the ventral skin of the first instar splits crosswise just caudad of the antennae and along the lateral margin of the body and, with all its remaining parts, rolls back onto the pygidium. This same phenomenon takes place in the second-stage female, except that usually the split is somewhat more mesal all around, leaving proportionately less tissue to roll back. Apparently the entire exuviae of the second, third, and fourth male instars are pushed back to the posterior region and left in a crumpled mass.

THE HEAD SKELETON AND ASSOCIATED PARTS

Detailed accounts of the head skeleton and associated parts are given by Berlese (*1*, *v. 5*), List (*7*), and Mark (*9*), these being in all probability the most exhaustive treatises on the subject extant. List and Mark, particularly the latter, make specific mention of the points where their observations led them to differ with the literature of their times. Both give good bibliographies.

The structures included in the sclerotic head framework (figs. 8, 9, 13, and 14) of the Coccidae have been called collectively the "Horngraten" by Mark. This seems rather a fanciful term. List's term "Schlundgerüst" is not adequate, for this framework is composed also of certain pieces intimately associated with the mandibles and maxillae. Berlese has called these structures the "rostro", which seems entirely unsuitable, since "rostrum" is a common word for the labium of the Hemiptera. A particular word to designate the parts would be desirable. For lack of one, the general term "head skeleton" will be used here. The associated parts are chiefly the coiled mouth parts, with covering membranes, and the rostrum. They are so closely linked with the head skeleton that all can be most conveniently discussed in one general section. It may be mentioned here that an entire new set of all these parts is produced for each instar. Mark (*9*) describes in detail the shape of the head skeleton of *Aspidiotus nerii* Bouché and its constituent parts, and this description he indicates as essentially covering the cases of allied genera. Berlese's descriptions of the head skeleton in a number of species of the diaspidines are in general accord with that of Mark. The head skeleton of *Parlatoria blanchardi* is, as might be expected, for the most part essentially in agreement with these two accounts.

To designate some of the boundaries of the head skeleton, the following unpublished terms of the late A. D. MacGillivray are used: "Inferarca", "superarca", "infercosta", "supercosta", and "interarca." The first four are modifications of Mark's terms "arcus inferior", "arcus superior", "costa inferior", and "costa superior", respectively. "Interarca" takes the place of the "columella" of Mark, because the structure it represents is in the form more of an arc than of a column, and "inter" indicates its position.

ADULT FEMALE, OR TYPE

In the following paragraphs the head skeleton of the adult female is used as a type (figs. 8 and 9). The ventral surface (*vs*) is broadest cephalad, appearing dome-shaped. It narrows slightly laterally in a caudal direction to more than half its length, then bends rather sharply caudad to a distinct point. A broadly curving ridge (fig. 9, *C*, *vsr*) of this surface is directed toward this point. This surface is covered by the membranous tissue characteristic of the entire body. As far as can be observed, no part of the head skeleton projects above the general surface, although the latter appears roundly raised, particularly caudad, where it dips inward. The ventral surface is the only one in contact with the external body wall.

Cephalad the ventral surface of the head skeleton is bounded by the comparatively narrow inferarca (figs. 8 and 9, *B*, *ina*), which

joins laterally the ventromesal margins of the pair of vaulted, curving bars, the interarcae (figs. 8 and 9, *B*, *ita*), which extend at right angles from the former into the lumen of the body. Along

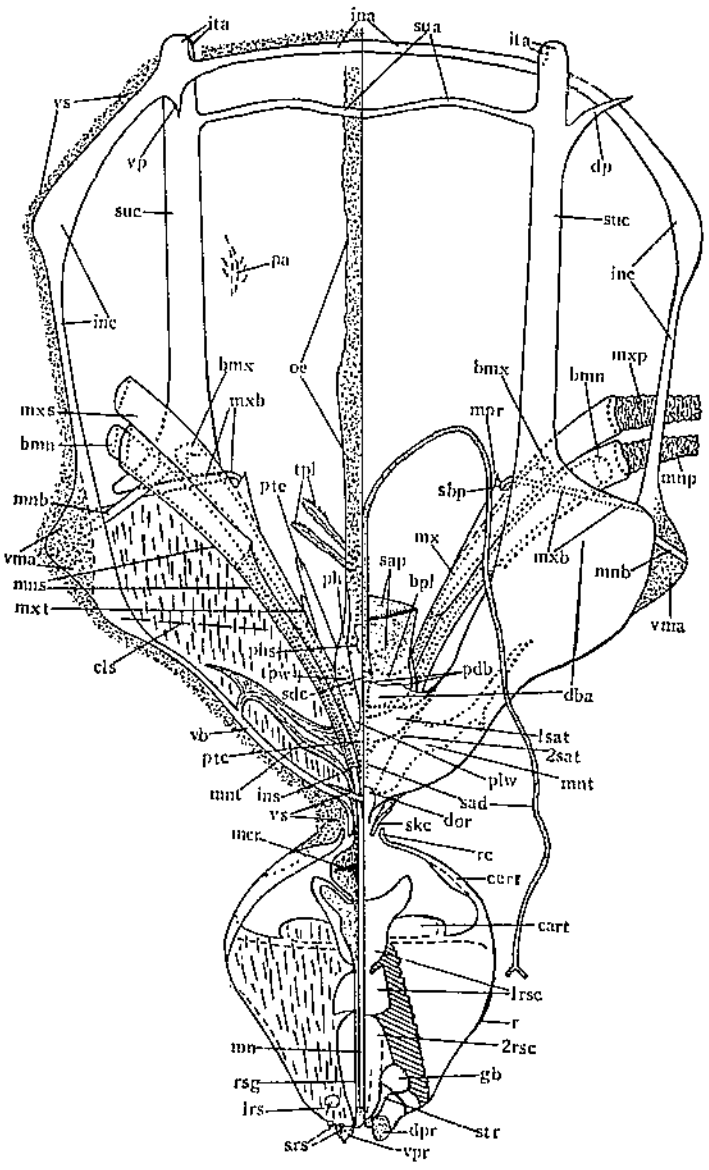


FIGURE 8.—Adult female, head skeleton and rostrum (ventral surface at left of observer). × 845.

the ventrolateral margins of the interarcae, and continuing the dome-shaped cephalic border of the ventral surface, the infercostae (figs. 8 and 9, *A*, *B*, *inc*) begin as comparatively broad bands. About midway of their lengths they narrow noticeably, and bend

from a caudolateral direction to a caudomesal one, to about the median point of the head skeleton. Here the laterial margins connect with some membranous tissue, the ventral membranous area (figs. 8 and 9, *A*, *vma*), which merges into the moderately sclerotic band (fig. 9, *B*, *lb*) covering the caudal half of the entire lateral surface of the skeleton. The infercostae are considered as continuing to a suture (fig. 8, *cls*). From here a narrow band (*vb*) extends in a curving caudal direction to the meson.

