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A systematic revision of the armoured scale genus *Crenulaspidiotus* MacGillivray (*Diaspididae, Homoptera*)

Rewizja systematyczna czerwców z rodzaju *Crenulaspidiotus* MacGillivray (*Diaspididae, Homoptera*)

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Abstract. Descriptions and illustrations are given of adult females of 11 species of the armoured scale insect genus *Crenulaspidiotus*; descriptions and illustrations of second and first instars are given for nine species and of adult males for three species. Four species are redescribed: *C. maurellae* (Laing), *C. mini* Davidson, *C. portoricensis* (Lindinger), and *C. sinuatus* (Ferris), and seven species are described as new: *C. anticheir*, *C. cyrtus*, *C. dicentron*, *C. greeneri*, *C. monocentron*, *C. russellae*, and *C. truncus*. Keys are given as are phenetic and cladistic dendograms.

INTRODUCTION

In the early 1940's Louise Russell (now Resident Cooperating Scientist, Systematic Entomology Laboratory, U. S. Department of Agriculture) investigated two new genera of whiteflies (*Crenidorsum* and *Bellitudo*) that were commonly found on Neotropical species of *Coccoloba* (*Polygonaceae*) (Russell, 1943, 1945). During the search for whiteflies on herbarium material, a large series of specimens of the armoured scale insect genus *Crenulaspidiotus* MacGillivray was also collected. We decided to study the group because of the abundant material including many undescribed species. The genus demonstrated some interesting distribution patterns and host associations.

METHODS

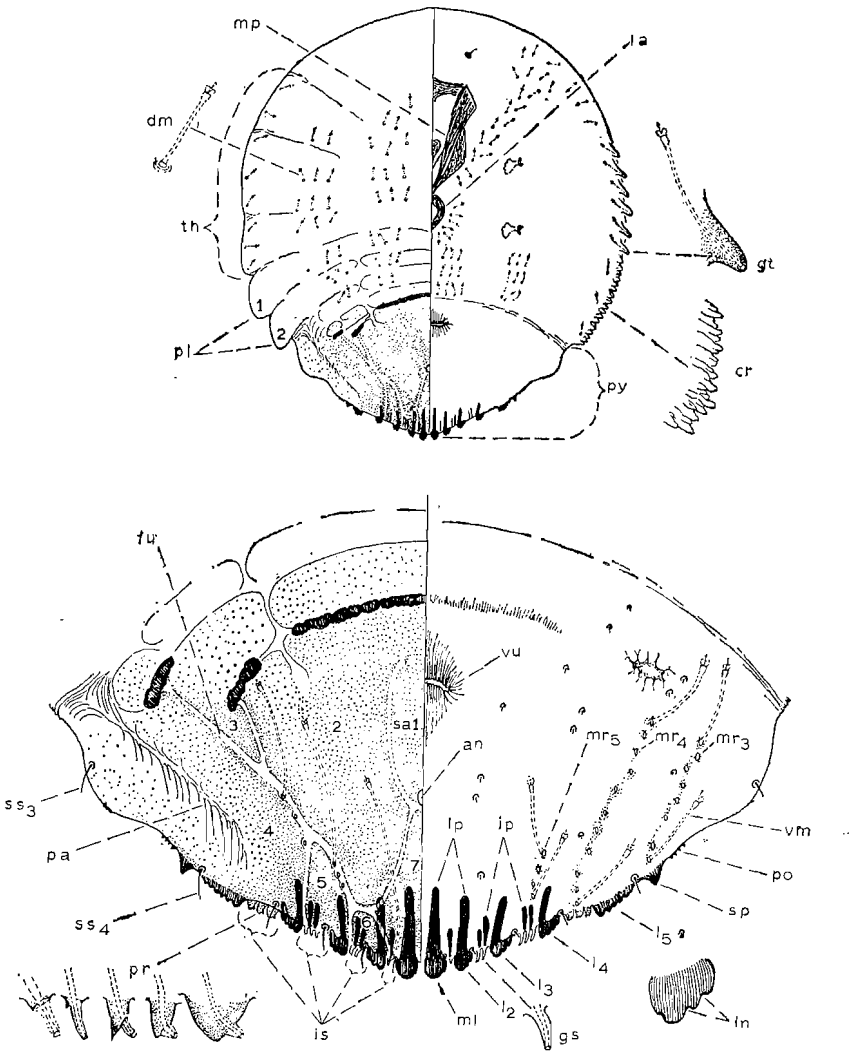
Numerical data are taken from 10 specimens and are given as a range and mean. Specimens were examined at magnifications of 256×, 640×, and 1,600× using a Zeiss, phase contrast microscope. Measurements were made using an ocular micrometer. Locality data are given as written on the label.

Crawler descriptions, in nearly all cases, are based on embryos inside the bodies of slide-mounted adult females. No attempt has been made to distinguish males from females because the body setae and tarsal, campaniform sensilla on the embryos are exceedingly difficult to see. The terminology used in the crawler descriptions is that of STOETZEL and DAVIDSON (1974) and HOWELL and TIPPINS (1977). It is important to remember that on crawlers of the *Aspidiotini* the apical pygidial lobes are the second lobes, not the first as in second instars and adult females. When examining crawlers, it is absolutely essential that high magnification, oil immersion objectives be used because plates and setae are often small and exceedingly difficult to see.

Terminology used in descriptions of second instars and adult females is given in fig. 1. We have used "prepygidium" to include segments of the head, thorax, and abdomen that are anterior of the pygidium. We have found it useful to assign numbers to the dorsal sclerotized, pygidial areas and to the interlobular spaces. We have arbitrarily designated the structures between lobes 4 and 5 as processes, the structures between the other lobes are gland spines even though an occasional gland spine may be similar in appearance to a process. The gland-spine formula refers to the numbers of gland spines in interlobular spaces 2 and 3 respectively (e.g. gland-spine formula 3–4 indicates that there are three gland spines in the second interlobular space and four in the third space). It is not practical to count gland spines in the first interlobular space or in the space between the medial lobes, because they are often hidden by the adjacent lobes. We also used an interlobular-paraphysis formula. This formula refers to the numbers of paraphyses in spaces 1, 2, 3, and sometimes 4 respectively (e.g. interlobular-paraphysis formula 1–2–2 means that there are one paraphysis in the first space, two paraphyses in the second space, and two in the third space).

Terminology used in the descriptions of adult males is given in fig. 17 and follows GHAURI (1962).

Arrows on illustrations indicate key characters. Abbreviations lst,



1. General morphology of adult female of *Crenulaspidiotus*. an — anus, cr — crenulations, dm — dorsal microduct, fu — furrow, gs — gland spine, gt — gland tubercle, ip — interlobular paraphysis, is — interlobular spaces, l — lobes (numbered 2–5), la — labium, ln — lobe notches, ml — median lobes, mp — mouthparts, pa — pattern, pl — prepygidial lobes (segments 1 and 2), po — point, pr — process, py — pygidium, sa — sclerotized areas (numbered 1–7), sp — spur, ss — segmental seta (segments 3 and 4), th — thorax, vm — ventral microduct, vu — vulva

2nd, m. in type-material and material examined sections indicate that first instars, second instars, or adult males and adult females were examined from that locality.

DEPOSITORIES

Depositories are abbreviated as follows: British Museum (Natural History), London (BMNH); California State Department of Food and Agriculture, Sacramento (CDA); Florida State Collection of Arthropods, Gainesville (FSCA); Museo de Historia Natural de Ciudad de Mexico, Mexico City (MHN): Muséum National d'Histoire Naturelle, Paris (MNHN); South African National Collection of Insects, Pretoria (SA); University of California, Davis (UCD); University of Hawaii at Manoa, Honolulu (UH); United States National Museum of Natural History, Washington, D. C. (USNM); Virginia Polytechnic Institute and State University, Blacksburg, (VPI); Zoological Institute, Academy of Sciences of USSR, Leningrad (ZI); Zoologisches Staatsinstitut und Zoologisches Museum, Hamburg, West Germany (ZMH).

Crenulaspidiotus MacGillivray

Crenulaspidiotus MACGILLIVRAY, 1921: 389, 426; FERRIS, 1937: 51; BORCHSENIUS, 1966; 359; DAVIDSON, 1970: 500. Type-species: *Chrysomphalus* (*Melanaspis*) *portoricensis* LINDINGER, 1910, by original designation and monotypy.

Crenulaspidiotus MACGILLIVRAY, as a junior synonym of *Melanaspis* COCKERELL. LINDINGER, 1937: 182; FERRIS, 1941: SIII–347; BALACHOWSKY, 1951: 578, 1958: 191.

In MACGILLIVRAY's description of *Crenulaspidiotus* the type-species "*Aspidiotus*" *portoricensis* LINDINGER is said to be from Venezuela on *Bletia*. This is an error. LINDINGER's description of *portoricensis* clearly indicates that it is from Puerto Rico on *Coccoloba excoriata*. However, LINDINGER published the morphological description in 1910 (p. 441) but published the locality data, etc. in 1911 (p. 9). This apparently confused MACGILLIVRAY causing him to use the data from the species that LINDINGER treated just before *C. portoricensis*, i.e. *Aspidiotus perseae* COMSTOCK on *Bletia* from Venezuela. Unfortunately, MACGILLIVRAY rarely examined specimens when formulating his classification of the scale insects.

Diagnosis of adult female. Four or 5 pairs of lobes, lobes 4 and 5 wider than long; dorsal pygidium divided by furrows which form distinct, sclerotized areas, area 6 being unique; lobes 1–4 each with 1 paraphysis, lobular paraphyses longer than interlobular paraphyses; interlobular paraphyses

in spaces 1–3 or 4; gland spines in spaces 1–3 and between medial lobes; processes in fourth space often developed into small lobes, apparently modified gland spines; macroducts slender, usually present along posterior pygidial margin and in furrows dividing areas 2 and 4, and 2 and 5; antennae each usually with 1 seta, rarely 2.

Notes. Adult females are unique among the *Aspidiotini* by having the following combination of characters: Dorsum of pygidium divided into sclerotized areas, area 6 always present, pygidial margin with 4 or 5 pairs of lobes; longest paraphyses attached to lobes; fourth lobe with associated paraphysis; gland spines simple or bifurcate.

Diagnosis of second instars. Same as adult female except without vulva, with fewer microducts, and with reduced, dorsal pygidial furrows. Four or five pairs of lobes, fifth lobes with or without notches; lobular paraphyses longer than interlobular paraphyses; gland spines, fourth space processes, macroducts, and antennae same as on adult female.

Notes. Second instars differ from second instars of other *Aspidiotini* genera in the same characters that differentiate the adult females. Males and females differ from each other principally in setal pattern; females have mediolateral setae on each side of segment 2, these are absent from segment 1; males have mediolateral setae on each side of segments 1 and 2. Males often have more dorsal prepygidial microducts than do females.

Diagnosis of first instar. Lobes 2 and 3 well developed, occasionally with small lobe 4. Plates absent or simple; those between second lobes visible on two species, possibly exceedingly small on other species; plates absent anterior of third lobes. Setae and ducts as given by HOWELL and TIPPINS (1977) except invaginated setae on last segment of antenna both located subapical of apex of segment and coxae with 3 setae.

Notes. Crawlers of *Crenulaspidiotus* are typical of the *Aspidiotini* by having a distinct tibiotarsus septum and no submedial seta on segment 3. These crawlers differ from all members of the tribe by having simple plates, or plates absent. Males and females differ in setal pattern in the same way as second instars. We were unable to determine if the tarsal, companiform sensillum is effective in distinguishing the sex of the crawler as suggested by HOWELL and TIPPINS (1977).

Diagnosis of adult male. Typical of most *Aspidiotini* genera but postoccipital ridge lacks anterior arms or has arms very reduced; ocelli absent.

Crenulaspidiotus is similar in appearance to several other genera. *Melanaspis* COCKERELL differs in the adult females by having fewer sclerotized areas with area 6 absent and by having the longest paraphyses in the interlobular spaces. Crawlers of *Melanaspis* have fimbriate plates; adult

males have definite anterior arms of the postoccipital ridge. Adult females of *Pygidiaspis* MacGillivray are similar to *Crenulaspidiotus* in having long paraphyses on the lobes, but differ by lacking definite sclerotized areas, interlobular paraphyses, and gland spines. Adult females of *Greenoidea* MacGillivray differ from *Crenulaspidiotus* females by lacking interlobular paraphyses and by having fewer sclerotized areas.

Melanaspis williamsi DeLotto, 1957, adult females show a remarkable resemblance to species of *Crenulaspidiotus* but differ by having paraphyses on lobes 1–3 only, by having fimbriate "gland spines" and by having fewer sclerotized areas. This species does not appear to belong in *Melanaspis* or *Crenulaspidiotus*.

Borchsenius (1966) included four species in *Crenulaspidiotus*, i.e., *C. lahillei* (Lizer y Trelles, 1917), *C. phyllanthi* (Green, 1965), *C. portoricensis*, and *C. sinuata* (Ferris, 1941). We consider only the last two species to be members of *Crenulaspidiotus*. *C. phyllanthi* recently has been redescribed and placed in *Greenoidea* (Gerson and Davidson, 1974). *C. lahillei* clearly is not a species of *Crenulaspidiotus* because it has the longest paraphyses in the interlobular spaces and has fewer sclerotized areas than *Crenulaspidiotus*. We are uncertain where *lahillei* should be placed.

The 11 species of *Crenulaspidiotus* are principally Neotropical and primarily are known on species of sea grape (*Coccoloba*).

Key to species of *Crenulaspidiotus* based on adult females

1. Body margin anterior of segment 3 with conspicuous gland tubercles 2
—. Body margin anterior of segment 3 without conspicuous gland tubercles 4
2(1). Fifth sclerotized area with transverese furrow near pygidial margin; space between lobes 4 and 5 with 3 small processes . . . . . *truncus* sp. n.
—. Fifth sclerotized area without transverse furrow near pygidial margin; space between lobes 4 and 5 with 4, rarely 3, conspicuous processes 3
3(2). Interlobular paraphysis formula 1–2–1; dorsal microducts scattered over thorax; conspicuous spur anterior of lobe 5 . . . . . *monocentron* sp. n.
—. Interlobular paraphysis formula 1–2–2; dorsal microducts absent from medial and mediolateral areas of thorax; small points anterior of lobe 5 or points absent . . . . . *anticheir* sp. n.
4(1). Ventral microducts in area anterior of interlobular space between lobes 3 and 4 5

—. Ventral microducts absent from area anterior of interlobular space between lobes 3 and 4 6

5(4). Dorsal area adjacent to lobe 4 without reticulate pattern; dorsum of thorax with numerous microducts scattered over surface; interlobular paraphysis formula normally 1–1–1 . . . *maurellae* (LAING)

—. Dorsal area adjacent to lobe 4 reticulate (fig. 3); dorsum of thorax without microducts except on submargin; interlobular paraphysis formula normally 1–2–2 . . . . . *cyrtus* sp. n.

6(5). Interlobular space between lobes 4 and 5 with 4 processes; paraphysis on medial lobes longer than, equal to, or slightly shorter than paraphysis on lobe 2 7

—. Interlobular space between lobes 4 and 5 with 3 or fewer processes; paraphysis on medial lobes normally much shorter than on lobe 2 8

7(6). Processes between lobes 4 and 5 rounded, lobelike; microducts abundant near labium and in medioventral areas of abdomen anterior of vulva . . . . . *portoricensis* (LINDINGER)

—. Processes between lobes 4 and 5 apically acute; with 0–3 microducts near labium, microducts absent from medioventral areas of abdomen anterior of vulva . . . . . *mini* DAVIDSON

8(6). Interlobular space between lobes 4 and 5 with 2 or fewer processes; lobe 5 with less than 3 notches and with microduct on medial margin; paraphysis formula normally 1–2–1 with additional minute paraphysis in interlobular space between lobes 3 and 4 . . . . . *sinuatus* (FERRIS)

—. Interlobular space between lobes 4 and 5 with 3 processes; lobe 5 with series of notches and without microduct; interlobular paraphysis formula usually 1–2–2 9

9(8). Anal opening touching or located posterior of imaginary line drawn between apices of paraphyses of lobe 2; body margin of segment 3 nearly straight; processes between lobes 4 and 5 rounded; at least 2 large spurs on body margin anterior of lobe 5 . . *dicentron* sp. n.

—. Anal opening located anterior of imaginary line drawn bewteen apices of paraphyses of lobe 2; body margin of segment 3 convex; processes between lobes 4 and 5 truncate or similar to other gland spines; series of small points on body margin anterior of lobe 5 . 10

10(9). Segments 1 and 2 with conspicuous prepygidial lobes; anterior margin of pygidium nearly straight sided; interlobular space between lobes 4 and 5 with small "paraphyses" . . *greeneri* sp. n.

—. Segments 1 and 2 without conspicuous prepygidial lobes; anterior margin of pygidium convex; interlobular space between lobes 4 and 5 often without paraphyses . . . . . *russellae* sp. n.

Key to species of *Crenulaspidiotus* based on second instars

1. Fifth sclerotized area with transverse furrow near pygidial margin . . . . . *truncus* sp. n.

—.Fifth sclerotized area without transverse furrow near pygidial margin 2
2(1). Medial lobe paraphysis approximately equal in length to second lobe paraphysis 3
—. Medial lobe paraphysis conspicuously shorter than second lobe paraphysis 4
3(2). Lobes 1 and 2 without notches . . . . . *mini* DAVIDSON
—. Lobes 1 and 2 with notches . . . . . *portoricensis* (LINDINGER)
4(2). Gland-spine formula 3–3 . . . . . *dicentron* sp. n.
—. Gland-spine formula 3–2 or 2–2 5
5(4). Anal opening located anterior of imaginary line drawn between apices of second-lobe paraphyses 6
—. Anal opening touching or located posterior of imaginary line drawn between apices of second-lobe paraphyses 7
6(5). Prepygidial lobes present . . . . . *russellae* sp. n.
—. Prepygidial lobes absent . . . . . *sinuatus* (FERRIS)
7(5). Gland tubercles present . . . . . *monocentron* sp. n.
—. Gland tubercles absent 8
8(7). Lobe 5 represented by series of small points (fig. 13C) . . . . . *maurellae* (LAING)
—. Lobe 5 well developed (fig. 13A) . . . . . *anticheir* sp. n.