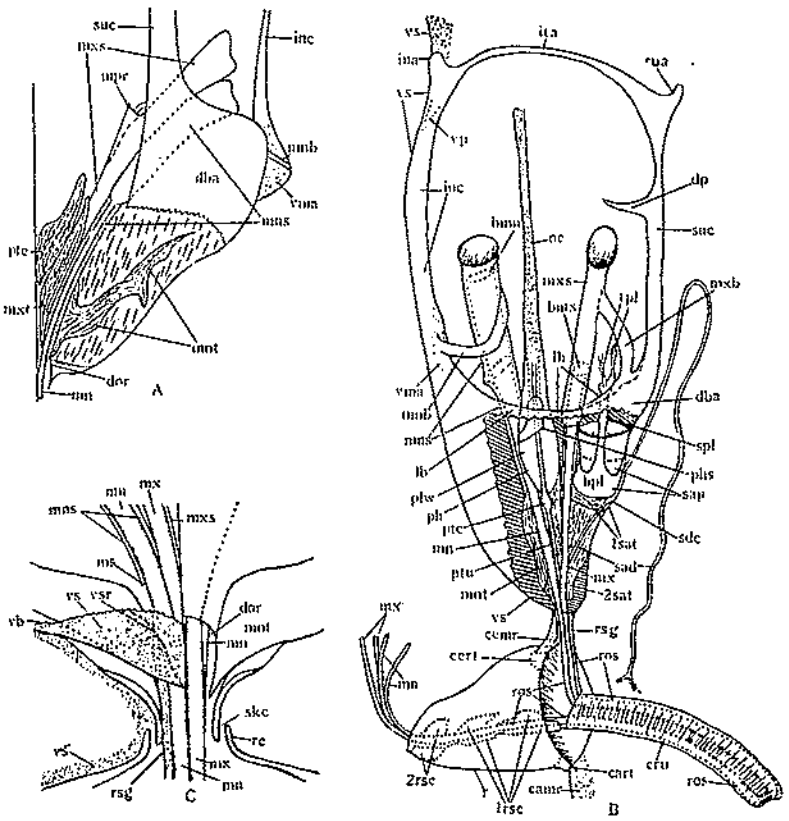


FIGURE 9.—Adult female: *A*, Intermediate dorsal aspect of head skeleton, × 700; *B*, lateral aspect of head skeleton and rostrum, × 500; *C*, articulation of head skeleton and rostrum (ventral surface at left of observer), × 2,800.

The suture beginning at the caudal end of the infercostae and extending across the ventral surface is prominent, and may in this region separate the labrum from the clypeus. Berlese considers the ventral surface of the head skeleton to be a union of these sclerites. If this is so, this suture is in all probability the clypeolabral suture. It is frequently of irregular curvature. In the figure the long dash lines simply indicate its position, since the surface tissue is represented as removed.

Projecting caudad from the ventral ends of the interarea, and flush with the membranous tissue of the body, is a pair of spinelike processes, the ventral processes (figs. 8 and 9, *B*, *vp*). These pro-

jections point toward very faintly sclerotic areas near the central part of the ventral surface of the skeleton, the process areas (fig. 8, *pa*).

The interarcae extend dorsad from their union with the inferarcae and intercostae, and join the superarca (figs. 8 and 9, *B*, *sua*) and the supercostae (figs. 8 and 9, *B*, *suc*) at a common point. The superarca limits the cephalic margin of the dorsal surface of the skeleton. It is a slender bar, at first slightly arched, then dipping caudad to the meson. The supercostae are broader bars and limit the lateral margins of the cephalic half of the dorsal surface. At their caudal ends they expand and merge into the broad dorsal bands (figs. 8 and 9, *A*, *B*, *dba*), which limit the remaining part of the cephalolateral margin of the dorsal surface. Along the cephalolateral margin of each supercosta occurs a prominent projection, the dorsal process (figs. 8 and 9, *B*, *dp*).

The dorsal bands are broadest cephalad, they narrow perceptibly caudad, and are indistinguishably fused on the meson. They might, in fact, be considered as a single band across the caudal part of the dorsal surface. Their cephalomesal margins usually have one or more slight prominences (fig. 8, *pdb*). The caudomesal margins are considerably invaginated to form the caudal boundary of the opening for the mouth parts (figs. 8 and 9, *A*, *dor*).

The ventral, lateral, and dorsal bands form a single piece, and apparently serve as a unit in holding the caudal half of the skeleton rigid. The bars apparently serve a similar function in holding the cephalic half of the skeleton rigid. Where the various bars and bands join one another the fusion is practically indistinguishable, the separation of the parts being based on form and position.

Attached to the cephalolateral margin of each ventral membranous area is a slender bar, the mandibular brace (figs. 8 and 9, *A*, *mnb*), which curves cephalomesad around a prominent strongly sclerotic tube, the mandibular sheath (figs. 8 and 9, *A*, *B*, *C*, *mns*), and flares slightly where it is rigidly joined to the dorsal surface of the sheath. The connections take place a short distance from the cephalic open end of the sheath. The sheath curves gently caudomesad and ends probably a little cephalad of the caudal point of the ventral surface. Because of the crowding of structures in this region, the exact location could not be determined. The cephalic sclerotic portion of the sheath is nearly cylindrical, and is slightly smaller caudad. The heavy sclerotization ends rather abruptly, at about half way caudad, the remaining portion being very delicate and easily overlooked.

Attached to the cephalolateral margin of each dorsal band is a slender bar, the maxillary brace (figs. 8 and 9, *B*, *mxb*). This bar curves cephalomesad and connects with the cephalic end of a long, triangular projection, the maxillary process (fig. 8, *mxpr*), which is fused to a prominent strongly sclerotic tube, the maxillary sheath (figs. 8 and 9, *A*, *B*, *mxs*). This structure curves gently caudomesad, and ends dorsad of, and in the same general vicinity as, the mandibular sheath. The cephalic opening of the maxillary sheath is oval, rather than round like that of the mandibular sheath, and the sclerotization extends farther caudad; its end is less noticeable. The maxillary sheath, however, is somewhat smaller in diameter in this

region. The caudal half is delicate, its limits being difficult to distinguish because of the proximity of surrounding structures.

In all the literature that the writer has seen, the sheaths are apparently mistaken for the bases of the mandibles and maxillae, but the latter can be seen either partly or entirely within the sheaths; and also, during ecdysis, the new mandibles and maxillae can be easily observed entering the new sheaths while the old head skeleton and all its associated parts are in process of being discarded.

The mouth bristles, or stylets, come together to form a sucking tube. This tube has frequently been called the "proboscis" by American writers, but as this term has been used to include a lesser number of parts in the case of other insects, or other parts than those forming the tube among the Coccidae, it is not a distinctive expression. "Bristle" has also been commonly used, but this is even less satisfactory, since it calls to mind a short, stiff, blunt structure, such as a seta or spine, just the opposite of its meaning here. List employs "Borstenbundel", which, although implying more than merely "bristle", is open to the same objections. Mark's term "Schnabel" is not precise, for it might be thought to refer to the rostrum. Furthermore, "snout" or "beak" is used commonly to designate the prolongation of a beetle's head, including structures entirely different from the ones referred to among the scale insects. "Stylet" or "stylets" is not satisfactory, for this term has been definitely applied to the genital armature of the male coccid, as well as to other structures of the insect body. MacGillivray uses "rostralis." Although one cannot be sure through analysis exactly what the word means, it can be seen that a structure associated with the rostrum is implied. Since the word is distinctive in that it designates nothing else, just as "rostrum" is coming to mean, among sucking insects, solely the labium, formed to hold the tube, the writer has adopted it here.

Mark (*9*) quotes Mecznikov (*10*) as stating that the mandibles and maxillae appear early in the embryo, only to fuse later with other parts of the head, and that the bristles forming the sucking tube are entirely new structures, secreted from flasklike cells on each side of the head. Mark does not refute this statement; neither does List. The writer believes that much more evidence will have to be submitted to disprove the homology of these parts with the mandibles and maxillae.

A mandible (*mn*) and a maxilla (*mx*) develop in a single coil (fig. 10, *A*) on each side of the head, each one making about nine loops. Each is entirely separate from the other, and in specimens cleared in potash the loops frequently show considerable irregularity in size and position.

The mandibles and maxillae can readily be distinguished from one another by differences in their bases. The mandibular base is somewhat greater in diameter than the maxillary base, but has thinner walls. The walls, furthermore, are smooth, and the end is even in contour, whereas the maxillary base has ridges in its walls and the end is greatly depressed on one side and has a prominent spinelike projection in the depression. Except for the bases, no differences in size or form were detected between the mandibles and maxillae. Their bases are much swollen as compared with the remaining parts, but the mandibles and maxillae rapidly taper down from their bases

to slender threads, even in thickness to their tips, which are reduced to extremely fine points, with no teeth or other irregularities discernible. The basal ends of the mandibles and maxillae are observed to be hollow, and this condition prevails in any cross section of the mandibles and maxillae, except that their tips appear to be closed.

In developing, the tips are formed first, and are in the same position up to the time of molting (fig. 10, *A*), that is, just outside the cephalic ends of the sheaths. The remaining parts are laid down successively toward the bases. In mounted material the developing mandibles and maxillae are twisted, a condition (fig. 10, *B*) brought about, perhaps, by the comparatively flat condition in which they seem to be at first. The ribbonlike parts are composed of three

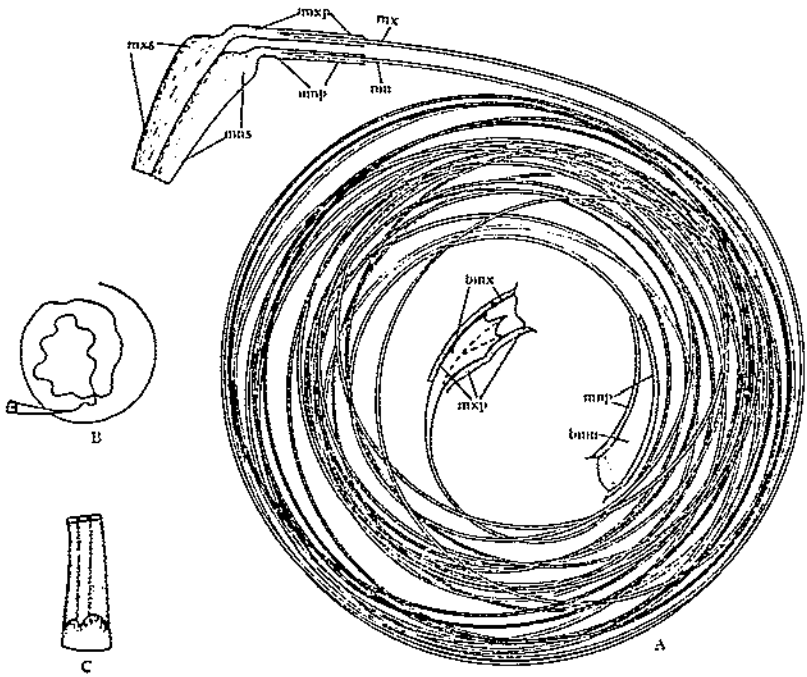


FIGURE 10.—Adult female: *A*, Coiled mandible and maxilla, × 500; *B*, part of developing maxilla, × 200; *C*, base of developing maxilla, × 800.

hollow tubules (fig. 10, *C*), which gradually become a single hollow tube toward the bases, the maxillae taking the longest time to do so.

Fused nearly at right angles to the cephalic ends of the sheaths, and surrounding closely in the coils each mandible and maxilla, are very delicate membranes, the mandibular and the maxillary pockets (fig. 10, *A*, *mnp*, *mxp*), within which the mandibles and maxillae develop. These pockets are most distinct around the tips of the mandibles and maxillae, and fade out toward the bases, where they appear to end blindly. No secreting cells at the basal ends were discerned, even in slightly cleared specimens. The pockets are considered to be invaginated continuations of the sheaths, the differences between the two being merely that of position and degree of sclerotization. A combination of sheath and pocket appears to be

produced in order to give the tremendously long mandible or maxilla sufficient room in which to develop. The sheath seems to serve the secondary function of supporting the base of the mouth part after it has slipped into the sheath. In the figure only parts of the pockets, those at each end, are shown in order to avoid too many confusing lines within the coils proper.