Key to species of *Crenulaspidiotus* based on first instars

1. Lobe 2 with medial notch 2
—. Lobe 2 without medial notch 3
2(1). Plates between lobes 2 and between lobes 2 and 3; body of embryo about 250 μm long . . . . . *portoricensis* (LINDINGER)
—. Plates absent; body of embryo about 215 μm long or less . . . . . *maurellae* (LAING) and *russellae* sp. n.
3(1). Lobe 2 with 1 lateral notch . . . . . *mini* DAVIDSON
—. Lobe 2 with 3 or more lateral notches 4
4(3). Length of mature embryo 160–220 (200) μm . . . . . *anticheir* sp. n. and *truncus* sp. n.
—. Length of mature embryo 225–275 (250) μm 5
5(4). Apical segment of antenna 33–43 (39) μm long . . *monocentron* sp. n.
—. Apical segment of antenna 50–56 (54) μm long 6
6(5). Two plates between lobes 2 and 3 . . . . . *dicentron* sp. n.
—. One plate between lobes 2 and 3 . . . . . *sinuata* (FERRIS)

Key to species of *Crenulaspidiotus* based on adult males

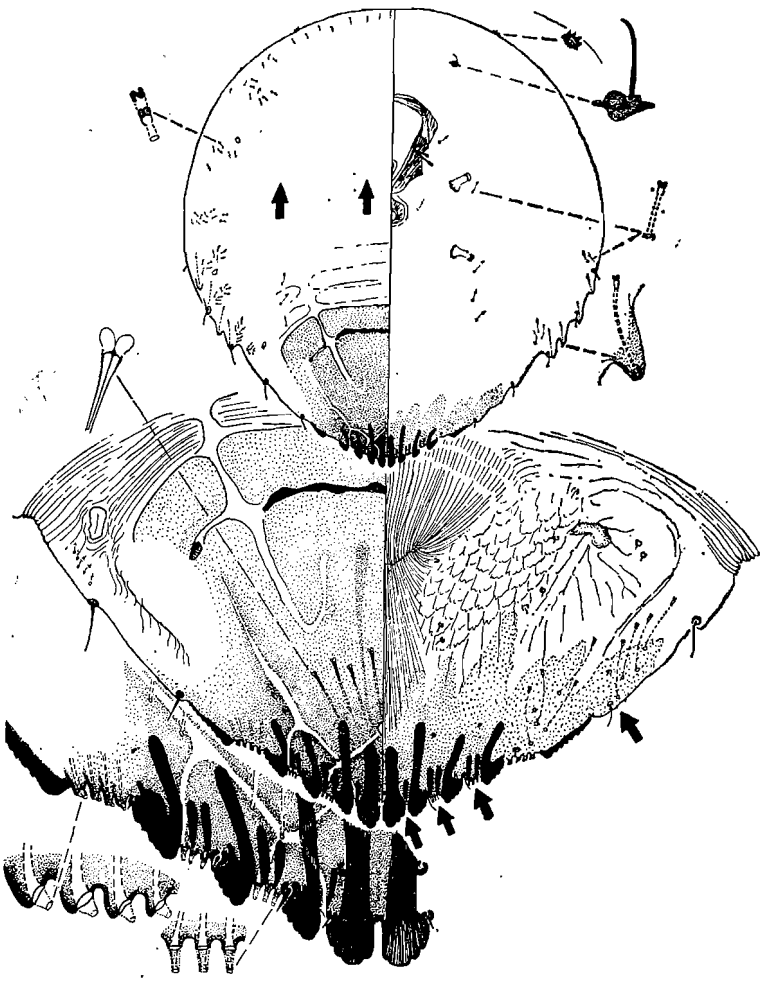
1. Antennal segments 3 and 4 each with less than 4 setae; lateral mar-

gin of segment 8 with indentation; penial sheath about 250 μ long . . . . . *mini* DAVIDSON

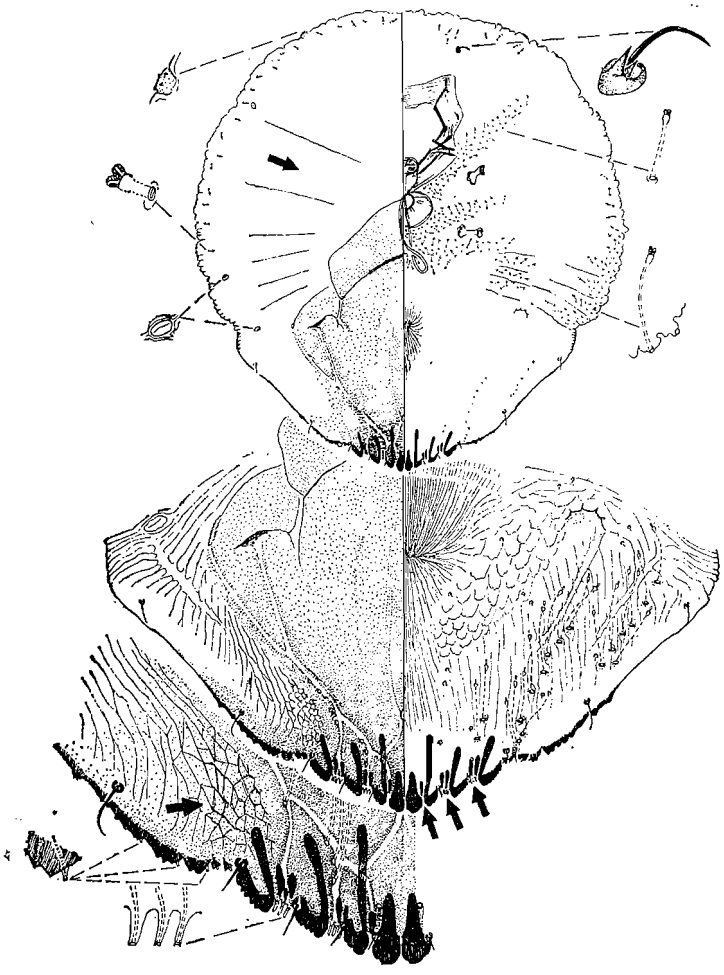
—. Antennal segments 3 and 4 each with more than 5 setae; lateral margin of segment 8 without indentation; penial sheath about 290 μ long 2

2(1). Apical antennal segment with 3 capitate setae; midcranial ridge represented by narrow sclerotized band . . . . . *anticheir* sp. n.

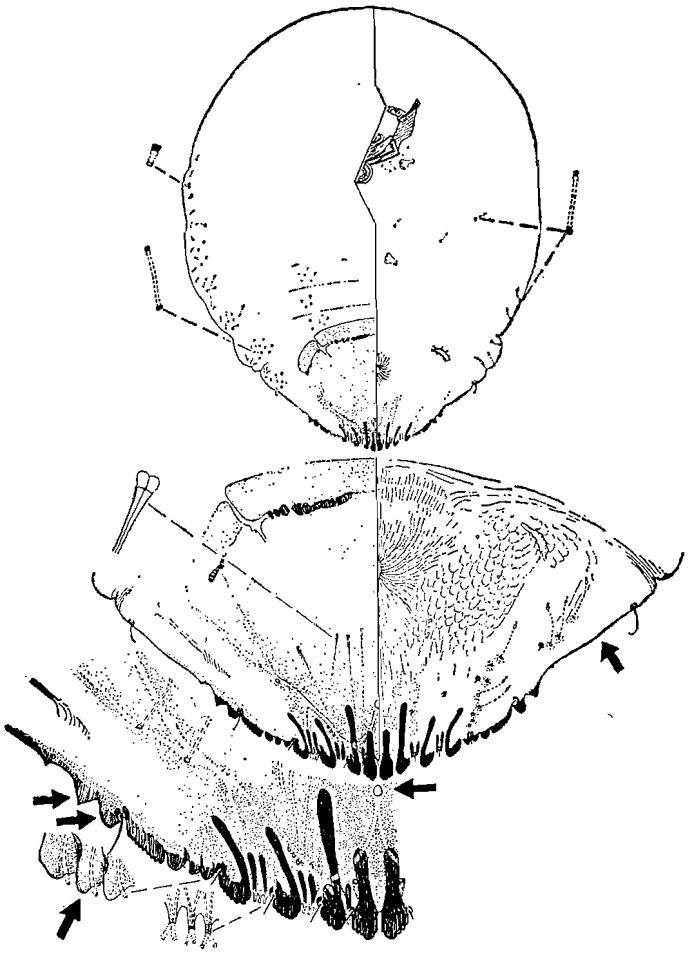
—. Apical antennal segment with 4 capitate setae; midcranial ridge represented by broad sclerotized plate . . *portoricensis* (LINDINGER)



2. Third instar female (adult) of *Crenulaspidiotus anticheir* sp. n.

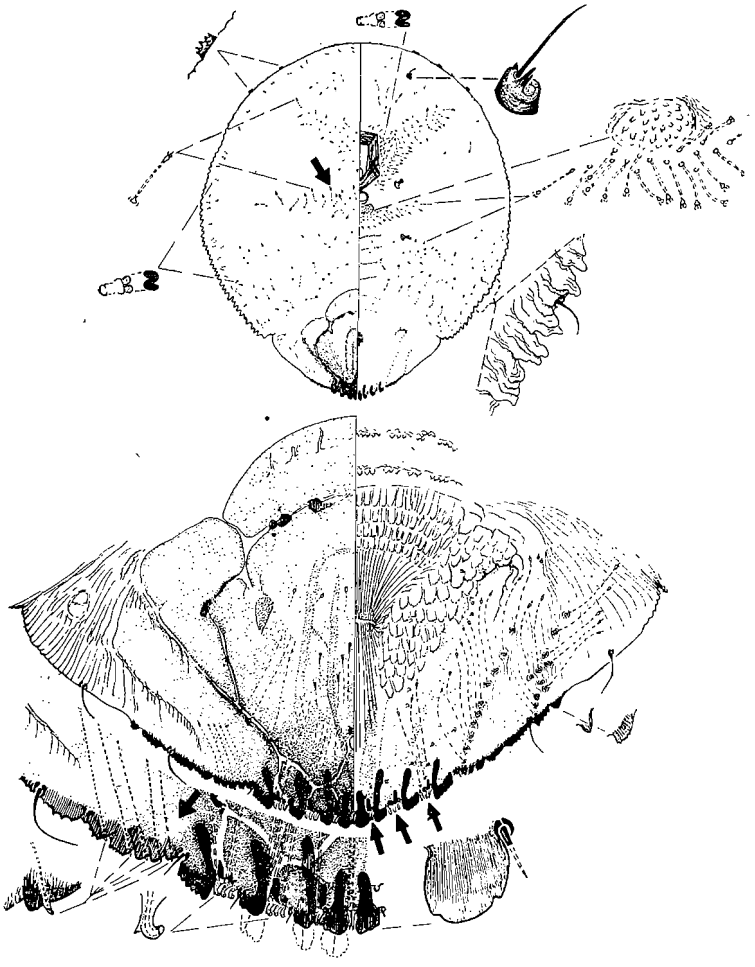


3. Third instar female (adult) of *Crenulaspidiotus cyrtus* sp. n.

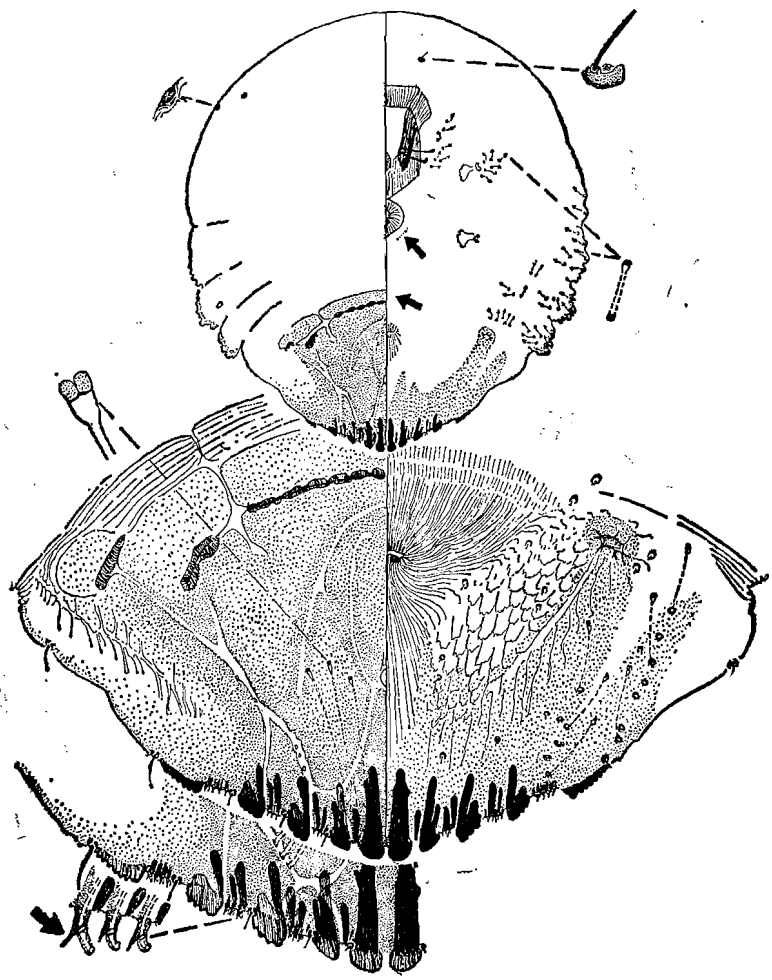


4. Third instar female (adult) of *Crenulaspidiotus dicentron* sp. n.

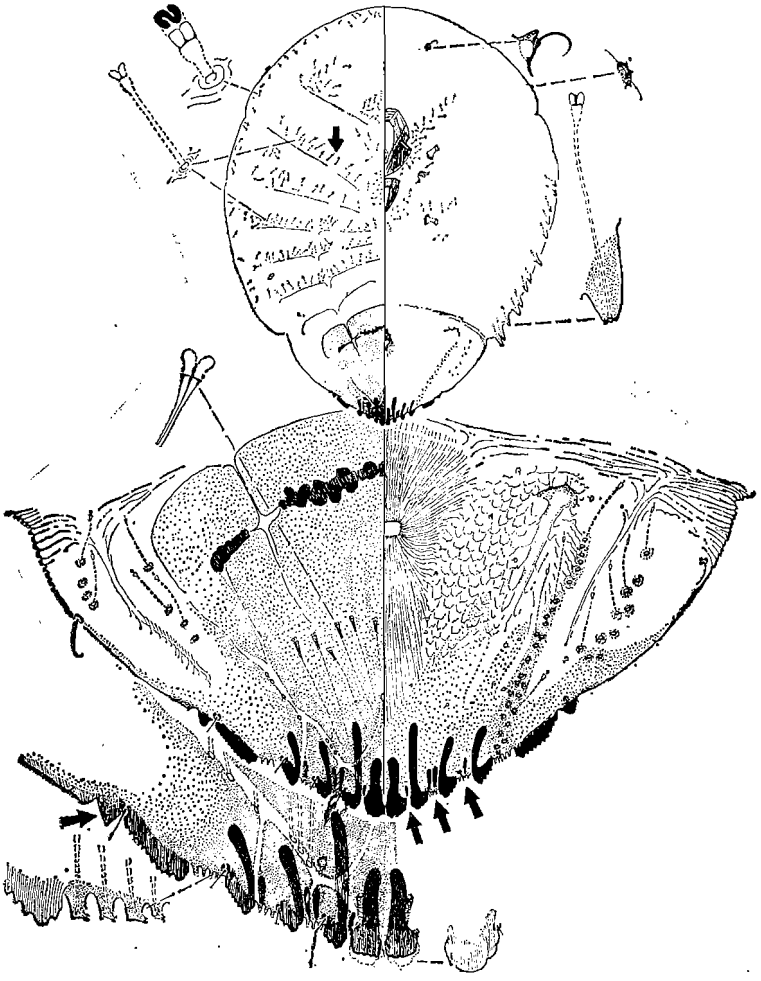
5. Third instar female (adult) of *Crenulaspidiotus greeneri* sp. n.



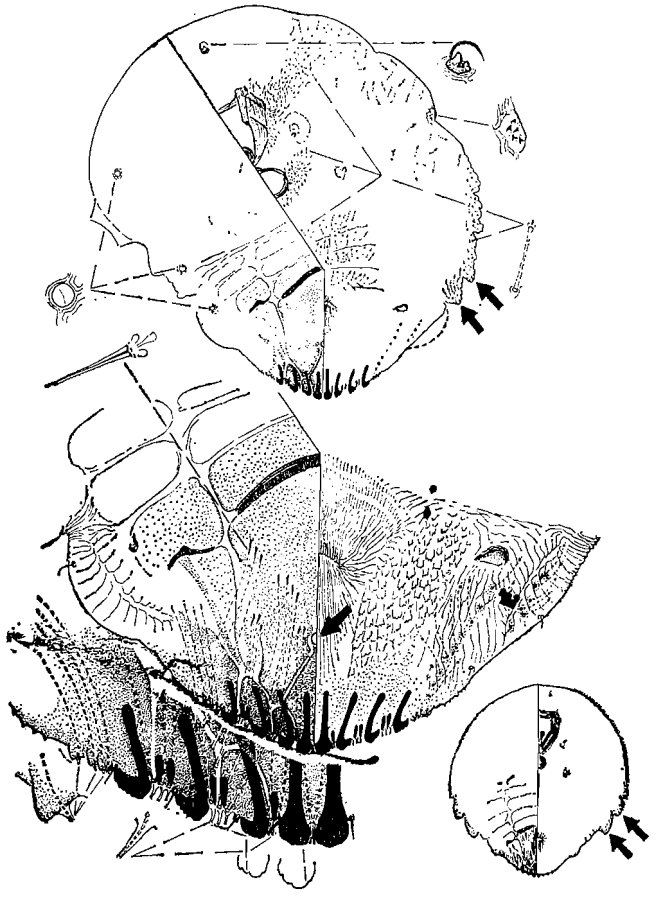
6. Third instar female (adult) of *Crenulaspidiotus maurellae* (LAING)



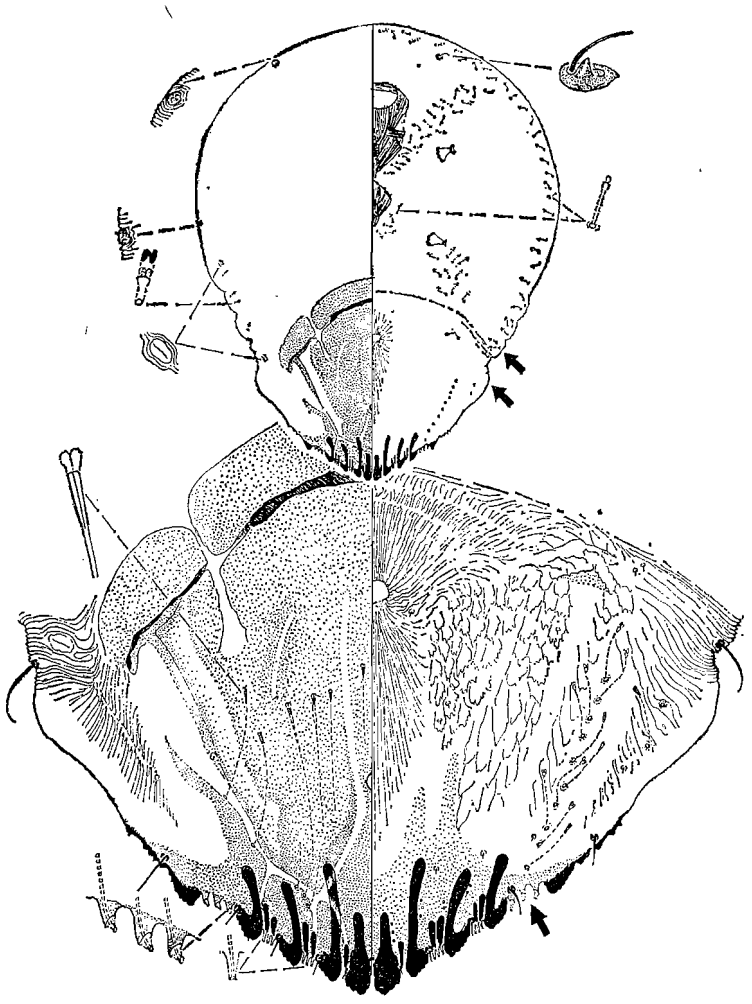
7. Third instar female (adult) of *Crenulaspidiotus mini* DAVIDSON



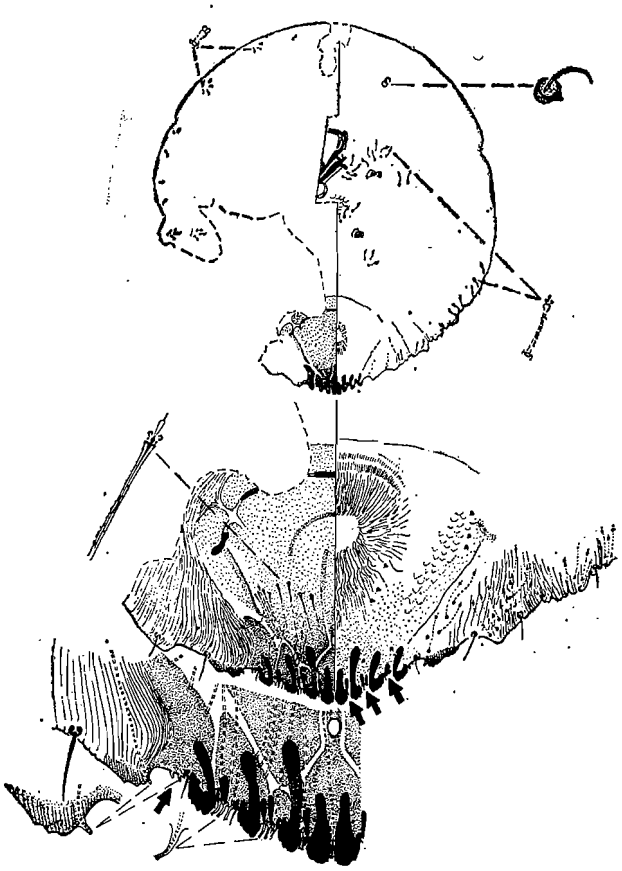
8. Third instar female (adult) of *Crenulaspidiotus monocentron* sp. n.



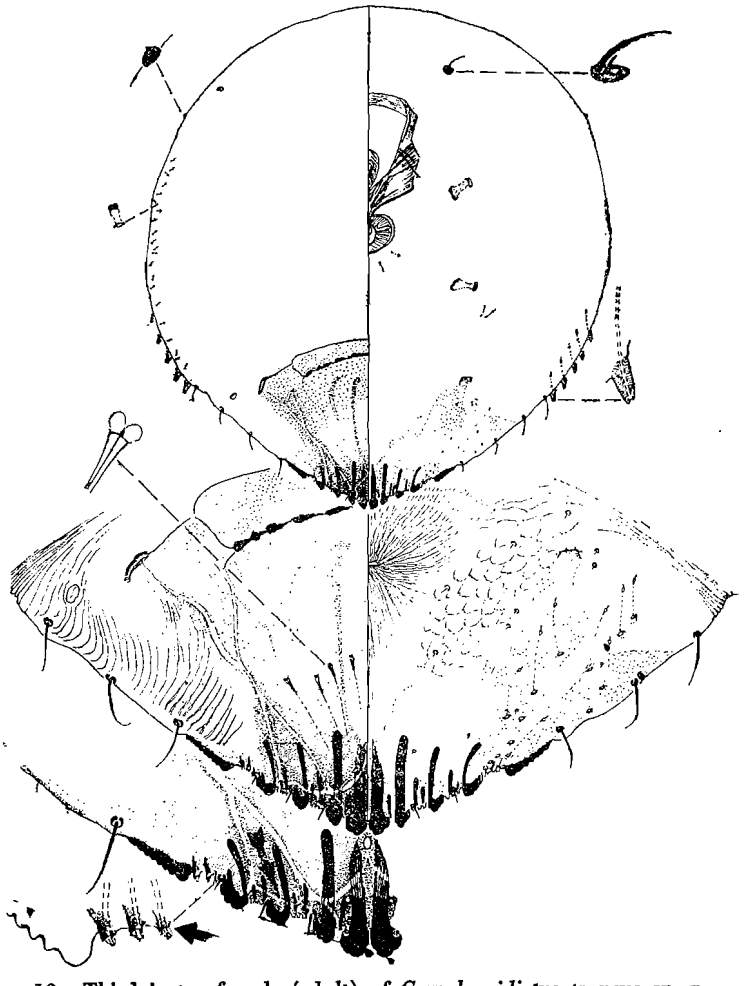
9. Third instar female (adult) of *Crenulaspidiotus portoricensis* (LINDINGER)



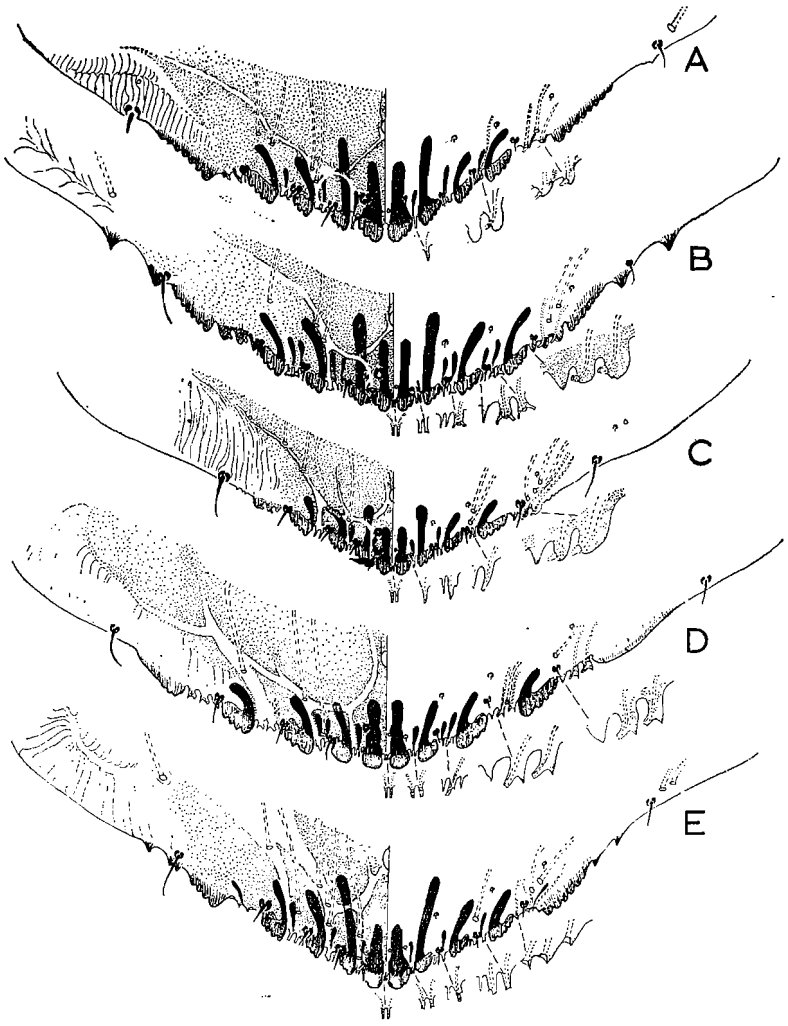
10. Third instar female (adult) of *Crenulaspidiotus russellae* sp. n.



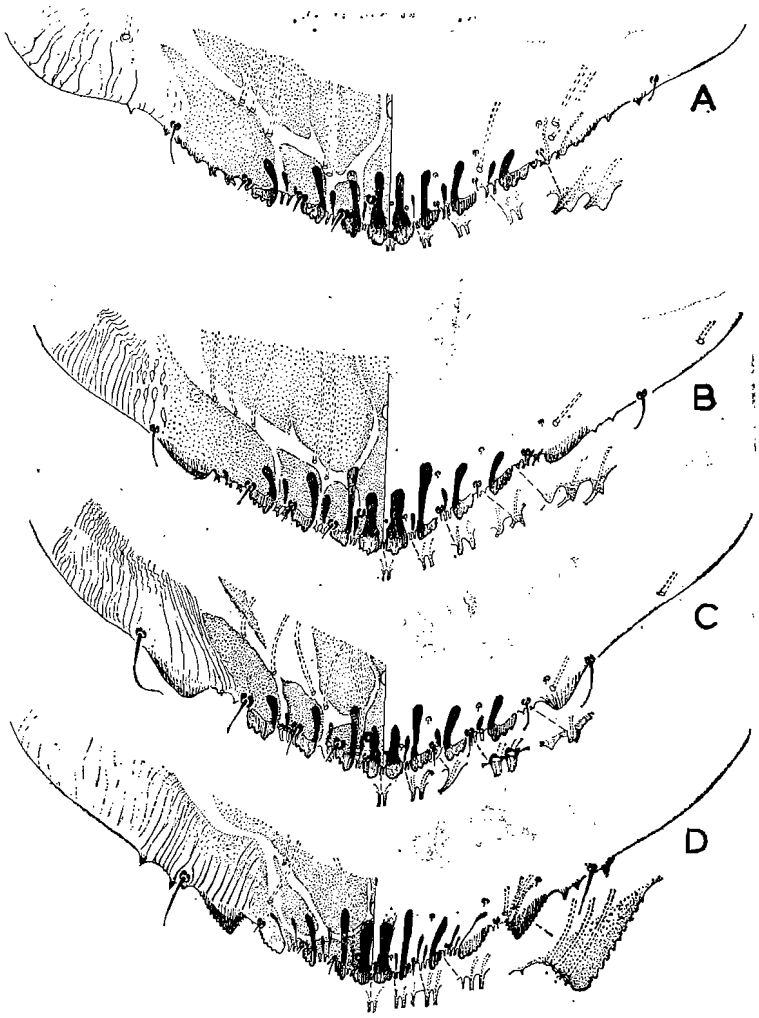
11. Third instar female (adult) of *Crenulaspidiotus sinuatus* (FERRIS)



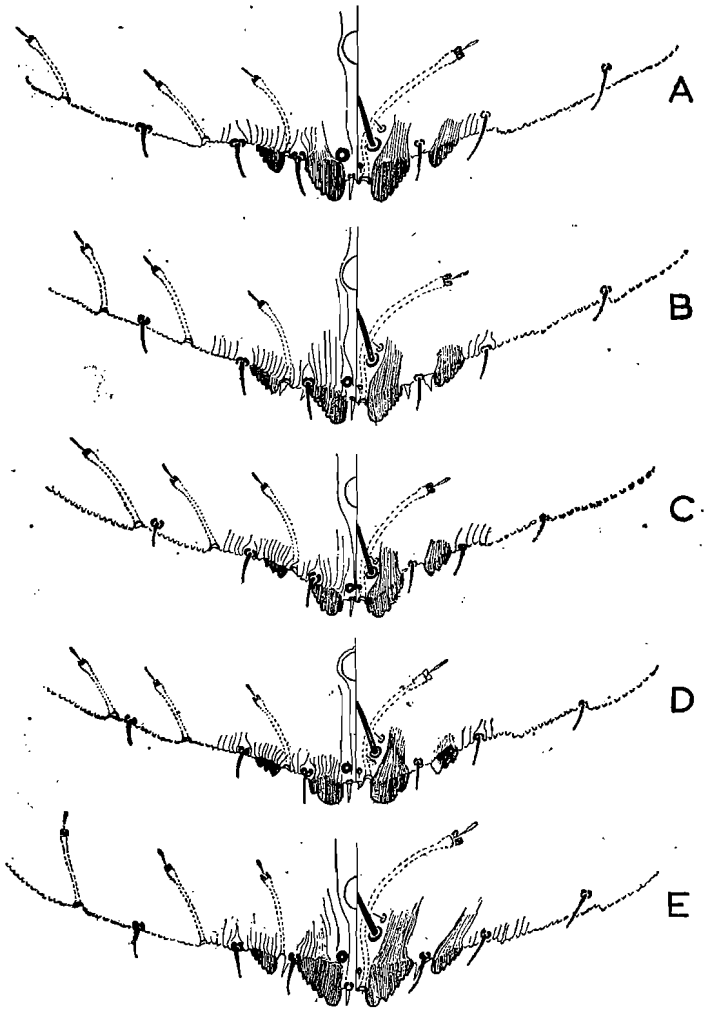
12. Third instar female (adult) of *Crenulaspidiotus truncus* sp. n.