The mechanics involved in the forcing of the mandibles and maxillae out of the pockets and into the sheaths is not known, though a study of the musculature would probably clarify the matter. Perhaps the coils are under considerable tention. This movement begins simultaneously as the new sheaths are molted from the old ones, the tips of the mandibles and maxillae penetrating the new sheaths as fast as the sheaths are free of the old ones. During the process the pocket tissue becomes piled up at the mouths of the sheaths, and as most of it is much smaller in diameter than the bases of the mandibles and maxillae, they probably rupture it, as a rule, when they enter the sheaths. This probability, together with the fact that the pockets are forced into numerous puckers, which undoubtedly strain the tissues severely, explains why most specimens show but distorted fragments of the pockets, or none at all, about the cephalic openings into the sheaths. Occasionally the pockets of a specimen stand the strain exceptionally well; such pockets are shown in figure 8. The entrance of the mandibles and maxillae into the sheaths appears to be facilitated by the construction of neighboring parts. As previously mentioned, the mandibular brace is fastened rigidly to the corresponding sheath. But at the other end it is attached to a membrane, which probably allows a certain freedom of movement through which the sheath can be bent back and forth. The maxillary brace, on the other hand, is not attached at either end to any membrane, but the end connecting with the projection of the sheath is bent caudad and narrowed at this point, and seems to be separated from the projection of the sheath by a suture (fig. 8, *sbp*). This construction would appear to allow for a sort of pumping action, the brace being the handle of the pump. A flexibility of movement in the sheath could therefore be produced, a desirable feature inasmuch as the mandibles and maxillae are nearly at right angles to the sheaths before penetration.

The cone-shaped structure caudad of the head skeleton is the labium, or rostrum (figs. 8 and 9, *B*, *r*), as it is particularly designated among the Hemiptera. It is one-segmented, very fleshy, and deeply invaginated lengthwise on the meson of the ventral surface (fig. 11) in order to receive and hold the rostralis (fig. 9, *B*, *ros*). The rostrum is broadly rounded along the cephalic margin of the ventral surface. This margin, which is strongly sclerotic, is broken near the meson, the ends curving cephalad to form condyles (figs. 8 and 9, *C*, *rc*). These articulate against similar condyles (figs. 8 and 9, *C*, *skc*) issuing from the ventral surface membrane of the body, and in opposing positions along the mesal margin of the surface membrane (fig. 9, *B*, *cemr*, *camr*). The cephalic membrane, which is usually raised above the other body membrane, is attached along the lateral margins of the condyles, and articulates against the rostrum at two moderate thickenings (figs. 8 and 9, *B*, *cert*) of its margin. The caudal membrane articulates against the rostrum at two prominent broad thickenings (figs. 8 and 9, *B*, *cart*). Because

it is attached to the body solely by membrane, the rostrum has considerable freedom of movement in any direction.

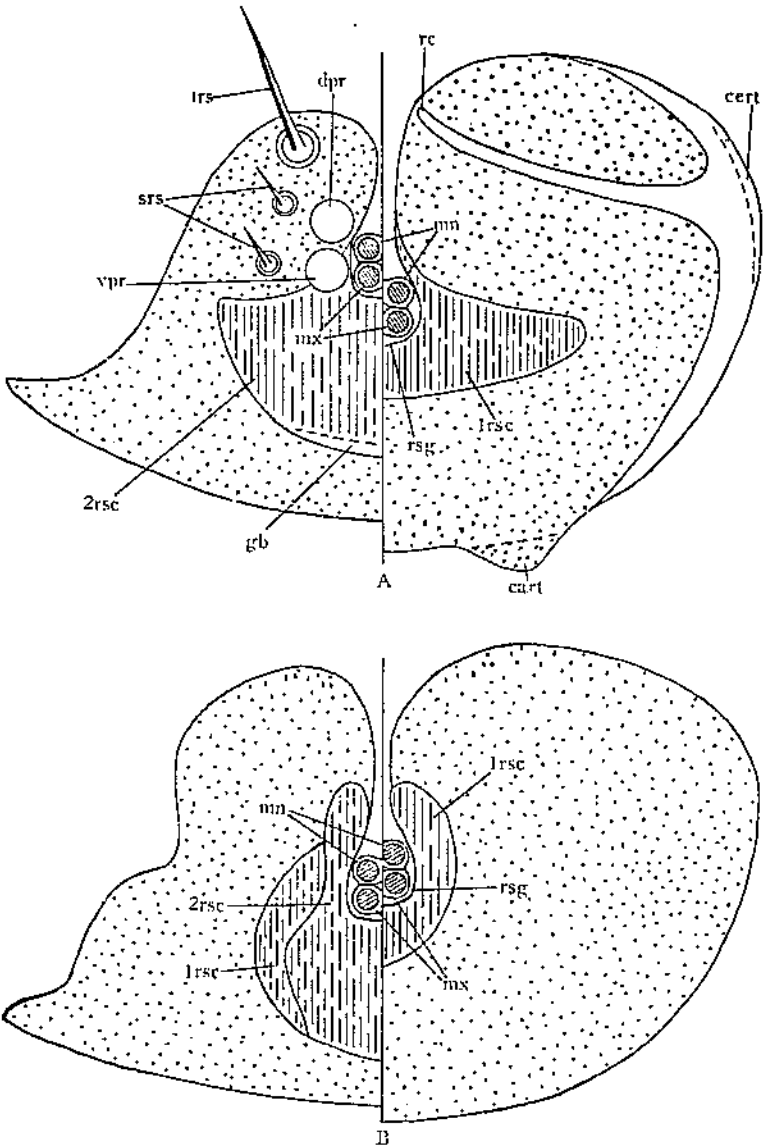


FIGURE 11.—Second-stage nymph: *A*, Apical and basal aspects of rostrum; *B*, Intermediate aspects, between apical and basal. (Apical aspect at left of observer.) × 2,250.

The floor of the rostral invagination is continuous with a membrane issuing from the head skeleton. This membrane probably merges in part with the dorsal walls of the sheaths. Immediately caudad of the rostral condyles it is deeply invaginated (fig. 8, *mcr*), to form the crumena (fig. 9, *B*, *cru*) of Mark. Caudad of the cru-

mena this membrane covers the mesal floor of two sclerites, the first and second rostral sclerites (figs. 8 and 9, *B*, *1rsc*, *2rsc*). The first of these is much constricted near its center, and there appear to be two present, but since on the dorsal surface the constriction does not reach the meson, Berlese was probably right in considering this a single piece. The second sclerite is arched, simple in outline on the ventral surface, but more complicated on the dorsal. Two ridges extend along the length of the sclerite, curving toward the meson at the caudal end. Pointing in nearly the same direction is a spinelike thickening (fig.8. *sth*) which is attached to a globular base (fig. 8. *gb*). The sclerite extends caudolaterad of this base to the margin. The ridges and thickenings evidently help to strengthen this part of the rostrum and to hold the rostralis in place. On the ventral surface a similar purpose is effected by the tall arched portion of the sclerite which lies over the *rostralis*, and the strong caudal point which undoubtedly holds and guides the rostralis. Furthermore, the membranous floor of the sclerites lies in a groove (fig. 8, *rsg*) of the sclerites, along which the rostralis slides.

At the caudal end of the rostrum are three pairs of setae, the large rostral setae (fig. 8, *lrs*), which are easily observed, and the small rostral setae (fig. 8, *srs*), which are more difficult to see. Dorsad of the setae are two delicate roundish prominences (fig. 8, *vpr*, *dpr*), one above the other. The upper, or ventral, one has a distinct but delicate projection, which looks like a small seta but probably is not one. These prominences are joined on their mesal margins to the caudal end of the membranous floor of the sclerites. Their positions at the apex of the rostrum indicate that they probably have sensory functions.

The tip of the rostralis, in issuing to the exterior, passes over the crumena and along the membranous floor of the rostrum to project slightly from the caudal end of the rostrum, undoubtedly against plant tissue. The remaining part of the rostralis is forced into the crumena by the unwinding of the coils.

Because in a large number of newly molted individuals, perhaps as many as a hundred, the rostralis, when not in the coils, was always found looped within the body, usually to its full extent, it is believed that the rostralis is always forced into the crumena before it is inserted into the plant. The frequency with which individuals were found in this condition leads to the conclusion that the rostralis remains for an appreciable time within the crumena. The mandibles and maxillae were never found partly unwound and partly within the crumena. Evidently as soon as the exuvia is rolled out of the way the coil unwinds rapidly.

The bases of the mandibles and maxillae usually pass down no further than the cephalic portions of their sheaths, although the exact location varies. Sometimes, even in old specimens, one or more bases will partially protude from the cephalic ends, others may be sunk low in the sheaths. This apparently means that the parts can function in various positions. Mark states that the tips of the rostralis may enter the crumena. This hardly seems possible, considering their sharpness, and has never been noted by the writer. On the contrary, in all the many specimens observed the tips have passed directly into the rostrum while the coils were still unwound.

Before the rostralis enters the crumena, the latter is in the wrinkled condition, and typically in the position, shown in figure 12. It is readily observed in all well-stained specimens. After entrance of the rostralis the crumena is stretched to six or seven times the length of the body, and is looped within it in a manner which is decidedly irregular, at least in prepared specimens. After the rostralis is withdrawn from the crumena, the latter shrivels up until it is greatly reduced in length (fig. 9, *B*). In this condition it is also readily observed in well-stained specimens, though frequently it appears badly distorted.

The shape and position of the rostral sclerites suggest that, when the rostralis is forced into the palm tissue, they slide back and forth upon one another, bearing down all the while on the rostralis, first on one side and then on the other. Since the rostralis is apparently unwound and within the delicate crumena before the palm tissue is penetrated to any extent, and much the greater part of it is eventually inserted into the host plant, this view of the mechanics of the rostral parts appears reasonable.

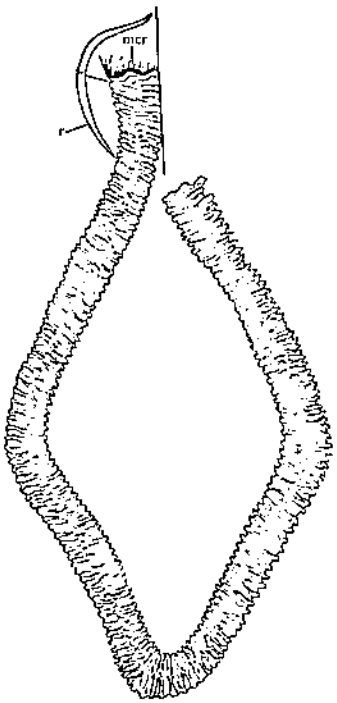


FIGURE 12.—Crumena, before entrance of rostralis, second-stage female. × 600.

On the median line of the skeleton, in a plane between the mandibles and the maxillae, is a swollen structure, the pharynx (figs. 8 and 9, *B*, *ph*). Its walls (figs. 8 and 9, *B*, *phw*) are greatly thickened laterally, but ventrodorsad they are comparatively thin. Within the walls, on each lateral side, is usually observed a rather distinct oval thickening (fig. 8, *thw*). Piercing the thickened walls of the pharynx on the median line, a small delicate tube, the pharyngeal tube (fig. 9, *B*, *ptu*), extends to the point where the rostralis is formed. Immediately caudad of the pharynx this tube is distinctly expanded bulblike into the pharyngeal tube chamber (figs. 8 and 9, *B*, *ptc*). From its structure the pharynx appears to be a powerful pump, and undoubtedly draws the nutritive substances through the pharyngeal tube.

On the median line of the pharynx lies a sclerite, characteristically shield-shaped as viewed from the ventral surface. This is the pharyngeal sclerite (figs. 8 and 9, *B*, *phs*), which serves, according to Mark, for the attachment of muscles. From the lateral aspect (fig. 9, *B*) the pharyngeal tube extends cephalad, and appears to pass through the pharyngeal sclerite and cephalad into a large, membranous tube, the esophagus (fig. 9, *B*, *oe*). The sclerite appears to have a direct influence upon the operation of the tube. It is quite different in appearance laterally and ventrally, on account of the prolongation of its base, which, however, does not project beyond

the surface of the pharynx. Berlese (*1, v. 5, pp. 16–17, figs. 185, 186*) figures the pharyngeal sclerite as being entirely outside the pharynx in *Aspidiotus limonii* Sign. (apparently synonymous with *A. nerii* mentioned above), and presumably he believes this is the case for related forms.

Immediately dorsad of the pharynx, and close against the dorsal surface of the skeleton, is a cuplike structure, the base of which is rounded and thickened, the lower sides thickened and directed inward, and the upper sides thin and directed outward. This structure is designated the salivary pump (figs. 8 and 9, *B*, *sap*). Arising from its center and directed cephalad is a rodlike projection called the salivary plunger (fig. 9, *B*, *spl*), which expands gently, and ends in two prominences, a small ventral one and a longer dorsal one. Each prominence is capped by a small tendon (figs. 8 and 9, *B*, *tpl*). Nearly the entire lower half of the pump is filled by the base of the plunger (fig. 9, *B*, *bpl*).

A delicate tube, the salivary duct (figs. 8 and 9, *B*, *sad*), issues from the caudodorsal point of the pump, extends free of the skeleton into the body cavity some distance cephalad, and bifurcates. Each branch is at first directed cephalolaterad, then bent rather sharply in a caudal direction, and in turn bifurcates in the region of the rostrum. Berlese gives the salivary duct as penetrating the walls of the pump (ghianda), but to the present writer it appears to enter the pump just cephalad of the margin of the dorsal band, bend beneath the pump for a short distance, and expand into a bulblike chamber (fig. 9, *B*, *sdc*). In this particular it resembles the pharyngeal tube. Beyond this the salivary duct extends in a caudoventral direction toward the pharyngeal tube. Berlese states that it ends in a large chamber. Nothing like this was discernible to the writer, but a narrow tube, smaller and darker than the pharyngeal one, and deeply imbedded in tendonous tissue, appeared to be present. As far as could be determined, this salivary-duct tube did not extend so far caudad as the pharyngeal tube, and ended before the rostralis was formed, indicating that the salivary tube probably connects directly with the pharyngeal tube.