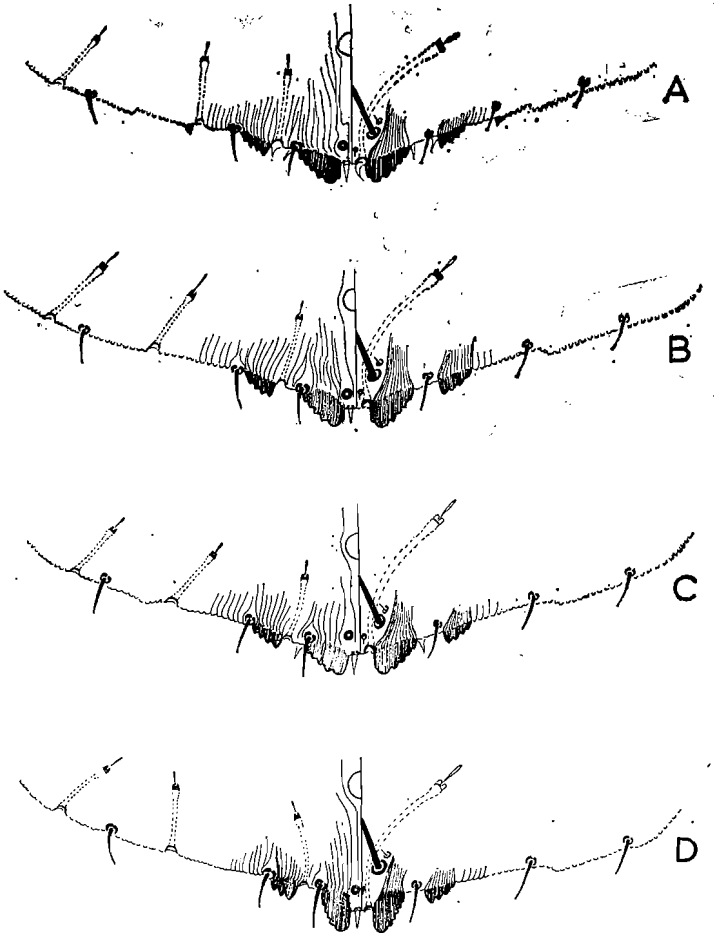
13. Pygidium of second instars. A — *Crenulaspidiotus anticheir*, B — *C. dicentron*, C — *C. maurellae*, D — *C. mini*, E — *C. monocentron*



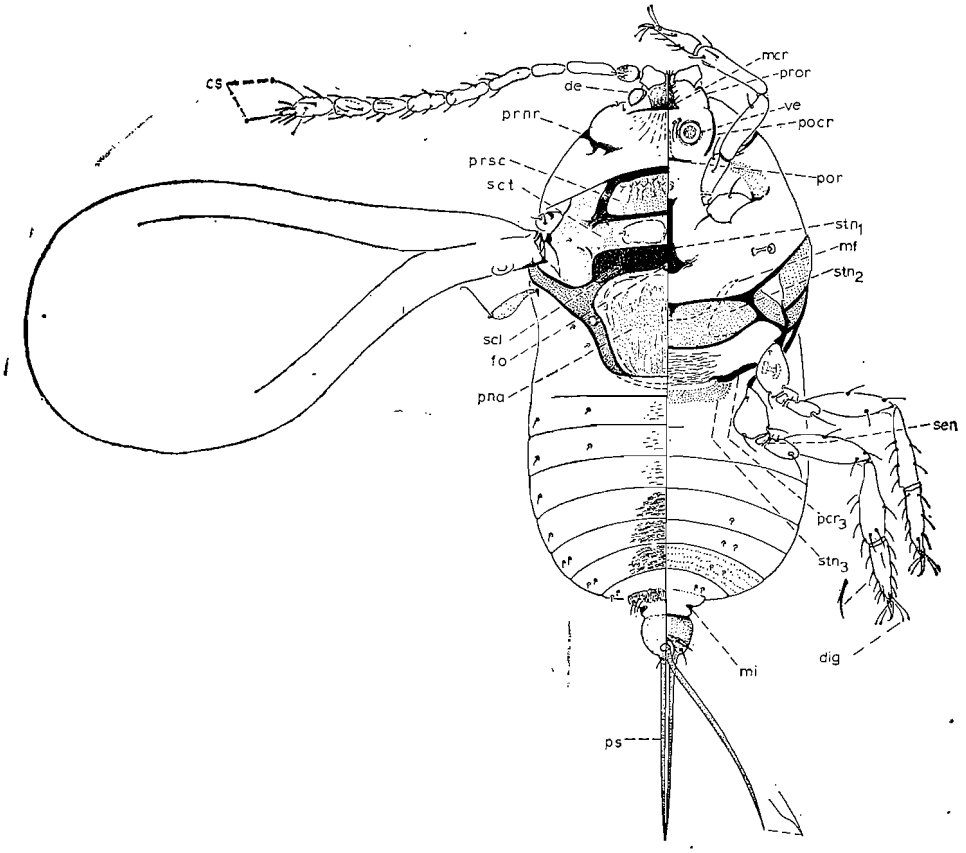
14. Pygidium of second instars. A — *Crenulaspidiotus portoricensis*, B — *C. russellae*, C — *C. sinuatus*, D — *C. truncus*



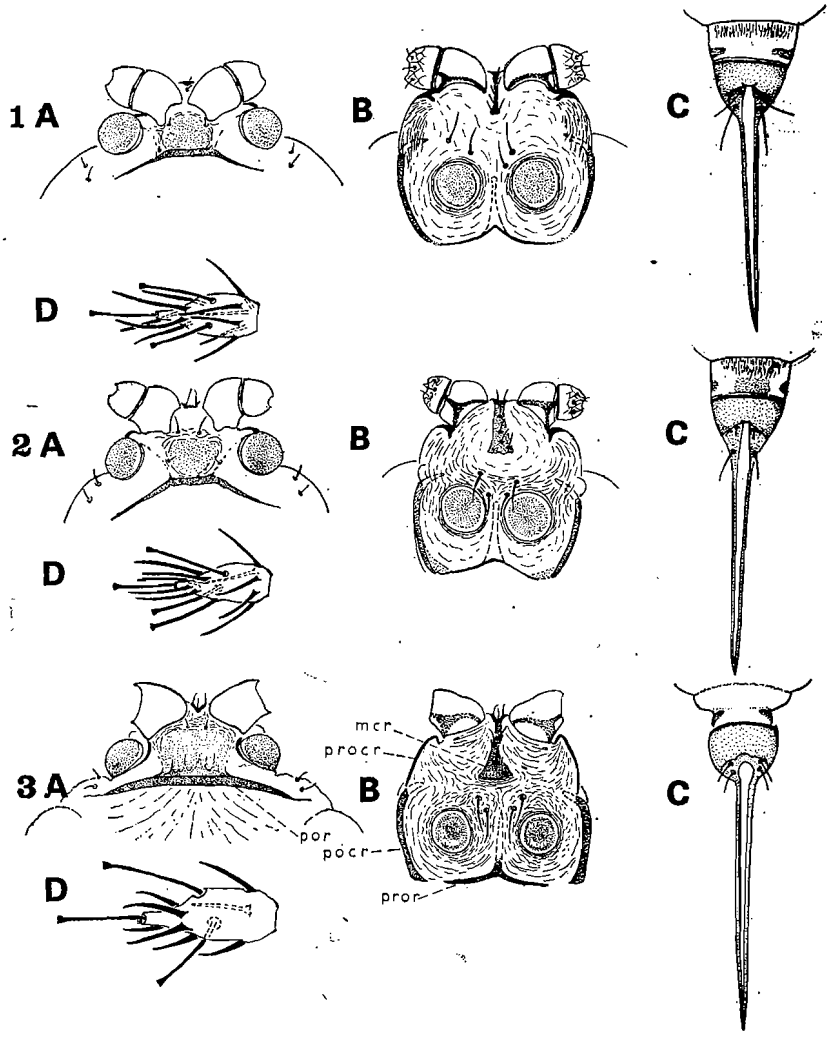
15. Pygidium of first instars. A — *Crenulaspidiotus anticheir*, B — *C. dicentron*, C — *C. maurellae*, D — *C. mini*, E — *C. monocentron*



16. Pygidium of first instars. A — *Crenulaspidiotus portoricensis*, B — *C. russellae*, C — *C. sinuatus*, D — *C. truncus*



17. Fifth instar male (adult) of *Crenulaspidiotus mini* DAVIDSON. cs — capitate setae, de — dorsal eye, dig — digitule, fo — scutellar foramen, mcr — midcranial ridge, mf — mesofurca, mi — medial indentation of segment 8, pcr — precoxal ridge of metathorax, pna — pronotal area, pocr — postocular ridge, prnr — pronotal ridge, pror — preoral ridge, prsc — prescutum, ps — penial sheath, sen — sensilla of trochanter, scl — scutellum, sct — scutum, stn_1 — prosternum, stn_2 — basisternum, stn_3 — metasternum



18. Fifth instar male (adult) of: 1 — *Crenulaspidiotus anticheir*, 2 — *C. portoricensis*, 3 — *C. mini*; A — head, dorsal view, B — head, ventral view, C — penial sheath and segment 8, ventral view, D — terminal antennal segment (abbreviate legends as in fig. 17)

Crenulaspidiotus anticheir sp. n.

Etymology. The species epithet is a noun in apposition and is Greek for "thumb". The name is used for the unusual thumblike process on either side of sclerotized area 2.

Field features. No information available.

Third instar females (adults) (fig. 2).

Description. Holotype, mounted, 0.6 mm long (paratypes 0.4–0.8(0.6) mm) 0.5 mm wide (paratypes 0.4–0.8(0.6) mm). Body margin of prosoma with four gland tubercles on each side of body from base of pygidium to level of posterior spiracle (paratypes 4–15(9) gland tubercles). Pattern on dorsosubmargin of segment 3 absent or limited to short, parallel lines radiating from small groove which extends to anterior margin of lobe 5. Prepygidial dorsum with 2 sizes of microducts, larger size in mediolateral longitudinal line of 2 or 3 ducts on each side of posterior, prepygidial segments, smaller size in clusters on submargin of abdomen and thorax, forming a submarginal row on head; 2 cicatrices on one side of body, 3 on other. Eyes protruding, with 4 slightly sclerotized points. Prepygidial venter with microducts of larger size only, few near mouthparts, spiracles, and body submargin adjacent to gland tubercles. Pygidium with anterior margin nearly straight, not protruding into prepygidium. Pygidial dorsum with 10 sclerotized areas, area 1 absent, furrows between areas 4, 5, 6, and 7 obscure; area 2 partially dissected by furrows forming thumblike process. Anal opening 8 μm long (paratypes (6–8 (6) μm), located 5 times its length from base of medial lobes (paratypes 4–7(6) times), opening touching or occurring posterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobe with 2 lateral notches (paratypes with 2 or 3) and 1 medial notch, lobe 2 with 3 lateral notches (paratypes with 2 or 3), lobe 3 with 3 notches (paratypes with 2–4), lobe 4 with 4 notches (paratypes with 3–6), lobe 5 with 7 notches (paratypes with 7–12), 1 or 2 small points anterior of lobe 5. Gland-spine formula 3–3. Fourth space with 4 processes appearing as rounded knobs and with a microduct. Pygidial venter with row of 4 microducts on each side of segment 3 (paratypes with 1–4(3)), 4 microducts on each side of segment 4 (paratypes with 4–7(6)), microducts absent from segment 5. Paraphyses on lobes from longest to shortest: 2, 1, 3–4; interlobular-paraphysis formula 1–2–2.

Variation. Paratypes may have marginal gland tubercles to level of anterior spiracles; number of microducts on dorsal prepygidium variable,

normally large microducts absent, rarely scattered over area between submarginal, small microduct clusters and mediolateral line of ducts as illustrated; small ducts often more abundant than on the holotype; ventral microducts generally distributed as on holotype but frequently more abundant; one paratype has many microducts scattered over ventral, prepygidial abdomen; sclerotized areas difficult to see in many instances, occasionally area 1 partially visible and area 3 absent; areas 5 and 6 often difficult to see because of paraphyses; small points on the holotype adjacent to marginal seta marking segment 4 often replaced by 1 or 2 small, spurlike processes on paratypes; rarely with 3 processes in fourth space; relative lengths of paraphyses on lobes variable, from longest to shortest relative lengths normally 2, 1, 3, 4.

Description based on 77 specimens from 26 localities.

Second instars (fig. 13A)]

Description. Same as adult female except: Mounted, about 0.4 mm long, 0.4 mm wide. Body margin of prepygidium without gland tubercles. Pattern on dorsosubmargin of segment 3 composed of series of parallel lines and small groove, extending to anterior margin of lobe 5. Prepygidial dorsum with 2 sizes of microducts, larger size in mediolateral, longitudinal line on each side of posterior, prepygidial segments and near body margin, smaller size in submarginal clusters on head and abdomen, occasionally scattered along body margin; cicatrices absent. Eyes with 0–4 sclerotized points. Prepygidial venter with microduct of larger size, few near mouthparts, spiracles, and near body margin of anterior abdomen and posterior thorax. Anal opening about 5 μm long, located 4 or 5 times its length from base of medial lobes, opening touching or occurring slightly anterior of imaginary line drawn between apices of second-lobe paraphyses. Medial lobe with 1 or 2 lateral notches, lobe 2 with 2 notches, lobe 3 with 2, lobe 4 with 2 or 3, lobe 5 with 5–7, 0–1 small points anterior of lobe 5. Gland-spine formula 2–2. Fourth space with 2 processes appearing as rounded knobs, each with microduct; similar gland-spines in third space. Pygidial venter with 1 microduct on each side of segments 3 and 4, microducts absent from segment 5. Interlobular-paraphysis formula 1–1–1 or 1–1–2.

Description based on four specimens from four localities.

First instars

Description. Body 164–220(199) μm long, 140–164(150) μm wide. Pygidium with 2 pairs of lobes; second lobes each without medial notch, with 4–6(5) lateral notches; third lobes with 2–5(3) notches. Space between lobes

2 and 3 with 1 plate. Distance between posterior apex of anal opening and base of second lobes 10–15(12) μm. Antenna 59–66(61) μm long; apical segment 36–43(40) μm long; antennal length/apical segment length 1.5–1.7 (1.5). Hind leg 69–83(77) μm long; hind trochanter + femur length/tibia + tarsus length 1.3–1.5(1.4).

Description based on 38 specimens from 18 localities.

Fifth instar males (adults) (fig. 18, 1)

Description. Same as adult male of *C. mini* except as follows: Allotype 0.9 mm long, 0.3 mm wide at mesothorax. Dorsum with lateral margin of segment 8 smooth, without indentation, with 4 setae; submarginal areas of abdominal segment 6 and 7 each with 3 setae, segments 2–5 each with 2 setae; scutum without abortive setae; one pair of setae slightly anterior of postoccipital ridge. Abdominal segment 8 with posterior portion sclerotized. Mesothorax with scutellum with definite, small foramen. Prothorax with lightly sclerotized pronotal sclerites. Head with posterior arms of postoccipital ridge at slight angle to main ridge. Dorsal eye 25 μm in diameter. Penial sheath 293 μm long; greatest width/length 0.3. Venter with medial areas of abdomen with reticulate pattern. Mesothorax with basisternum 73 μm long, mesofurca not extending beyond anterior margin of basisternum. Head with midcranial ridge narrow throughout, with preocular ridge inconspicuous; preoral ridge touching postocular ridge. Ventral eye about 28 μm in diameter. Legs increasing in length posteriorly, hind legs about 385 μm long; hind tibia/tarsus length 1.2; setae predominately hairlike, bifurcate setae common on tarsi, tarsi each with spine, spine on front tarsi larger than on other tarsi. Antennae 427 μm long, half as long as body length; antennal setae abundant on segments 3 and 4, apical segment with 14 setae, "sensory pegs" not seen.

Description based on one specimen.

Type-material. The holotype adult female is on a slide with three paratypes; the holotype is on the left side of the cover slip closest to the bottom. The label states "*Crenulaspidiotus anticheir* MILLER & DAVIDSON, on *Coccoloba uvifera*, E. of Montego Bay, Jamaica. Maxon & Killip, colrs., Mar. 28, 1920. U.S.N.H. 1046630." The right label has a map of the position of the holotype and "HOLOTYPE and 3 paratypes, DET. J. A. DAVIDSON, 1973" (USNM). The allotype has the left label "On *Coccoloba longiflora*, Negril & vicinity Jamaica, Britton and Hollick, Colrs., Mar. 9, 12, 1908, N.Y. Bot. Expl. Jamaica 2034, H.N.Y. Bot.G." The right label reads "*Crenulaspidiotus anticheir* MILLER & DAVIDSON, ALLOTYPE."

There are 116 paratypes including embryos on 34 slides; at least one slide is deposited in the BMNH, CDA, FSCA, MNH, MNHN, SA, UCD, UH, USNM, VPI, ZI, ZMH.

Paratypes, COSTA RICA: *Coccoloba longipes*, 1912 (lst); HONDURAS: Point Truinfo (?), *C. barbadensis*, 16. I. 1903 (P. Wilson) (lst); JAMAICA: *C. plumieri*, 1850 (R. C. Alexander) (lst); Upper Clarendon, Peckham Woods, *C. diversiflora*, 27. IX. 1912 (W. Harris); near Claverty Cottage, *C. barbadensis*, 21. II. 1894 (W. Harris); Content Road, Port Royal Mtns., *C. barbadensis*, 9. III. 1894 (W. Harris) (lst); between Constant Spring and Bardowie, *C. diversifolia*, 2. VIII. 1915 (W. Harris) (2nd); Crown's Lands, near Troy, *C. longifolia*, 29. VI. 1904 (W. Harris) (lst); Great Goat Island, *C. krugii*, 18. VII. 1906 (W. Harris) (lst); Hillside Lancaster, to Moody's Gap, *C. diversifolia*, 10. IX. 1908 (N. L. Britton) (lst); Hillside Malvern, Santa Cruz Mts., *C. diversifolia*, 5. IX. 1907 (N. L. Britton) (lst); Hillside Mandeville, *C. diversifolia*, 3. IX. 1908 (N. L. Britton) (lst); John Crow Mts., Southeastern foothills, *C. longifolia*, 2. III. 1909 (W. Harris and N. L. Britton) (lst, 2nd); east of Kingston, *C. krugii*, 30. VII. 1926 (W. Maxon) (lst, 2nd); Kingston, road to Waureka, *C. krugii*, 30. VII. 1926 (W. Maxon); Long Mtn., *C. krugii*, 19. XI. 1907 (W. Harris) (lst); Lovers Leap, Santa Cruz Mts., *C. krugii*, 4. IX. 1917 (N. L. Britton) (lst); Moneaque, Union Hill, *C. diversifolia*, II. 1881 (lst); Negril, *C. jamaicensis*, 3. X. 1908 (W. Harris); Oxford, *C. diversifolia*, 13. IX. 1906 (N. L. Britton (lst); Savoy, *C. diversifolia*, 29. VIII. 1913 (W. Harris) (lst, 2nd); Soho, St. Anns, *C. longifolia*, 5. XI. 1915 (W. Harris) (lst); Stanmore Hill, Santa Cruz Mts., *C. longifolia*, 11. IX. 1907 (N. L. Britton); Troy, *C. diversifolia*, 22. XI. 1905 (W. Harris); VIRGIN ISLANDS: *C. diversifolia*, 9. V. 1919 (W. C. Fisk) (lst).

Crenulaspidiotus cyrtus sp. n.

Etymology. The species epithet is from the Greek *kyrtos* meaning "curved" and refers to the greatly curved, anterior margin of the pygidium.

Field features. No available information.