About half way along each ventral band there is joined to it a curving, strongly sclerotic structure. Laterad this structure tapers to a point against the lateral band, and mesad it expands against the caudolateral side of a mandibular sheath, tapering against it both cephalad and caudad. From its shape and position it is thought to be a tendon, and it is here designated as the mandibular tendon (figs. 8 and 9, *A*, *B*, *C*, *mnt*). Besides covering the entire lateral surface of a mandibular sheath, this tendon curves slightly and covers in this region some of both dorsal and ventral surfaces of the sheath. The parts of the tendon connecting it with the ventral and lateral bands apparently serve as braces. On the ventral surface, mesad of the maxillary sheath of each side, there is just visible a projection that is considered to be a part of the maxillary tendon (figs. 8 and 9, *A*, *mxt*). This tendon covers some of the mesal surface and much of the dorsal surface of the maxillary sheath; it tapers caudomesad, coming to an end on the dorsal surface.

With the position of these tendons in mind, the manner in which they operate on the parts concerned may be considered. The mandibles are apparently clasped, chiefly laterally, and partly ventrally

and dorsally, by the mandibular tendons, and forced mesad. On the other hand, the maxillae appear to be clasped or imbedded in the maxillary tendons mainly dorsally but partly mesally, and would therefore be forced ventrally and laterally against the mandibles. The mandibular tendons are larger, and also much more extensive laterally, than the maxillary tendons are mesally. As a result the maxillae are pressed against the mandibles directly beneath (dorsad), while the maxilla and mandible of each side are being brought together on the meson by the more powerful mandibular tendons. In this way the rostralis would be produced in the region of the caudal end of the head skeleton. The rostralis is square in cross section, with apparently a single sucking tube in the center. Unfortunately, no good cross sections of the rostralis were obtained; so the writer hesitates to state this positively, though the cross sections he did have appeared to have the parts in these positions, as would be expected from the position and shape of the tendons. List (7), however, states that for *Orthezia cataphracta* Shaw the maxillae are placed, one dorsally and the other ventrally, in juxtaposition, a concavity in the surface of each producing a central tube, while a mandible is placed on each side, a concavity in each pressed against the median line of the maxillae, producing two secondary tubes, resulting in three sucking tubes altogether.

On the ventral surface, mesad of a maxillary tendon, is another, considerably larger, pointed structure, the pharyngeal tendon (figs. 8 and 9, *A*, *pte*). This tendon covers the lower part of the pharynx laterally and dorsally, and tapers sharply to an end on the dorsal surface. The pharynx is cupped within this tendon, which on contraction would apparently squeeze it. Perhaps, however, this tendon serves the greater purpose of holding the pharynx steady, while the powerful walls of the pharynx do the contracting during the pumping operations. In either case the pharynx is considered to be the pump which draws the substances into the alimentary tract. The bulblike chamber of the pharyngeal tube seems to serve as a vacuum chamber.

Immediately dorsad of the pharyngeal tendon, and just beneath (caudad of) the salivary pump, lies the thickest of all the tendons of the head skeleton, the first salivary tendon (figs. 8 and 9, *B*, *1sat*). It is the only one which extends to the dorsal band. Cephalad this tendon expands slightly against the meson some distance below the cephalic margin of the dorsal band; caudad it expands more appreciably, with a small part of it tapering out against the salivary duct. Laterally this tendon curves, and tapers sharply to a point at the margin of the dorsal band. Caudad of the first salivary tendon lies the second (figs. 8 and 9, *B*, *2sat*), which tapers from the whole caudal margin of the former to the caudal invagination of the dorsal band. This second salivary tendon also covers like a sheet the whole dorsal surface of the lower part of the maxillary tendons. The mandibular tendon extends far enough around dorsad to expand against the ventrolateral surface of the second salivary tendon. The salivary plunger apparently works up and down, the pump being the framework which holds the plunger steady. The tendons of the plunger probably instigate its up-and-down movement. The strong first salivary tendon supports the pump and holds it in

place, as well as the part of the salivary tube penetrating it. The bulblike chamber of the tube probably serves as a vacuum chamber, being similar in function to that of the pharyngeal tube. The second salivary tendon guides the remainder of the caudal part of the tube, and probably also supports the dorsal surface of the mandibular and maxillary tendons, and helps to bind together in this region the free ends of the tendons.

VARIATIONS FROM TYPE IN OTHER STAGES

The head skeleton and associated parts of the first and second instars are essentially like those of the adult female, although smaller. To indicate to better advantage most of the parts of the head skeleton and rostrum, certain parts are featured in each of figures 1, 3, 4, 5, and 6. In the first instar the ventral processes and process areas appear to be missing, whereas in the second instar of both sexes they are prominent. The superarea, inferarea, and interarea are membranous in the first instar, and somewhat less so in the second, especially the inferarea, which approaches the sclerotic condition. No sex differences were found in the head skeleton and associated parts of these two stages.

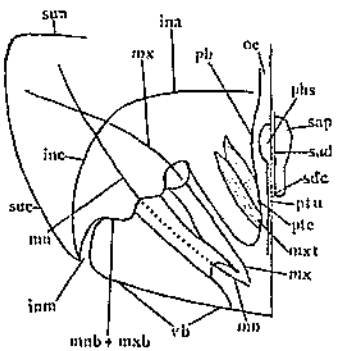


FIGURE 13.—Developing head skeleton of embryo (ventral surface at left of observer). × 2,000.

Figure 13 shows the condition of the head skeletal structures in an early embryo. It may give some indication of the formation of these parts in older stages, about which it is difficult to gain information owing to the intimate presence of the old, strongly sclerotic parts. Most of the parts can be recognized. The interarea and the lateral and dorsal bands are *not* distinguishable, but the ventral band appears as a single curved line, like the bars, just as it resembles these in form in the older stages. The mandibular and maxillary sheaths and the pharynx are distinctly invaginated, each opening into a common chamber. The membranes of the mandibular sheath can be seen almost to the point of invagination. A mandible and a maxilla are distinct within the sheaths as simple curving lines. At the bottom of a deep invagination (*inm*) a twisted line is observed to arise and connect both sheaths, circling around the maxillary one. Considering that one line connects both sheaths, it is thought to be a combination of the mandibular and maxillary braces. These appear to begin there as a single invagination. A theory of their later development is that the two braces split in the direction of the invagination, which becomes filled with tissue by the two braces stretching away from each other, producing the cephalic part of the lateral band. The pharyngeal tube is distinct, leading directly into the pharyngeal sclerite. The comparatively wide mouth of the invagination on each side of the tube is apparently filled later with the pharyngeal wall tissue. The maxillary and pharyngeal tendons were distinct, but the mandibular tendon was not distinguishable;

neither were the tendons associated with the salivary apparatus, though both salivary pump and duct were plainly discernible.