Third instar females (adults) (fig. 3)

Description. Holotype, mounted, 0.6 mm long (paratypes 0.7 mm), 0.6 mm wide (paratypes 0.6 mm). Body margin of prepygidium crenulate; margin of segment 3 developed into lobe. Pattern on dorsosubmargin of segment 3 reticulate, with small groove, extending to anterior margin of lobe 4. Prepygidial dorsum with 1 size microduct, same size as on margin

of head of venter, on submargin of thorax and head; 3 cicatrices on each side of body. Eyes represented by sclerotized area with minute points on body margin near antenna. Prepygidial venter with microducts of 2 sizes, smaller size on submargin of head, larger size abundant near mouthparts, spiracles, mediolateral area posterior of hind spiracle, and lateral margin of prepygidial segment. Pygidium with anterior margin, strongly protruding into prepygidium. Pygidial dorsum with 11 sclerotized areas. Anal opening 10 μm long (paratypes 9 and 10 μm), located 6 times its length from base of medial lobes (paratypes 6 and 7 times) opening occurring slightly anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 4 pairs of lobes, medial lobe with 1 lateral and 1 medial notch, lobe 2 with 2 lateral notches (paratypes with or without medial notch and with 2 lateral notches) lobe 3 with 3 lateral notches and 1 medial notch (paratypes with or without medial notch), lobe 4 with 5 lateral notches, lobe 5 area with series of small points. Gland-spine formula 3–3. Fourth space with 5 lobelike processes, sometimes with notches, each with 1 microduct. Pygidial venter with row of 7 microducts on each side of segment 3 (paratypes 6 and 8), 9 microducts on each side of segment 4 (paratypes 7 and 9), 3 on segment 5 (paratypes 2 and 3). Paraphyses on lobes from longest to shortest: 2, 3, 4, 1; interlobular paraphysis formula 1–2–3.

Variation. The paratypes vary by having 4 or 5 processes on fourth interlobular space and an interlobular-paraphysis formula of 1–2–2.

Description based on four specimens from type locality only.

Type-material. The holotype adult female is on a slide with three paratypes and is the specimen nearest the right label. The left label states "*Crenulaspidiotus cyrtus*, on *Coccoloba* sp., Flora de Territorio de Formosa, Rep. Argentina, Col. P. Jorgenson, Gary 1-1." The left label has a map of the position of the holotype and "HOLOTYPE, 3 paratypes, DET. J. A. DAVIDSON" (USNM).

Paratypes on slide with holotype.

Crenulaspidiotus dicentron sp. n.

Etymology. The species epithet is a noun in apposition derived from the Greek words *di* — meaning "two" and *centron* — meaning "spur" and refers to the two prominent spurs just anterior of lobe 5.

Field features. The dorsal cover is dark, convex, and circular. The scales are found on the leaf of the host, predominately the upper surface, and often are under the outer epidermis of the leaf tissue.

Third instar females (adults) (fig. 4)

Description. Holotype, mounted, 1.0 mm long (paratypes 0.8–1.5(1.2) mm), 0.9 mm wide (paratypes 0.7–1.3(1.1) mm). Body margin of prepygidium smooth, without crenulations, lobes, or tubercles. Pattern absent from dorsosubmargin of segment 3, small groove present. Prepygidial dorsum with 2 sizes of microducts, larger size in mediolateral, longitudinal line on posterior prepygidial segments and near submarginal clusters of small microducts, smaller size in clusters near lateral margin of abdomen and posterior thorax, forming line around body margin of anterior thorax and head; cicatrices absent. Eyes represented by flat, clear area on derm with 3 small, sclerotized points. Prepygidial venter with microducts of larger size only, present near mouthparts, spiracles, and body margin. Pygidium with anterior margin nearly straight, not protruding into prepygidium. Pygidial dorsum with 11 sclerotized areas, area 1 weakly defined, area 3 weakly defined on 1 side of body. Anal opening, 6 μm long (paratypes 8–13(9) μm), located 6 times its length from base of medial lobes (paratype 4–6(5) times), opening occurring posterior of or touching imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobe with 3 lateral notches (paratypes 2 or 3) and 1 medial notch (paratypes 0 or 1), lobe 2 with 3 lateral notches (paratypes 2 or 3) and 1 medial notch (paratypes without medial notch), lobe 3 with 3 lateral notches (paratypes 4–6) and 1 medial notch (paratypes without medial notch), lobe 4 with 6 notches (paratypes 5–8), lobe 5 with 8 notches (paratypes 7–13), 2 rounded spur and 1 small point anterior of lobe 5. Gland-spine formula 3–3. Fourth space with 3 processes appearing as knobs, each with microduct. Pygidial venter with row of microducts on each side of segment 3 (paratypes 0–4(1)), 8 microducts on each side of segment 4 (paratypes 5–9(8)), microducts absent from 5. Paraphyses on lobes from longest to shortest as follows: 2, 3=4, 1; interlobular paraphysis formula 1–2–2.

Variation. Paratypes may have more small microducts on submargin of dorsal prepygidium and fewer large ducts; ventral prepygidial microducts often less abundant than on holotype, sometimes absent; paratypes have 1–5(2) sclerotized points on each eye, often inconspicuous; cicatrices vary from 0–2(1); sclerotized areas 1 and 3 often weakly defined; 1 paratype has 4 processes in fourth space; small point near seta marking segment 4 may be absent; relative lengths of paraphyses on lobes may be from longest to shortest as follows: 2, 3, 4, 1 or 2, 4, 3, 1.

Description based on 24 specimens from 8 localities.

Second instars (fig. 13B)

Description. Same as adult female except: Mounted, 0–4–0.9(0.6) mm long, 0.4–0.6(0.5) mm wide. Pattern on dorsosubmargin of segment 3 absent except for groove near spurs. Anal opening 5–7(6) μm long, located 4–6(5) times its length from base of medial lobes. Medial lobe with 1 or 2 lateral notches, absent medially, lobe 2 with 1 or 2 notches, lobe 3 with 2 or 3 notches, lobe 4 with 3 or 4, lobe 5 with 4–8 notches, 2 spurs, occasionally 1 or 3, anterior of lobe 5. Gland-spine formula 3–3–2 and 2 between medial lobes; third space normally with 2 large, bifurcate gland spines and 1 small, simple gland spine; second space normally with 1 bifurcate gland spine and 2 simple gland spines. Fourth space with 3 processes, appearing as rounded lobes, anterior 2 processes each with microduct, posterior process without duct. Pygidial venter with 0–2(1) microducts on each side of segment 3, 1 or 2 (2) microducts on each side of segment 4, microducts absent from segment 5. Interlobular paraphysis formula variable, normally 1–2–2 with paraphysis in first space unusually small, sometimes 1–1–1, 1–1–2, or 1–2–1.

Description based on 10 specimens from three localities.

First instars (fig. 15B)

Description. Body 238–265(254) μm long, 195–207(203) μm wide. Pygidium with 2 definite pairs of lobes, fourth lobes indicated by small, unsclerotized protuberance; second lobes each without medial notch, with 4–6(5) lateral notches; third lobes with 3 or 4(3) notches. Space between lobes 2 and 3 with 2 plates. Distance between posterior apex of anal opening and base of second lobes 18–21(20) μm. Antenna 75–83 (80) μm long; apical segment 53–55(54) μm long; antennal length/apical segment length 1.4 or 1.5(1.5). Hind leg 88–103(96) μm long; hind trochanter + femur 34–45(41) μm long; hind tibia + tarsus 26–33(29) μm long; trochanter + femur length/tibia + tarsus length 1.2–1.6(1.4).

Description based on eight specimens from two localities.

Type material. The holotype adult female is on a slide with three paratypes; the holotype is the second specimen from the left. The label states "*Crenulaspidiotus dicentron*, on *Cocolobis* [sic] *pirifolia* [sic], Maricao, P. R. [Puerto Rico], Martorell & DeLeon Coll., May 5, 1940, Acc. 360–40". The right label has a map giving the position of the holotype and "HOLOTYPE and 3 paratypes, DET. J. A. DAVIDSON" (USNM). There are

31 paratypes including embryos on 13 slides; at least one slide is deposited in the BMNH, UCD, and USNM.

Paratypes, PUERTO RICO: Cataling, Yunque Trail, *C. diversifolia*, 23. II. 1923 (N. L. Britton and Bruner); Mnt. between Cavey & Cuayama, *C. pyrifolia*, 15. III. 122 (N. L. Britton) (2nd); Maricao, *C. pyrifolia*, 5. V. 1940 (L. F. Martorell and DeLeon) (1st); Maricao, *C. sintenisii*, 21. VII. 1977 (S. Nakahara) (1st, 2nd); Maricao, *C. swartzii* forma *urbaniana*, 24. IV. 1937 (F. H. Sargent); Maricao, *C. diversifolia*, 18. XI. 1884 (P. Sintensis); Sierra de Luquilla, *C. swartzii* forma *urbaniana*, VI. 1885 (P. Sintensis); North of Yauco, *C. swartzii* forma *urbaniana*, 4–11. II. 1923 (N. L. and E. G. Britton) (1st).

Crenulaspidiotus greeneri sp. n.

Etymology. This species is named in honor of Ralph GREENER of the American Cyanamid Co., Linden, N.J., in appreciation of the friendship and guidance he provided Davidson before and during the latter's undergraduate studies.

Field features. No information available.

Third instar females (adults) (fig. 5)

Description. Holotype mounted, 0.8 mm long (paratypes 0.7 and 0.8 mm), 0.7 mm wide (paratypes 0.7 and 0.8 mm). Margin of segment 3 developed into broad lobe, metathorax and segments 1 and 2 crenulate and developed into conspicuous marginal lobes. Pattern on dorsosubmargin of segment 3 composed of series of nearly parallel lines radiating from central furrow, not extending to lobe 5. Prepygidial dorsum with 1 size microduct on lateral margin of posterior prepygidial segments; 3 cicatrices on each side of body. Eyes absent. Prepygidial venter with 1 size microduct larger than those on dorsum, on marginal areas of posterior prepygidial segments and near spiracles and mouthparts. Pygidium with anterior margin nearly straight, not extending into prepygidium. Pygidial dorsum with 8 sclerotized areas, areas 1 and 3 indistinct, area 6 unusually elongate and difficult to see. Anal opening 13 μm long (paratypes 11 and 15 μm), located 6 times its length from base of medial lobes (paratypes 6 and 8 times), occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobe with 1 lateral notch and 1 medial notch, lobe 2 with 2 lateral notches, lobe 3 with 4 lateral notches (paratypes with 3 lateral notches), lobe 4 with 5 lateral notches (paratypes 4 and no medial notches), lobe 5 with 5 notches (paratypes 4 and 5), several small projections anterior of lobe 5,

no well-developed spur. Gland-spine formula 3–3. Fourth space with 3 processes similar in appearance to gland spines. Pygidial venter with row of 6 microducts on each side of segment 3 (paratypes 7 and 8), 8 microducts on each side of segment 4 (paratypes 7), microducts absent from segment 5. Paraphyses on lobes from longest to shortest as follows: 2, 3, 4=1; interlobular paraphysis formula 1–2–2, with small paraphyses in fourth space.

Variation. Paratypes may have areas 1 and 3; may have small spur anterior of lobe 5; lobe 5 has well-developed paraphysis on both paratypes; 1 paratype has 3 interlobular paraphyses in third space.

Description based on three specimens from type locality.

Type-material. The holotype adult female is on a slide with two other specimens; the holotype is on the left side of the cover slip. The left label states "*Crenulaspidiotus greeneri* MILLER and DAVIDSON, Concordia, Argentina, from H. L. Parker, Oct. 31, 1940". Right label gives a map of the position of the holotype and states "HOLOTYPE, 2 PARATYPES, DET. J. A. DAVIDSON" (USNM).

Paratypes on slide with holotype.

Crenulaspidiotus maurellae (Laing), comb. n.

Aonidiella maurellae LAING, 1929: 492; MCKENZIE, 1938: 1; FERRIS, 1941: SIII-364; BORCHSENIUS, 1966: 359.

Melanaspis maurellae (LAING); LINDINGER, 1943: 147.

Field features. According to LAING (1929) the scale cover of the adult female is subcircular, convex, black, with concentric ridges. The exuviae are subcentral and are paler than the wax of the cover. The under side of the dorsal cover has a white center and a broad, reddishbrown border. There is a complete ventral cover. The scale apparently occurs on the bark of its host.

Third instar females (adults) (fig. 6)

Description. Mounted, 0.6–1.1(0.8) mm long, 0.5–1.0(0.6) mm wide. Body margin of prepygidium crenulate from base of pygidium to level of anterior spiracle. Pattern on dorsosubmargin of segment 3 weak, composed of small groove and few parallel lines, often extending to lobe 5 area. Prepygidial dorsum with 2 sizes of microducts, larger size in submedial areas, smaller size normally in marginal and submarginal areas, sometimes scattered over entire dorsal prepygidium; cicatrices varying from 0–3. Eyes normally absent, rarely as illustrated. Prepygidial venter with microducts of same 2 sizes as on dorsum, smaller size normally restricted

to area immediately adjacent to clypeolabial shield, occasionally scattered on head between anterior edge of mouthparts and anterior body margin, larger size distributed as illustrated. Pygidium with anterior margin strongly protruding into prepygidium. Pygidial dorsum with 11 sclerotized areas, area 3 often indistinct. Anal opening 8–13 (10) μm long, located 4–8 (5) times its length from base of medial lobes, occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 4 or 5 pairs of lobes, medial lobe with 1 lateral notch and with or without medial notch, lobe 2 with 1 or 2 lateral notches, lobe 3 with 1–3 notches, lobe 4 with 2–5 notches, lobe 5 area normally represented by series of sclerotized serrations, small space and conspicuous spur, rarely without spur or with spur modified into lobe similar in appearance to lobe 4. Gland-spine formula 3–3. Fourth space usually with 4 or 5 processes normally lobe-like, often with notches, each with 1 microduct. Pygidial venter with row of 7–10 (8) microducts on each side of segment 3, 8–13 (10) microducts on each side of segment 4, 2–6 (4) on each side of segment 5. Paraphyses on lobes from longest to shortest normally as follows: 2, 3, 4, 1; sometimes 3=4 or 4=1; interlobular paraphysis formula normally 1–1–1 or 1–1–0, occasionally a second very small paraphysis may occur in second or third interlobular space.

Description based on 55 specimens from 29 localities.

Second instars (fig. 13C)

Description. Same as adult female except: Mounted, 0.5 or 0.6 mm long, 0.4 or 0.5 mm wide. Body margin without crenulations. Pattern on dorsosubmargin of abdominal segment 3 conspicuous, composed of series of noticeable lines, extending to lobe 5 area, groove absent. Microduct patterns and cicatrices not visible on available specimens. Anal opening 10 or 13 μm long, located 3 or 5 times its length from base of medial lobes, touching or occurring slightly anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 4 pairs of lobes, medial lobe with 1 lateral notch, absent medially, lobe 2 with 2 notches, lobe 3 with 2 or 3 notches, lobe 4 with 3 or 4 notches, lobe 5 area with 1–3 small points, spurs absent. Gland-spine formula 2–2–1 and 2 between medial lobes. Fourth space with 3 processes appearing as rounded knobs, sometimes with notch, anterior 2 processes each with microduct. Pygidial venter with 1 or 2 microducts on each side of segment 3, 3 microducts each side of segment 4, 1 on each side of segment 5. Paraphyses on lobes from longest to strongest 2–1=3=4 or 2–1=3–4; interlobular paraphysis formula 1–1–0.

Description based on 2 specimens from 2 localities.

First instars (fig. 15C)

Description. Body 195–226(212) μm long, 140–171(157) μm wide. Pygidium with 2 pairs of lobes, second lobes each with medial notch and 2–4(3) lateral notches; third lobes small, with 2 or 3(2) notches. Plates absent. Distance between posterior apex of anal opening and base of second lobes 13–16(13) μm. Antenna 50–65(58) μm long; apical segment 28–35(32) μm long; antennal length/apical segment length 1.7–1.9(1.8). Hind leg 65–78(72) μm long; hind trochanter + femur 28–34(30) μm long; hind tibia + tarsus 20–28(23) μm long; trochanter + femur length/tibia + tarsus length 1.2–1.4(1.3).

Description based on 33 specimens from 12 localities.

Type-material. Because no mention of a "type" or "holotype" is made in the original description, the type series is considered to be syntypical. From the syntypes we have chosen and marked as lectotype an adult female labeled "*Aonidiella maurellae* LAING, Columbia: Tucurinca, on, H. V. 1926., C. C. Gowdey (No. 1213), British Museum (Nat. Hist)" (BMNH). There is one adult female on the slide; a scale cover is glued to the left side of the slide and a small label reads "TYPE". We have placed a label on the back of the slide stating "*Aonidiella maurellae* LAING Lectotype designated by MILLER and DAVIDSON". There is one paralectotype (BMNH).

Material examined. (In SNM unless otherwise indicated.) ARGENTINA: Coman Formosa, *Coccoloba paraguariensis*, V. 1918 (P. Jorgensen). CANAL ZONE: Barro Colorado Island, north shore, *C. lehmannii*, 7. IX. 1929 (F. M. Salvoza) (1st); Gamboa, *C. acuminata*, 7. II. 1911 (Pittier). COLOMBIA: *C. padiformis*, 18. VII. 1935 (P. Arbelaez) (1st); Cartagena vicinity, *C. ramosissima*, 1919 (Heriberto); Cartagena Beach. *C. ramosissima*, X. 1857 (Schott); Chinu, *C. caracasana*, 27. I. 1918 (F. C. Pennell) (1st, 2nd); Puerto Berrio vicinity, between Carare and Magdalena Rivers, *Coccoloba* sp., 26. V. 1935 (O. Haught) (1st); Puerto Colombia, Barranquilla vicinity, *Coccoloba* sp., I. 1928 (Elias); Santa Maria, *C. densifrons*, 1898–1901 (H. H. Smith). EL SALVADOR: Laguna de Maquique, *C. caracasana*, 18. II. 1922 (P. Standley); Laguna de Olmega, *C. venosa*, 20. II. 1922 (P. Standley). GUATEMALA: Near Mazatenango, *C. venosa*, 2. III. 1905 (Maxon and Hay) (1st); Naranjo, Dept. de Esquintla, *C. barbadensis*, 1892 (J. D. Smith); Rio Ocosito, *C. barbadensis*, IV. 1892 (J. D. Smith). GUYANA: Kuyiiwini River 150 miles from mouth, Essequibo Territory, *C. marginata*, 12. II. 1938 (A. C. Smith) (1st). HONDURAS: Puerto Sierra, along Tela River, *C. marginata*, 18. I. 1903 (P. Wilson)

(1st). MEXICO: Near Acapulco, *C. barbadensis*, 1894–1895 (E. Palmer); Las Canoas, San Luis Potosi, *C. humboldtii*, 18. VII. 1891 (C. G. Pringle) (1st); south of Carrizal Michoacan, *Coccoloba* sp. (G. F. Ferris, UCD); Las Carzas, Acapetagua, *C. caracasana* and *C. venosa*, I. 1939 (E. Matudo) (1st); near Conala, Chiapas, *C. barbadensis*, 13. XII. 1906 (Collins and Doyle) (1st); El Paso, Yucatan, *C. barbadensis*, 17. IV. 1932 (C. L. Lundell); Finca Islanda, *Coccoloba* sp., VI. 1914 (C. A. Purpus). NICARAGUA: *C. barbadensis*, 1853–1856 (Ringold and Rogers) (1st, 2nd). PANAMA: Near Marraganti, *Coccoloba* sp., 8. IV. 1908 (R. S. Williams) (1st). PARAGUAY: Pilcomayo River, *C. paraguariensis*, 1888–1890 (T. Morong). VENEZUELA: Near Cumaraba, *C. uvifera*, 4. IV. 1917 (H. M. Curran and M. Haman).

Crenulaspidiotus mini Davidson

Crenulaspidiotus mini DAVIDSON, 1970: 500.

For details of field characters see DAVIDSON (1970).

Third instar females (adult) (fig. 7).

Description. Adult females 0.4–0.6 (0.5) mm long, 0.4–0.6 (0.5) mm wide. Margin of segment 3 developed into broad lobe, mesothorax, metathorax, and segments 1 and 2 crenulate and developed into conspicuous, marginal lobes. Pattern on dorsosubmargin of segment 3 absent but with small groove and few short, parallel lines. Prepygidial dorsum without microducts except one specimen on mediolateral area just anterior of pygidium; 1 or 2 cicatrices on each side of body. Eyes variable, represented by 1–3 small, sclerotized areas, without sclerotized points. Prepygidial venter with 1 size microduct on marginal and submarginal areas of posterior prepygidial segments, near clypeolabral shield, and laterad of anterior spiracle, rarely near posterior spiracle. Pygidium with anterior margin nearly straight, not extending into prepygidium. Pygidial dorsum with 11 sclerotized areas, unique furrow in area 2 often attached to furrow separating area 1. Anal opening 9–13 (10) μm long, located 6–9 (7) times its length from base of medial lobes, occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobes and second lobes without notches, lobe 3 with 2 or 3 lateral notches, lobe 4 with 2–4 notches, lobe 5 with 4–8, 1 small spur anterior of lobe 5. Gland-spine formula 3–3, sometimes difficult to see. Fourth space with 4 processes similar to gland-spines. Pygidial venter with row of 4–6 (5) microducts on each side of segments 3, 5 or 6 (6) microducts on each side of segment 4, absent from segment 5. Paraphyses on

lobes from longest to shortest as follows: 1, 2, 3, 4; interlobular paraphysis formula variable, normally 1–2–2, rarely 1–2–3, 1–3–2, or 1–3–3, with small paraphyses in fourth space.

Description based on 12 specimens from type locality only. Twelve additional specimens have been mounted from dry material collected at same time as holotype.

Second instars (fig. 13D)

Description. Same as adult female except: Mounted 0.3–0.5 (0.4) mm long, 0.3 or 0.4 (0.4) mm wide. Margin of segments 3 and 2 developed into small prepygidial lobes, without crenulations. Pattern on dorsosubmargin of segment 3 conspicuous, consisting of series of nearly parallel lines, extending to lobe 4. Some specimens with few large microducts in mediolateral area of prepygidial abdominal segments and posterior thoracic segments and near body margin of segments 1 and 2. Eyes absent or represented by small sclerotized area. Anal opening 5–7 (5) μm long, located 4–6 (5) times its length from base of medial lobes; occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Medial and second lobes without notches, lobe 3 with 2–5 notches, lobe 4 with 2–6 notches, lobe 5 with 0–3 notches, without spurs. Gland-spine formula 3–3–2 or 3–3–1 and 2 between medial lobes. Fourth space with 3 acute processes, normally anterior 2 processes each with microducts, rarely only 1 or 3 have ducts; anterior gland spine in third space normally similar to processes in fourth space. Pygidial venter with 0–2 (1) microduct on each side of segment 3, 1 on segment 4, normally absent from segment 5, 1 rarely present. Interlobular paraphysis formula variable, normally 1–1–0, occasionally 1–1–1, 1–2–1, without paraphyses in fourth space.

Description based on 28 specimens from one locality.

First instars (fig. 15D)

Description. Body 220–250 (238) μm long, 140–183 (163) μm wide. Pygidium with 2 pairs of lobes, second lobes each without medial notch, with 1 lateral notch, third lobes with 1 or 2 (2) notches. Space between second lobes with 2 plates, space between second and third lobes with 1 plate. Distance between posterior apex of anal opening and base of second lobes 14–19 (16) μm. Antennae 63–73 (68) μm long; apical segment 38–45 (41) μm long; antennal length/apical segment length 1.6–1.7 (1.6). Hind leg 85–91 (89) μm long; hind trochanter + femur 35–39 (37) μm long; hind tibia + tarsus 24–28 (26) μm long; trochanter + femur length/tibia + tarsus length 1.4–1.5 (1.4).

Description based on 15 specimens from one locality.

Fifth instar males (adults) (fig. 17; 18, 3)

Description. Mounted, about 0.8 mm long, about 0.3 mm wide at mesothorax. Dorsum with lateral margin of segment 8 with medial indentation, extending ventrally with 3 setae. Setae as illustrated; note abortive setal bases on scutum. Abdominal sclerotization absent except segment 8 partially sclerotized laterally, reticulate pattern on medial areas. Mesothorax with prescutum rectangular, without reticulation; scutum without reticulation, scutellum with foramen indefinite or absent; postnotal area with longitudinal striation. Prothorax with conspicuous pronotal ridges; pronotal sclerites, posttergites, and medial pronotal sclerite apparently absent. Head with midcranial ridge represented by anterior, lateral arms only, postoccipital ridge large, anterior arms absent, replaced by lightly sclerotized, rectangular plate, posterior arms on same plane as main part of ridge. Dorsal eye about 23 μm in diameter. Ocelli absent. Penial sheath about 250 μm long; greatest width/length about 0.2; length of antenna/length of penial sheath about 1.5. Venter with setae as illustrated. Abdominal sclerotization absent. Metathorax with sternum inconspicuous, precoxal ridge conspicuous. Mesothorax with basisternum about 45 μm long, mesofurca extending anterior of edge of basisternum without median ridge. Prothorax with sternum well-developed, lateral arms short, without triangular plates. Head with midcranial ridge expanding posteriorly; preocular ridge evident; postocular ridge well developed; preoral ridge thin, not connected to postocular ridge even by sclerite. Ventral eye about 23 μm in diameter. Legs approximately equal in length, about 335 μm long; hind tibia/tarsus about 1.3; setae hairlike, bifurcate setae rare, spurs absent, digitules capitate, extending beyond tip of claw; trochanter with 6 sensilla, tarsus with 1; tarsi 2-segmented. Antennae about 370 μm long, about half as long as body length, 10-segmented, third segment about 1.2 times longer than apical segment; antennal setae absent on segment 1–4 except 1 on segment 2 and rarely 1 on segment 4, apical segment with 11 setae excluding 2 "sensory pegs" including 3 capitate setae.

Description based on two specimens from one locality.

Type material. We have examined the holotype and 10 paratypes. The type data is: Ajo, Pima Co., Arizona, 30. IV. 1969, *Prosopis* sp., D. B. Carver. Through the courtesy of Ray Gill, Department of Food and Agriculture, Sacramento, California, we have mounted additional material collected 15. VII. 1969 from the same *Prosopis* tree as the type series. Additional material includes many immature forms and several adult males.

Crenulaspidiotus monocentron sp. n.

Etymology. The species epithet is a noun apposition derived from the Greek words *monos* meaning "one" and *centron* meaning "spur" and refers to the single prominent spur just anterior of lobe 5.

Field features. No information available.

Third instar females (adults) (fig. 8)

Description. Holotype, mounted, 1.1 mm long (paratypes 0.7–1.2 (0.9) mm), 0.9 mm wide (paratypes 0.6–0.9 (0.8) mm). Body margin of prepygidium with 13 and 14 gland tubercles on each side of body from base of pygidium to level of clypeolabial shield (paratypes 13–23 (17) gland tubercles). Pattern on dorsosubmargin of segment 3 absent except for small groove and few, short parallel lines. Prepygidial dorsum with 2 sizes of microducts, larger size in transverse rows over most of surface except head, smaller size forming submarginal line on anterior abdominal segments, thorax, and head; 1 cicatrix on 1 side of body, 2 on other. Eyes protruding slightly, with 5 sclerotized points. Prepygidial venter with microducts of larger size only, adjacent to mouthparts and spiracle. Pygidium with anterior margin nearly straight, not protruding into prepygidium. Pygidial dorsum with 10 sclerotized areas, area 1 absent. Microducts similar to ducts on pygidial venter on segments 4 and 3, with 4 on 1 side of segment 4 and 6 on other (paratypes 0–3 (0)), with 3 on 1 side of segment 3 and 8 on other (paratypes 0–5 (2)). Anal opening 13 μm long (paratypes 8–13 (10) μm), located 7 times its length from base of medial lobes (paratypes 6–11 (8) times), occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobes with apices worn (paratypes with 2 or 3 lateral notches and 1 medial notch), lobe 2 with 2 lateral notches (paratypes 2 or 3), lobe 3 with 2 notches (paratypes 2 or 3), lobe 4 with 5 notches (paratypes 4–7), lobe 5 with 10 notches (paratypes 8–14), apically acute spur anterior of lobe 5. Gland-spine formula 3–4 on 1 side 3–3 on other. Fourth space with 3 or 4 processes appearing as knobs, each with a microduct. Pygidial venter with row of 8 microducts on each side of segment 3 (paratypes 7–11 (9)), 26 microducts on each side of segment 4 (paratypes 12–24 (17)) absent from segment 5. Paraphyses on lobes from longest to shortest as follows: 2, 3=4, 1; interlobular-paraphysis formula 1–2–1.

Variation. Paratypes may have gland tubercles on body margin to level of anterior spiracles; 0–3 (2) cicatrices; eyes varying from large, protruding, sclerotized structures to small, flat, unsclerotized areas, and

having 1–4 (3) points; spur near lobe 5 sometimes has 1 notch; gland-spine formula normally 3–4, occasionally 3–3 or 4–4; 4 processes in fourth space of all paratypes; lobe paraphyses vary from longest to shortest as follows: 2, 3, 1, 4 or 2, 3, 4, 1 or 2, 3, 4, =1.

Description based on 20 specimens from 12 localities.

Second instars (fig. 13E)

Description. Same as adult female except: Mounted 0.4 mm long, 0.3 mm wide. Body margin of prepygidium with 3 or 4 gland tubercles on each side of body. Pattern on dorsosubmargin of segment 3 conspicuous, composed of series of lines, not extending to lobe 5. Prepygidial dorsum with 2 sizes of microducts, larger size scattered over posterior thoracic segments and anterior abdominal segments, smaller size in reduced numbers near body margin of anterior thoracic segments; 2 cicatrices. Eyes conspicuous, 1 with 2 sclerotized points other with 1 point. Prepygidium venter with microducts of larger size only, near mouthparts and spiracles, on mediolateral area posterior of posterior spiracle, near body margin of posterior thorax and anterior abdomen. Anal opening 15 μm long, located about 4 times its length from base of medial lobes, occurring slightly anterior of imaginary line drawn between apices of second-lobe paraphyses. Medial lobes with 1 lateral notch, absent medially, lobe with 2 notches, lobe 3 with 2 or 3, lobe 4 with 3 or 4, lobe 5 with 3 to 6 notches 2 or 3 spurs anterior of lobe 5. Gland-spine formula 3–2–2 and 2 between medial lobes. Processes in fourth space difficult to see on available specimen, apparently 3 processes in each space, anterior 2 with microduct. Gland spines in third space unlike fourth space processes. Pygidial venter with 2 microducts on each side of segment 3, 2 microducts on each side of segment 4, 1 microduct on segment 5. Interlobular paraphysis formula 1–1–1.

Description based on 1 specimen.

First instars (fig. 15E)

Description. Body 229–250 (239) μm long, 153–183 (168) μm wide. Pygidium with 2 pairs of lobes, second lobes each without medial notch, with 4–6 (5) lateral notches; third lobes with 2–4 (3) notches. One plate between lobes 2 and 3. Distance between posterior apex of anal opening and base of second lobes 10–13 (12) μm. Antenna 60–75 (69) μm long; apical segment 33–43 (39) μm long; antennal length/apical segment length 1.7–2.0 (1.8). Hind leg 70–100 (90) μm long; hind trochanter + femur 33–43 (38) μm long; hind tibia + tarsus 25–33 (29) μm long; trochanter + femur length/tibia + tarsus length 1.2–1.4 (1.3).

Description based on 25 specimens from 6 localities.

Type material. The holotype adult female is mounted alone on a slide. The label states "*Crenulaspidiotus monocentron*, on *Coccoloba longifolia*, Mt. Diabolo, Jamaica, Wm. R. Maxon, colr., May 25–27, 1904, USNH 520133." The right label states "HOLOTYPE, *Crenulaspidiotus monocentron* MILLER and DAVIDSON, DET. J. A. DAVIDSON, 1973" (USNM). There are 47 paratypes including embryos on 12 slides deposited in the BMNH, UCD, and USNM.

Paratypes, JAMAICA: *Coccoloba* sp., 1850 (R. C. Alexander) (1st); Amity Hall Hill, *C. longifolia*, 9. III. 1909 (W. Harris and N. L. Britton) (1st); Grierfield, near Moneaque, *C. longifolia*, 3. IV. 1908 (N. L. Britton); Holly Mount vicinity, Mt. Diablo, *C. longifolia*, 27. V. 1904 (W. R. Maxon) (1st); near John Crow Mountains, *C. venosa*, 10. III. 1909 (N. L. Britton and W. Harris); Negril, *C. longifolia*, 9–12. III. 1908 (N. L. Britton and Hollick) (2nd); gully near New Market, *C. longifolia*, 22. IX. 1907 (W. Harris); St. Thomas Parish, *C. longifolia*, 19. IX. 1908 (N. L. Britton) (1st); Tea Gully, New Market vicinity, *C. longifolia*, 22. IX. 1907 (N. L. Britton) (1st); Tyre, near Troy, *C. longifolia*, 15. IX. 1906 (W. Harris) (1st); Tyre, *C. longifolia*, 18. IX. 1906 (N. L. Britton).

Crenulaspidiotus portoricensis (Lindinger)

Chrysomphalus (*Melanaspis*) *portoricensis* LINDINGER, 1910: 441; WOLCOTT, 1941: 61; MARTORELL, 1945a: 150, 1945b: 411; WOLCOTT, 1951: 182.
Aspidiotus (*Chrysomphalus*) *portoricensis* (LINDINGER); PIERCE, 1917: 158.
Aspidiotus portoricensis (LINDINGER); MACGILLIVRAY, 1921: 389.
Crenulaspidiotus portoricensis (LINDINGER); MACGILLIVRAY, 1921: 427; BORCHSENIUS, 1966: 359; DAVIDSON, 1970: 500; MARTORELL, 1976: 71, 73.
Melanaspis portoricensis (LINDINGER); LINDINGER, 1931: 27; MCKENZIE, 1939: 54; FERRIS, 1941: SIII-364, 1942: SIV-446, 1943: 64.
Chrysomphalus portoricensis LINDINGER; FERRIS, 1937: 51; ALI, 1970: 49.
Chrysomphalus sp.; WOLCOTT, 1941: 62; MARTORELL, 1945a: 148.

Field features. The dorsal cover of the adult female is black, convex, and circular. The ventral cover is about as thick as the dorsal cover and is black with a white, circular center. The exuviae are black and subcentral, and the covers of the crawler and second instar often are highlighted by a white band around their periphery. The covers of the adult males are black, elongate, and flattened with subterminal exuviae. The species usually occurs in heavy infestations under the leaf sheaths where the petioles attach to the stem.