The head skeleton of the third-stage male is distinct, and also the outline of the rostrum, though there is no visible connection between the two. The bars and the bands are all present, though in a membranous condition, and can be readily recognized (fig. 14, *A*). The sheaths, braces, mandibular and maxillary pockets, crumena, mandibles, and maxillae could not be distinguished. The pharynx, however, apparently persists. It is membranous, except for the pharyngeal sclerite, but is distinct. The salivary duct is also apparently distinct, and seems to be divided into two tubes as far as its point of invagination. Only one tube was distinguishable in some specimens. The salivary pump is extremely vestigial, but the faint outline of its lower sides can be made out. The rostrum is recognized

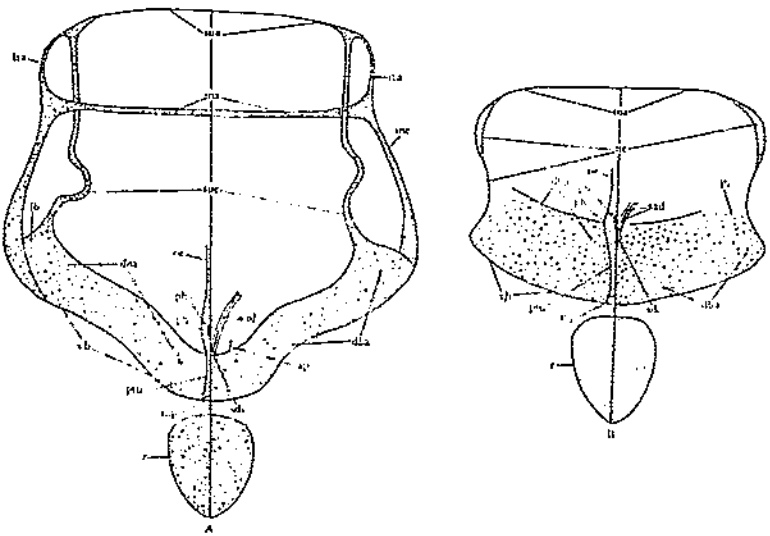


FIGURE 14.—Head skeleton and rostrum: *A*, Third-stage male; *B*, fourth-stage male. (Ventral surface at left of observer.) × 500.

by its typical shape, position, and constant presence. It is an undifferentiated membrane.

The head skeleton of the fourth instar (fig. 14, *B*) can also be distinguished, but it is not so noticeable as that of the third instar on account of its smaller size and the smaller number of parts in the framework, which is composed of more delicate membrane. All parts absent in the third-stage male are absent in this stage, and, in addition, the superarcae, the interarcae, the supercostae, and the salivary pump; also, the lateral and dorsal bands are not complete, the former being almost lacking. The remaining corresponding parts, including the rostrum, are almost, if not quite, as noticeable as they are in the third-stage male.

The pharyngeal tube is apparently present in the adult male. No other parts of the head skeleton or any associated with the head skeleton could be definitely distinguished in this instar.

Measurements, in microns, of typical head skeletons of the various instars were: First, length 66, width 46; second female, length 110, width 83; adult female, length 130, width 110; third male, length 77, width 64; fourth male, length 46, width 40.

SUMMARY

The Parlatoria date scale (*Parlatoria blanchardi* Targioni Tozzetti), probably the most serious insect enemy of the date palm, has 3 female and 5 male instars. A detailed account is given of all the distinguishable structures of the external anatomy and the endoskeleton of the head and associated parts for all instars of both sexes. For every instar except the third and fourth male instars, four or more specimens from each of the four known host palms were examined thoroughly. The number of individuals studied completely ranged from 7 to 32. All structural details proved substantially the same regardless of host. It was possible, therefore, to group the specimens of each instar for discussion.

A variation in size, position, and occurrence of structures and groups of structures is characteristic, and is frequently noted specifically. Where subject to satisfactory measurement, the average and range of variation are recorded, the number of cases used for each determination ranging from 7 to 2,378.

Sex can apparently be determined in the first stage. In the specimens studied (28 males and 24 females) the outer surface of the tibia of all six legs of the male possessed a prominent spine. This was lacking in two thirds of the females examined and in the remaining third never occurred on more than two of the legs.

The segmentation of the body is indicated for all instars. It is based not only on sutures, where these are present, but also on the number and position of the setae, pores, plates, and lobes. The head is not clearly differentiated except in the adult male. On the venter the mesothorax and metathorax are each divided into two segments or sections, the anterior section of the mesothorax being fused with the prothorax, and the first abdominal segment is apparently missing; on the dorsum neither the mesothorax (except in the adult male) nor the metathorax is apparently divided and the first abdominal segment is normally developed. The ninth abdominal segment is much reduced on both surfaces in the first and second instars and in the adult female. In the third male instar it is moderately reduced on the dorsum and occurs as an elongated invaginated projection on the venter. In the two later male instars it is well developed as a pointed caudal projection.

The structure and distribution of pores and setae follow a rather definite pattern through the various instars. A separation of them into certain groups is possible. In general, pores vary in all respects more appreciably than do setae.

The pores are limited to two fundamental types: (1) An invaginated type, possessing one external opening and within the body a single membranous tube capped by two bars, from the center of which issues a delicate club-shaped tube, and (2) a disk type. The invaginated type can be divided into two kinds, one varying in size and opening on the surface, and the other small and opening at the

peak of a raised area. The invaginated pores with surface openings occur more frequently along the margin and submargin of the thorax and abdomen, but may be present elsewhere, in the first, the two second, and the adult female instars; the raised kind is limited to the margin and submargin of the second instars and the adult female. The disk type of pore is limited to the second instars and the adult female. In the former it is present only in the region immediately cephalad of the mesothoracic spiracles, but in the adult female in this region and also around the genital opening. The three later male instars possess no pores of either type.

From stage to stage there is a general increase in the number of pores along the margin and submargin of the thorax and abdomen, and also toward the mesal region of both abdominal surfaces in the adult female. In these regions the increase in number of pores is distinctly greater in the second-stage male than it is in the female of this stage.

In general, in the female instars the setae progressively increase in number on the ventromesal region of the thorax and abdomen, and along the submargin of the thorax. Including both sides of the body, as compared with the second-stage female, the male of this stage possesses 4 to 8 more setae on each surface of the head and near the mesodorsal region of the thorax and abdomen, as well as an extra pair on the ventral margin of the eighth abdominal segment. Elsewhere the setae are essentially alike in both sexes. In the 3 later male instars the number of setae progressively increases on the head but remains approximately the same elsewhere. These 3 instars have no setae on the ventral margin and submargin of the first 3, and usually the next 2, abdominal segments.

Because of variability in the occurrence, size, and form of the lobes and plates, and in the occurrence and position of the pores, on the pygidium, this region of the body should be used diagnostically with caution. The lobes and plates are in different degrees of permanence along the cephalic margin of the pygidium, and leave little doubt of their origin as simply modified bulgings in the surface tissue.

In the first instar a prominent pair of lobes, which are usually considered by coccidologists to be the first pair, are determined as the second, with the first pair probably absent; but in the second stage and in the adult female, the prominent pair farthest caudad are determined as the first ones.

The eye is apparently present in all instars except the third and fourth male ones and possibly the adult female. In the adult female a structure that at first resembles an eye in contour and general location may bear no relation to an eye, but this matter it still unsettled. The adult male has two pairs of well-developed eyes.

The legs persist in all instars except the adult female. In the first instar they are of the usual insect type except for a fusion of the tibia and tarsus. Those in the second-stage male are decidedly vestigial, varying in development from being almost lacking to plainly discernible, with evidences of segmentation. In the second-stage female they are in general more vestigial than they are in the male of this stage. Those in the three later male instars show in-

creasing development and sharper segmentation, being fully developed in the adult male, with tibia and tarsus plainly separated.

The wings may or may not be present in the three later male instars. In the adult male the wings and the halteres are frequently in various degrees of degeneration down to complete absence. The thoracic wing framework is always present and well developed in the adult male, but is wholly lacking in the two preceding instars. Its segmentation and the structure of the articulating parts of the wing agree in general with those found in other insects.

An undetermined structure laterad of each metathoracic leg in the first instar may be a vestige of the spiracle of the first abdominal segment.

The endoskeleton of the head is composed of a number of sclerotic bars and bands joined together into a boxlike framework without marked divisions, and of other pieces concerned in the operation of the mouth stylets, pharynx, and salivary duct. It is a rather complex assembly of more than 50 different single and paired structures. These parts are all figured and discussed. The endoskeleton is essentially the same in all instars, except the three later male ones, in which it becomes increasingly vestigial, though parts of it are plainly evident in the third and fourth instars. Only the external opening to the alimentary tract and a small section of the tube can be distinguished in the adult male.

The rostrum is one-segmented and persists in distinct form in all instars except the adult male, in which it is apparently lacking. The rostrum possesses characteristic sclerites and setae, and is essentially the same in all instars except the third and fourth male ones, in which it is wholly membranous with no differentiated tissue.

The rostralis, or mouth stylets, occurs only in the first, the two second, and the adult female instars. It develops anew for each instar in coils within delicate pouches or pockets on each side of the head skeleton. Before issuing from the body it unwinds and moves into a delicate pouch within the body cavity. It has an average length more than two but not three times that of the body in the newly hatched first instar, and six times or more that of the body in newly molted individuals of the other instars.

LITERATURE CITED

(1) Berlese, A.
1896-97. Le coccinigliе italiane viventi sugli agrumi. Parte III. I diaspiti. Riv. Patol. Veg. 4: [74]–292, illus., 1896; 5: [31]–73, illus., 1897.

(2) Comstock, J. H.
1918. The wings of insects; an exposition of the uniform terminology of the wing-veins of insects and a discussion of the more general characteristics of the wings of the several orders of insects. 430 pp., illus. Ithaca, N.Y.

(3) Crampton, G. C.
1909. A contribution to the comparative morphology of thoracic sclerites of insects. Acad. Nat. Sci. Phila. Proc. 61: 3–54, illus.

(4) Green, E. E.
1896–1922. The coccidae of ceylon. 5 v., illus. London.

(5) Hoke, G.
1921. Observations on the structure of the oraceratubae and some new lepidosaphine scales (hemiptera). Ann. Ent. Soc. Amer. 14: 337–343, illus.

(6) ———
1925. A DIASPINE WITH LEGS (HOMOPTERA: COCCIDAE). Ent. Soc. Wash. Proc. 27: 36–39, illus.
(7) LIST, J. H.
1886. ORTHEZIA CATAPHRACTA SHAW. EINE MONOGRAPHIE. Ztschr. Wiss. Zool. 45: 1–84, illus.
(8) MACGILLIVRAY, A. D.
1921. THE COCCIDAE, TABLES FOR THE IDENTIFICATION OF THE SUBFAMILIES AND SOME OF THE MORE IMPORTANT GENERA AND SPECIES, TOGETHER WITH DISCUSSIONS OF THEIR ANATOMY AND LIFE HISTORY. 502 pp. Urbana, Ill.
(9) MARK, E. L.
1877. BEITRÄGE ZUR ANATOMIE UND HISTOLOGIE DER PFLANZENLÄUSE INSBESONDERE DER COCCIDEN. Arch. Mikros. Anat. 13: [31]–86, illus.
(10) MECZNIKOV, E.
1866. EMBRYOLOGISCHE STUDIEN AN INSECTEN. Ztschr. Wiss. Zool. 16: [389]–500, illus.
(11) PATCH, E. M.
1909. HOMOLOGIES OF THE WING VEINS OF THE APHIDIDÆ, PSYLLIDÆ, ALEURODIDÆ AND COCCIDÆ. Ann. Ent. Soc. Amer. 2: 101–129, illus.
(12) SHEPARD, H. H.
1930. THE PLEURAL AND STERNAL SCLERITES OF THE LEPIDOPTEROUS THORAX. Ann. Ent. Soc. Amer. 23: 237–260, illus.
(13) SNODGRASS, R. E.
1927. MORPHOLOGY AND MECHANISM OF THE INSECT THORAX. Smithsn. Inst. Misc. Collect., v. 80, no. 1, 108 pp., illus.
(14) TARGIONI TOZZETTI, A.
1892. AONIDIA BLANCHARDI, NOUVELLE ESPÈCE DE COCHENILLE DU DATTIER DU SAHARA. Mém. Soc. Zool. France 5: 69–82, illus.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Under Secretary	REXFORD G. TUGWELL.
Assistant Secretary	M. L. WILSON.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Director of Finance	W. A. JUMP.
Solicitor	SETH THOMAS.
Agricultural Adjustment Administration	CHESTER C. DAVIS, *Administrator.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	J. N. DARLING, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	KNOWLES A. RYERSON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Weather Bureau	WILLIS R. GREGG, *Chief.*

This bulletin is a contribution from

Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Division of Fruit Insects	D. L. VAN DINE, *Principal Entomologist, in Charge.*

U. S. GOVERNMENT PRINTING OFFICE: 1934

END