Third instar females (adults) (fig. 9)

Description. Mounted 0.5–0.9 (0.7) mm long, 0.5–0.8 (0.6) mm wide. Margin of abdomen and some of thorax with prepygidial lobes; each lobe lightly crenulate. Pattern on dorsosubmargin of segment 3 with several nearly parallel lines radiating from groove, extending to lobe 5. Prepygidial dorsum without microducts or with 1–5 ducts in mediolateral areas overlying posterior spiracles and labium; or 3 cicatrices on each side of body. Eyes with 2–5 small, sclerotized points (not illustrated). Prepygidial venter with microducts of same size as on dorsum, distributed as illustrated. Pygidium with anterior margin convex, protruding into prepygidium. Pygidial dorsum with 10 or 11 sclerotized areas; area 1 often absent; furrow directed anteriorly from furrow separating areas 5 and 6 forming unusual, partial division in area 2. Anal opening 9–14 (11) μm long, located 7–11 (9) times its length from base of medial lobes, occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 4 or 5 pairs of lobes, medial lobe usually with 2 lateral notches and 1 medial notch, lobe 2 with 2 or 3 lateral notches and 0 or 1 medial notches, lobe 3 with 3–5 lateral notches and 0–2 medial notches, lobe 4 with 4–6 notches, lobe 5 occasionally very small, usually with 4–9 notches; spurs anterior of lobe 5 small or absent. Gland-spine formula 3–3. Fourth space with 4 processes appearing as small lobes, posterior process occasionally with 1 notch, each process with microduct. Pygidial venter with row of 3–7 (4) microducts on each side of segment 3, 9–12 (10) microducts on segment 4, absent from segment 5. Paraphyses on lobes from longest to shortest normally as follows: 2=1, 3=4 or 2, 1, 3=4; interlobular-paraphysis formula normally 1–2–2, St. Thomas specimens with 1–2–2 or 1–2–1, Virgin Gorda specimens with one large and one very small paraphysis in third space or 1–2–1.

Description based on 192 specimens from 48 localities.

Second instars (fig. 14A)

Description. Same as adult female except: Mounted 0.4–0.8 (0.6) mm long, 0.3–0.6 (0.5) mm wide. Margin of abdominal segments 3, 2, or 1 developed into rounded, prepygidial lobes; without crenulations. Pattern on dorsosubmargin of segment 3 consisting of few nearly parallel lines, extending to anterior edge of lobe 5 area. Microducts normally of 1 size, scattered along body margin, in mediolateral areas of posterior thoracic segments and anterior abdominal segments, and overlying lateral margin of clypeolabral shield on head, 1 specimen with several small ducts near

body margin; 0–2 cicatrices. Eyes represented by conspicuous sclerotized area, with 0–5 sclerotized points. Prepygidial venter with microducts variable, about same as on adult female but less abundant. Anal opening 4–8 (7) μm long, located 4–9 (6) times its length from base of medial lobes; occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Medial lobe with 1 or 2 lateral notches, 0 or 1 medial notches, lobe 2 with 1–3 notches, lobe 3 with 2–4, lobe 4 with 2–5 notches, lobe 5 represented by 2–5 scattered points or with 2–5 notches, 0–2 small spurs anterior of lobe 5. Gland-spine formula 2–2–2, with 2 between medial lobes. Processes in fourth space in most specimens as illustrated, 3 processes in each space, anterior 2 each with microduct, posterior process close to lobe 4 sometimes appearing as a projection of lobe; 4 specimens with processes in fourth space without associated microducts, process nearest lobe 4 often with notch; gland spines in third spaces unlike fourth space processes. Pygidial venter with 0–2 (2) microducts on each side of segment 3, 2 on each side of segment 4, 1 on each side of segment 5 of males, absent on females. Interlobular-paraphyses formula normally 1–1–1, rarely 1–1–0 or 1–1–2.

Description based on 22 specimens from 10 localities.

First instars (fig. 16A)

Description. Body 195–268 (247) μm long, 134–186 (169) μm wide. Pygidium with 2 pairs of definite lobes, third pair represented by small sclerotized projection near dermal opening of tubular duct of segment 6, second lobes each with medial notch and 3 or 4 (4) lateral notches; third lobes with 2 or 3 (3) notches; fourth lobe usually without notches, rarely with 1. Space between second lobes and between second and third lobes each with 2 plates. Distance between posterior apex of anal opening and base of second lobes 15–19 (17) μm. Antennae 60–75 (68) μm long; apical segment 33–45 (39) μm long; antennal length/apical segment length 1.7–1.9 (1.8). Hind leg 75–85 (82) μm long; hind trochanter + femur 33–35 (34) μm long; hind tibia + tarsus 25–28 (27) μm long; trochanter + femur length/tibia + tarsus length 1.2–1.4 (1.3).

Description based on 173 specimens from 31 localities.

Fifth instar males (adults) (fig. 18, 2)

Description. Same as adult male of *C. mini* except as follows: Mounted, 1.0 mm long, 0.3 mm wide at mesothorax. Dorsum with margin of segment 8 smooth, without indentation, with 4 setae. Submarginal areas of abdo-

minal segments 6 and 7 each with 3 setae, segments 2–5 each with 2 setae; scutum without abortive setae; one pair of setae slightly anterior of postoccipital ridge. Abdominal segment 8 with lateral and medial areas sclerotized, medial areas of remaining abdominal segments weakly sclerotized and with reticulation. Mesothorax with scutellum with definite, small foramen. Head with postoccipital ridge with weakly sclerotized anterior arms, rectangular plate absent, posterior arms at slight angle to main ridge. Dorsal eye about 25 μm in diameter. Small ocellus. Penial sheath 293 μm long; greatest width/length 0.3; length of antenna/length of penial sheath 1.3. Venter with medial areas of abdomen with reticulation and slight sclerotization. Metathorax with conspicuous sternum. Mesothorax with basisternum of normal length for armored scale, 60 μm long, mesofurca not extending beyond margin of basisternum. Head with preocular ridge inconspicuous; preoral ridge touching postocular ridge, midcranial ridge expanded posteriorly.

Legs increasing in length posteriorly, hind legs about 403 μm long; hind tibia/tarsus 1.5; setae predominately hairlike, spurs on tarsi. Antennae 378 μm long, slightly less than half as long as body, third segment collapsed on only available specimen, antennal setae abundant on segments 3 and 4, apical segment with 14 setae excluding "sensory peg", including 4 capitate setae.

Description based on 1 specimen.

Type-material. From the syntypes we have chosen and marked as lectotype an adult female with the left label "No. 269 Station Am. für Planzenschutz, *Chrysomphalus* (*Melanaspis*) *portoricensis* LINDG., *Coccoloba excoriata*, Portorico, Cayey, bei La Cruz. 11. X. 1885. HAMBURG (LINDGR.)." The right label states "285 Eing. 13/66, Syntype." A label has been placed on the reverse of the slide as follows "*Chrysomphalus* (*Melanaspis*) *portoricensis* LINDINGER, LECTOTYPE, designated by Miller and Davidson" (ZMH).

Material examined. (In USNM unless indicated otherwise.) HAITI: St. Michel de l'Atalaye vicinity, *Coccoloba buchii*, 20. XII. 1925 (E. C. Leonard). PUERTO RICO: *C. pyrifolia*, 14. III. 1931 (N. L. and E. G. Britton); Algarrobo *C. costata*, 2. XII. 1885 (1st); hills near Bayamon, *C. diversifolia*, 21. II. 1900 (A. A. Heller) (1st); Bayamon, *C. diversifolia*, 1. II. 1899 and 1924) (A. A. Heller) (1st, 2nd); Bayamon, *C. uvifera*, 23. III. 1955 (H. E. Records and L. E. Myers, CDA and UCD); Cabo Rojo, *C. krugii*, 28. II. 1915 (N. L. Britton) (1st); Cayey, *C. diversifolia*, 11. I. 1931 (N. L. and E. G. Britton) (1st); near Coamo Springs, *C. diversifolia*, 16. III. 1913 (N. L. Britton) (2nd); Coamo Springs vicinity, *C. venosa*, 23. III. 1906

(N. L. Britton and J. F. Cowell) (1st); Coamo Springs, *C. venosa*, 21. XI. 1899 (G. P. Goll) (1st); Camuy, *C. pyrifolia*, 26. I. 1938 (F. H. Sargent); Dorado vicinity, *C. diversifolia*, 22. III. 1922 (N. L. Britton) (1st); Guamani, *C. microstachya*, 25. I. 1886; Guanica, *C. diversifolia*, 25. I. 1886 (P. Sintensis); Guayanilla, *C. obtusifolia*, 10. III. 1913 (N. L. Britton and Shafer) (1st); Guayanilla, *C. microstachya*, 29. VIII. 1886 (1st); between Juana Diaz and Coamo Springs, *C. venosa*, 16. III. 1913 (N. L. Britton and Marble) Jvana Mata, Ponce, *C. venosa*, 26. XI. 1889 (G. P. Goll) (1st); Luquillo, "sea-grape", 10. X. 1940 (G. N. Wolcott) (1st, 2nd); near Mayaguez, *C. pyrifolia*, 9. II. 1900 (A. A. Heller); Mayaguez vicinity, *C. pyrifolia*, 10. III. 1906 (J. F. Cowell) (1st); Mayaguez, *C. obtusifolia*, 5. IV. 1913 (N. L. Britton and W. E. Hess); Mayaguez, *C. uvifera*, 4. I. 1885 (P. Sintensis); Monte Mesa, Mayaguez, *C. obtusifolia*, 5. IV. 1913 (N. L. Britton and W. E. Hess); Monte Mesa, Mayaguez, *C. pyrifolia*, 10. III. 1906 (J. F. Cowell) (1st); Isla Mona, *C. diversifolia*, 21. XII. 1913 (F. L. Stevens) (1st); Monte Florida, *C. tenuifolia*, 25. VIII. 1885 (1st, 2nd); Pinones, *C. uvifera*, 13. VII. 1977 (C. E. Miller and S. Nakahara) (1st, 2nd); Playa Aquila, *C. uvifera*, 18. VII. 1977 (S. Nakahara) (1st); hillside near Ponce, *C. krugii*, 22. VII. 1901 (Underwood and Griggs) (1st); east of Ponce, *C. diversifolia*, 3. XII. 1902 (A. A. Heller) (1st); 3 mi. W. Ponce, *Coccoloba* sp., 5. XII. 1902 (A. A. Heller) (1st); 2 mi. E. Ponce, *C. diversifolia*, 3. XII. 1902 (A. A. Heller) (2nd); 7 mi W. Ponce, *C. obtusifolia*, 26. III. 1902 (A. A. Heller) (2nd); "Pumula", *C. venosa*, VII. 1915 (E.L.S.) (1st); Punta Guaniquilla, *C. obtusifolia*, 24. II. 1915 (N. L. Britton); Rio Maricao, above Maricao, *C. pubescens*, 20. X. 1913 (Stevens and W. E. Hess) (1st); Rio Piedras, *C. uvifera*, 30. VI. 1944 (G. N. Wolcott) (1st); between San Juanto and Coamo Springs, *C. venosa*, 16. III. 1913 (N. L. Britton and Marble) (2nd); Santurce, *C. pyrifolia*, 24. II. 1899 (A. A. Heller) (1st); Santurce, *C. uvifera*, 25. V. 1899 (A. A. Heller) (1st, 2nd); above Toa Baja, *C. pyrifolia*, 14. III. 1931 (N. L. and E. G. Britton) (1st); Utuado, *C. costata*, 17. I. 1887 (P. Sintensis) (1st); Vega Alta, *C. pyrifolia*, 25. III. 1922 (N. L. Britton and Brown) (1st, 2nd). VIRGIN ISLANDS: St. Thomas, *C. diversifolia*, 1926 (A. Nelthrop) (1st, 2nd); Virgin Gorda, *C. diversifolia*, 5. I. and 9. V. 1919 (W. C. Fislock) (1st).

Crenulaspidiotus russellae sp. n.

Etymology. This species is named in honour of Louise M. RUSSELL, Resident Cooperating Scientist, Systematic Entomology Laboratory,

IIBIII, Agric. Res., U.S. Dept. Agric., who is responsible for gathering most of the specimens used in this paper.

Field features. No information available.

Third instar females (adults) (fig. 10)

Description. Holotype, mounted, 0.8 mm long (paratypes 0.6–0.8 (0.7) mm), 0.6 mm wide (paratypes 0.5–0.7 (0.6) mm). Margin of segment 3 developed into broad lobe, metathorax, segments 1 and 2 smooth, developed into small lobes. Pattern on dorsosubmargin of segment 3 with several nearly parallel lines radiating from groove, extending to lobe 5. Prepygidial dorsum with 2 sizes of microducts, larger size represented by 1 duct over posterior spiracle, smaller size on submargin of posterior prepygidial segments; 2 cicatrices on each side of body. Eyes represented by small, unsclerotized area with 5 small points. Prepygidial venter with microducts of larger size only, abundant around body margin, near mouthparts and spiracles. Pygidium with anterior margin convex, protruding into prepygidium. Pygidial dorsum with 11 sclerotized areas, area 6 unusually elongate. Anal opening 10 μm long (paratypes 8–11 (9) μm, located 10 times length from base of medial lobes (paratypes 8 or 9 (9) times), occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobe with 2 lateral notches (paratypes 1 or 2) and 1 medial notch; lobe 2 with 3 lateral notches (paratypes 2 or 3); lobe 3 with 3 lateral notches (paratypes 2 or 3) and no medial notches (paratypes 0 or 1), lobe 4 with 4 lateral notches (paratypes 3 or 4); lobe 5 with 6 notches (paratypes 3–5), several small projections anterior of lobe 5, no well-developed spur. Gland-spine formula 3–2 on 1 slide, 3–3 on other. Processes in fourth space with 3 processes apically flattened, each with a microduct. Pygidial venter with row of microducts on each side of segment 3 (paratypes 1), 10 microducts in row on each side of segment 4 (paratypes 8–10 (9)), absent from segment 5; lobe paraphyses of segment 4–8 with associated clear spots resembling duct orifices. Paraphyses on lobes from longest to shortest as follow: 2, 3, 4, 1; interlobular-pharaphysis formula 1–2–2.

Variation. Dorsal, prepygidial microducts may be absent except near body margin; cicatrices vary from 2–3 (2); occasionally small spur present anterior of lobe 5; all paratypes have gland-spine formula of 3–3; none of paratypes have clear spots resembling duct orifices near lobe paraphyses; paraphyses on lobes may vary from longest to shortest as follows: 2, 3=4, 1 or 2, 3, 4=1, or 2, 3, 1=4.

Description is based on 7 specimens from 4 localities.

Second instars (fig. 14B)

Description. Same as adult female except: Mounted 0.4 mm long, 0.2 mm wide. Margin of segment 2 developed into small lobe. Pattern on dorsosubmargin of segment 3 with many nearly parallel lines, extending to anterior margin of lobe 5. Prepygidial dorsum with microducts of 2 sizes, larger size in mediolateral line on posterior thoracic segments and anterior abdominal segments, and overlying labium, smaller size in small numbers on submargin of thorax; 1 cicatrix. Eyes with 7 or 8 sclerotized points. Prepygidial venter with large microducts in small numbers along body margin except between antennae, near mouthparts and spiracles. Anal opening 5 μm long, located about 8 times its length from base of medial lobes, occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Medial lobe and lobe 2 worn, notching uncertain, lobe 3 with 2 notches, lobe 4 with 3 notches, lobe 5 without notches; 2 small projections anterior of lobe 5. Gland-spine formula 2–2–2, with 2 between medial lobes. Fourth space with 3 pointed processes, anterior 2 each with microduct; anterior gland-spine in third space similar in appearance to anterior processes in fourth space. Pygidial venter with 1 microduct on each side of segment 3, 1 on each side of segment 4, absent from segment 5. Paraphyses on lobes from longest to shortest: 2, 3=4, 1; interlobular paraphysis formula 1–1–1.

Description based on 1 specimen.

First instars (fig. 16B)

Description. Body 189 and 195 μm long, 122 and 134 μm wide. Pygidium with 2 pairs of lobes, second lobes each with medial notch and 3 or 4 (3) lateral notches; third lobes with 2 or 3 (2) notches. Plates absent. Distance between posterior apex of anal opening and base of second lobes 18 and 20 μm. Antennae 60–65 (63) μm long; apical segment 33–35 (34) μm long; antennal length/apical segment length 1.7–1.9 (1.9). Hind leg 75–78 (76) μm long; hind trochanter + femur about 30 μm long; hind tibia + tarsus 23–24 (23) μm long; trochanter + femur length/tibia + tarsus length about 1.3.

Description based on three specimens from one locality.

Type-material. The holotype adult female is mounted alone on a slide. The left label states "*Crenulaspidiotus russellae*, On *Coccoloba incrassata*, Vicinity of Ennery, Haiti, E. C. Leonard, colr. Jan. 14, 1926. U.S.N.H. 1300202." (1st). The rigth label states "HOLOTYPE, *Crenulaspidiotus rus-*

sellae MILLER and DAVIDSON, DET. J. A. DAVIDSON, 1973: (USNM). There are nine paratypes including embryos on three slides (USNM).

Paratypes, DOMINICAN REPUBLIC: Edge of Savannah Higuey, *Coccoloba diversifolia*, 5. XII. 1909 (N. Taylor). HAITI: Grande Cayemite, *C. diversifolia*, VIII. 1927 (W. J. Eyerclam) (2nd); near Citronniers, *C. fuertesii*, 18. II. 1926 (E. L. Ekman).

Crenulaspidiotus sinuatus (Ferris)

Melanaspis sinuata FERRIS, 1941: SIII–365, 1942: SIV–446, 1943: 64.
Crenulaspidiotus sinuata (FERRIS); BORCHSENIUS, 1966: 359; DAVIDSON, 1970: 500.

Field features. According to FERRIS (1941) "Occurring concealed beneath bark flakes and actually within the soft bark of the host. Scale of the female of the type common to the genus, [*Melanaspis*] that of the male not recognized". FERRIS' illustration shows a black scale cover with central, dark exuviae.

Third instar females (adults) (fig. 11)

Description. Mounted 0.5–1.1 (0.9) mm long, 0.5–1.0 (0.8) mm wide. Body margin of prepygidium crenulate from base of pygidium to level of posterior spiracle. Pattern on dorsosubmargin of segment 3 composed of nearly parallel lines, pattern without groove, extending to posterior margin of lobe 5 area. Prepygidial dorsum with 1 size of microduct, smaller than ventral microducts, occurring along body margin, sometimes in clusters; 0–2 cicatrices on each side of body. Eyes absent. Prepygidial venter with 1 size of microduct located in areas near spiracles, mouthparts, and on posterior segments near body margin. Pygidium with anterior margin nearly straight, not protruding into prepygidium. Pygidial dorsum with 11, 10, or 8 sclerotized areas, areas 1 and 3 may be absent. Anal opening 6–8 (7) μm long, located 7–9 (8) times its length from base of medial lobes, occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 4 pairs of lobes, medial lobes normally with 1 lateral and 1 medial notch, rarely with 2 lateral notches, lobe 2 with 2 lateral notches, lobe 3 with 2–4 lateral notches, lobe 4 with 3 or 4 lateral notches, lobe 5 area with broad, sclerotized protrusion with 1 microduct, area anterior of seta marking segment 4 normaly developed into rounded lobe. Gland-spine formula 3–3. Fourth space with 3 gland spines of same general structure as those in second and third spaces, rounded processes absent. Pygidial venter with row of 5–8 (6) microducts on each side of segment 3, 5 or 6 (5) microduct on each side of segment 4, absent from segment 5. Paraphyses on lobes from longest to shortest: 2, 3, 4, 1 or 2, 4, 3, 1;

interlobular-paraphysis formula 1–2–2, lateral paraphysis in third space small, inconspicuous.

Description based on 4 specimens from type locality only.

Second instars (fig. 14C)

Description. Same as adult female except: Mounted 0.3 mm long, 0.3 mm wide. Body margin without crenulations. Pattern on dorsosubmargin of segment 3 conspicuous, composed of nearly parallel lines, extending to posterior margin of lobe 5 area. Prepygidial dorsum with microducts of 2 sizes, 1 or 2 of larger size in line near area overlying posterior spiracles, smaller size in submarginal area of anterior abdomen and thorax; 1 cicatrix. Eyes represented by clear area on derm. Prepygidial venter with large microducts rare, located near mouthparts. Anal opening 7 μm long, located 7 times its length from base of medial lobes; occurring anterior of imaginary line drawn between apices of second-lobe paraphyses. Medial lobe with 1 lateral notch, absent medially, lobe 2 with 2 notches, lobe 3 with 2 notches, lobe 4 with 2 notches, lobe 5 represented by membranous projection, without notches; without protrusion anterior of position of lobe 5. Gland-spine formula apparently 3–2–2 with 2 between medial lobes. Fourth space with 2 low processes, anterior process with 1 microduct similar to anterior 2 gland spines in third space. Pygidial venter with 1 microduct on each side of segment 3, 1 on each side of segment 4, absent from segment 5. Paraphyses on lobes from longest to shortest — 2, 3, 1, 4, interlobular-paraphysis formula 1–1–1 or 1–1–0.

Description based on 1 female.

First instars (fig. 16C)

Description. Body 226–275 (255) μm long, 164–195 (177) μm wide. Pygidium with 2 pairs of lobes; second lobes each without medial notch, with 3 or 4 lateral notches; third lobes with 1–4 (2) notches. Space between lobes 2 and 3 with 1 plate. Distance between posterior apex of anal opening and base of second lobes 16–19 (18) μm. Antenna 69–83 (76) μm long; apical segment 50–56 (53) μm long; antennal length/apical segment length about 1.5. Hind leg 78–93 (87) μm long; hind trochanter + femur 34–38 (35) μm long; hind tibia + tarsus 28–30 (28) μm long; trochanter + femur length/tibia + tarsus length 1.2–1.4 (1.3).

Description based on 5 specimens from 1 locality.

Type-material. From the syntypes we have chosen and marked as lectotype an adult female with the left label containing a map of the position of the lectotype and "*Crenulaspidiotus sinuata* (FERRIS), LECTOTYPE, DET.

J. A. DAVIDSON". The right label states "*Melanaspis sinuata* n. sp. TYPE, On indet. tree, Pedregal, near David, CHIRIQUI PROVINCE, PANAMA, E.J.C., FERRIS 1938 No. 302" (UCD). The lectotype slide contains 4 specimens; the specimen nearest the right side of the coverslip is the lectotype and the others are considered paralectotypes.

Paralectotypes on slide with holotype.

Crenulaspidiotus truncus sp. n.

Etymology. The species epithet is a noun in apposition and is Latin for "truncate end". It refers to the truncated, posterior end of area 5 that is diagnostic of this species.

Field features. No information available.

Third instar females (adults) (fig. 12)

Description. Holotype, mounted, 0.4 mm long (paratypes 0.4–1.0 (0.6) mm), 0.4 mm wide (paratypes 0.3–0.7 (0.5) mm). Body margin of prepygidium with 5 gland tubercles on each side of body from base of pygidium to level of posterior spiracle (paratypes 3–11 (8) gland tubercles). Pattern on dorsosubmargin of segment 3 composed of series of nearly parallel lines, pattern without groove, extending to anterior margin of lobe 5. Prepygidial dorsum with 1 size of microduct, smaller than those on venter, scattered around submargin to level of clypeolabral shield; 2 cicatrices on each side of body. Eyes protruding, sclerotized, with 2 small points. Prepygidial venter with microducts of 1 size, few near mouthparts and in mediolateral area posterior of hind spiracle. Pygidium with anterior margin nearly straight, not protruding into prepygidium. Pygidial dorsum with 10 sclerotized areas, area 1 absent, area 5 with transverse furrow near pygidial margin connecting areas 4 and 6. Anal opening 8 μm long (paratypes 5–8 (9) μm), located 4 times its length from base of medial lobes (paratypes 4–8 (6) times), opening occurring on or posterior of imaginary line drawn between apices of second-lobe paraphyses. Pygidium with 5 pairs of lobes, medial lobe with 2 lateral notches and 1 medial notch (paratypes 0 or 1), lobe 2 with 2 lateral notches (paratypes 2 or 3), lobe 3 with 2 notches (paratypes 2 or 3), lobe 4 with 2 notches (paratypes 3–5), lobe 5 with 7 notches (paratypes 7–11), spurs or points absent anterior of lobe 5. Gland-spine formula 3–3. Fourth space with 3 flat processes, barely protruding above interlobular surface, each with microduct. Pygidial venter with row of 6 microducts on each side of segment 3 (paratypes 3–7 (5)), 9 microducts on 1 side of segment 4, 7 on other (paratypes 6–10 (8)), absent from segment 5. Paraphyses on lobes from longest to

shortest: 2, 1, 3, 4; paraphysis on medial lobe indefinite apically; interlobular-paraphysis formula 1–2–2–2.

Variation. Paratypes may have gland tubercles anterior to level of anterior spiracle; submarginal microducts on dorsum may extend to level of antennae; 4 eyes on 1 paratype, eyes have 1–3 sclerotized points; cicatrices vary from 0–2 on each side of body; ventral prepygidial microducts sometimes slightly more numerous than on holotype, often several ducts posterior of labium; area 1 sometimes present; occasionally 1 or 2 small spurs or points on the margin anterior of lobe 5; paraphysis attached to medial lobe quite variable, may be much shorter than those on holotype; paraphyses attached to lobes from longest to shortest may vary considerably; interlobular-paraphyses formula may be 1–2–3–0, 1–2–3–3, or 1–2–2–0, paraphyses in fourth space often inconspicuous or absent.

Description based on 59 specimens from 27 localities.

Second instars (fig. 14D)

Description. Same as adult female except: Mounted, 0.3–0.6 (0.5) mm long, 0.3–0.6 (0.4) mm wide. Margin of prepygidium without tubercles. Pattern on dorsosubmargin of segment conspicuous, composed of series nearly parallel lines, extending to posterior margin of lobe 5 or anterior margin of segment 4. Prepygidial dorsum with 1 size of microduct on some specimens, 2 sizes on others, larger ducts, when present, forming mediolateral line on anterior abdominal and posterior thorax, smaller ducts on or near body margin; 0–1 cicatrices. Eye consisting of small, lightly sclerotized area, 0–2 sclerotized points. Prepygidial venter with microducts of large size in mediolateral line and near body margin on posterior thorax and anterior abdomen and near mouthparts. Area 5 separated from pygidial margin by unique transverse furrow connecting areas 4 and 6. Anal opening 4–7 (5) μm long, located 3–6 (4) times its length from base of medial lobes, occurring posterior of or touching imaginary line drawn between apices of second-lobe paraphyses. Medial lobe with 1 or 2 lateral notches, medial notch absent, lobe 2 with 1 or 2 notches, lobe 3 with 1–3 notches, lobe 4 with 3–7 notches, lobe 5 with 8–12 notches, 2 or 3 slender spurs anterior of lobe 5. Gland-spine formula apparently 3–3–2, with 2 between medial lobes. Fourth space with 3 relatively flat processes, anterior 2 each with microduct, gland spines in third space unlike fourth space processes. Paraphyses on first lobes with apical portion less sclerotized than basal portion; paraphysis on lobe 4 often absent; interlobular-paraphysis formula variable, normally 1–1–1, also 1–2–0, 1–2–1, and 1–2–2.

Based on 9 specimens from 5 localities.

First instars (fig. 16D)

Description. Body 183–213 (201) μm long, 122–165 (148) μm wide. Pygidium with 2 pairs of definite lobes, third pair represented by small projection near dermal opening of tubular duct on segment 6, second lobes each without medial notch, with 3–5 (4) lateral notches; third lobes with 1–4 (2) notches. Space between second lobes with 1 plate. Distance between posterior apex of anal opening and base of second lobes 13–18 (16) μm. Antennae 57–70 (64) μm long, apical segment 38–44 (40) μm long; antennal length/apical segment 1.5–1.6 (1.6). Hind leg 73–86 (79) μm long; hind trochanter and femur 33–39 (35) μm long; hind tibia and tarsus 23–28 (24) μm long; trochanter + femur length/tibia + tarsus length 1.4–1.5 (1.4).

Description is based on 26 specimens from 11 localities.

Type-material. The holotype adult female is on a slide with three paratypes; the holotype is on the upper, right side of the cover slip. The left label states "*Crenulaspidiotus truncus* MILLER and DAVIDSON, on *Coccoloba uvifera*, Saetia, Oriente, Cuba; Patricio & Carden Coll., April 10, 1922 — 342". The right label has a map of the position of the holotype and "HOLOTYPE and 3 paratypes, DET. J. A. DAVIDSON, 1973" (USNM). There are 92 paratypes including embryos on 38 slides; at least one slide is deposited in the BMNH, CDA, FSCA, MHN, MNHN, SA, UCD, UH, USNM, VPI, ZI, ZMH.

Paratypes, CUBA: South slope of Cajalbana, *Coccoloba* sp., 6.I. V. 1915 (Leon and Charles) (1st); Cayajabos, Loma Telada, *C. retusa*, 10. VIII. 1928 (Leon); Camaguey, *C. diversifolia*, 17. III. 1908 (J. A. Shafer); near Central Manate, woods in Sabaualamas, *C. diversifolia*, 6. VI. 1933 (Leon); near Cueva de Ama, *C. retusa*, 1. VIII. 1935 (R. Bucher); La Coloma, edge of Maglares, *C. reflexiflora*, 28. X. 1923 (E. L. Ekman); Loma del Gato, *C. retusa*, 4. VIII. 1924 (Leon); Loma del Gato, *C. saxicola*, 10. VII. 1931 (G. C. Bucher); Loma del Gato, *C. Wrightii*, 14. VIII. 1921 (Leon and Clement) (1st, 2nd); in Manacales at Rio Piloto, Sierra de Nipe, *C. retusa*, 16. XII. 1915 and 1. X. 1919 (E. L. Ekman) (1st); Minas, Cuabal de Jesus Maria, *Coccoloba* sp., 19. VIII. 1928 (Leon) (2nd); Minas, Cuabal de Soloman, *Coccoloba* sp., 9. I. 1929 (Leon); Monte Verde, *C. costata*, I. 1859 (C. Wright) (2nd); near Mordazo, *Coccoloba* sp., 29. XII. 1915 (Leon and Cazanos) (1st, 2nd); forest near Nagua, *C. retusa*, 13. VIII. 1922 (E. L. Ekman) (1st); Nagua, on Rio Yara, Sierra Maestra, *C. retusa*, 13. VIII. 1922 (E. L. Ekman); Saetia, *C. uvifera*, 10. IV. 1916 (P. Cardin); in Sierra Maestra, Oriente Province, *C. Wrightii*, 17. VII. 1918 (E. L. Ek-

man) (1st); Sierra Nipe, *C. costata*, 8. XII. 1909 (J. A. Shafer) (1st); Sierra Nipe, at Rio Yimbambay, *C. retusa*, 19. IX. 1922 (E. L. Ekman); Yagua, Sierra Maestia, *C. retusa*, 13. VIII. 1922. HAITI: Trail to Morne Rochelis, Miragoaue vicinity, *C.diversifolia*, 9. IX. 1927 (W. J. Egerdam); Port do Paix, *C. leoganensis*, 4. 1. and 5. III. 1925 (E. L. Ekman) (1st); St. Michel de l'Atalaye vicinity, *C. buchii*, 20. XI. 1925 (E. C. Leonard) (1st). DOMINICAN REPUBLIC: Santo Domingo, *C. nodosa*, 1. III. 1871 (Wright, Parry, Brummel) (1st); Sosua, *C. uvifera*, 22. XII. 1974 (H. E. Martin).

DENDOGRAMS

Characters used to construct the phenogram are given in the character martices (tables 1–3) and were chosen on the basis of their use in the species description, i.e., a character used to distinguish among species was also used in the phenogram. Similarity matrices were constructed for each of the first, second, and third instars; a matrix summarizing these data is given in table 4.

The phenogram (fig. 19) was formulated by the complete linkage method. Placement of *C. cyrtus* and *C. greeneri* is based on an analysis of similarity of third instars alone. There are two possible phenograms based on our data and method of analysis. The alternative not given in fig. 19 is a single step difference of *C. monocentron*. *C. anticheir* or *C. truncus* share at least 25 character states with each of *C. dicentron* and *C. sinuatus*. If one chooses to use this similarity relationship rather than the relationship of *C. monocentron* sharing at least 25 character states with each of *C. dicentron* and *C. sinuatus* then *C. monocentron* shares 24 character states with each of *C. anticheir*, *C. truncus*, *C. dicentron*, and *C. sinuatus*.

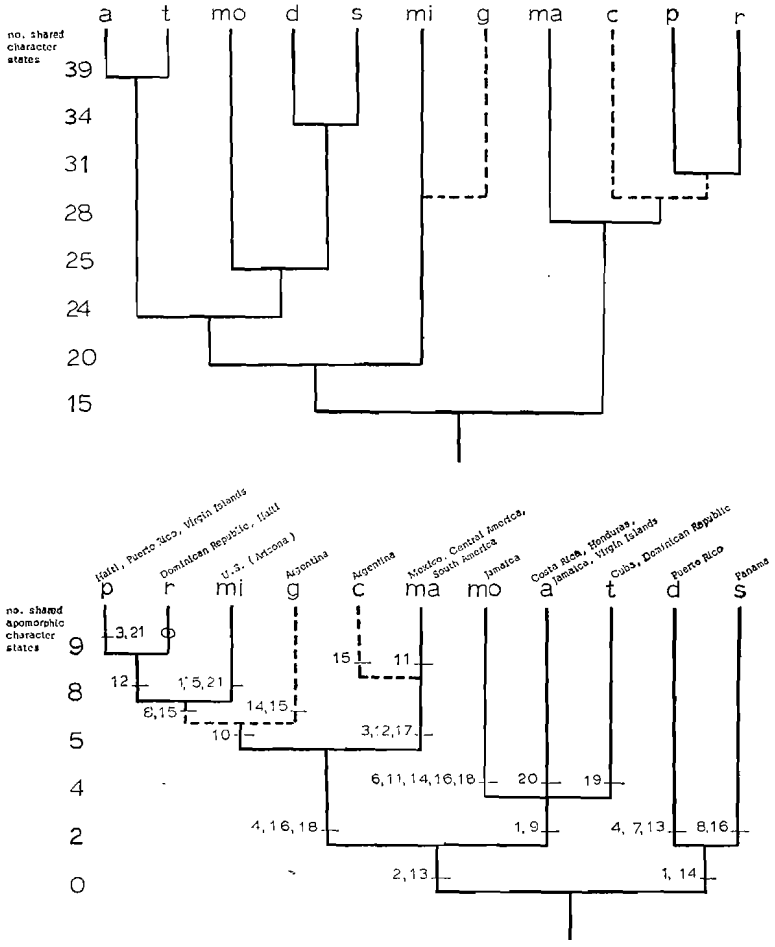
Characters used to construct the cladograms are as follows:

First instars

1. Second-lobe notching: o — lateral and medial, 1 — lateral only.
2. Means of length of apical antennal segment: o — longer than 50 μm, 1— shorter than 50 μm.

Second instars

3. Fifth lobe: o — membranous or sclerotized, 1 — absent or with a few small projections.
4. Fourth-space processes: o — simple protrusions, 1 — large, well developed.
5. Medial-lobe notches: o — present, 1 — absent.



19. Phenogram showing similarities (top) and cladogram showing hypothetical relationships (bottom) of species of *Crenulaspidiotus*. a — *C. anticheir*, c — *C. cyrtus*, d — *C. dicentron*, g — *C. greeneri*, ma — *C. maurellae*, mi — *C. mini*, mo — *C. monocentron*, p — *C. portoricensis*, r — *C. russellae*, s — *C. sinuatus*, t — *C. truncus*. Dotted lines are lineages inferred from adult female data only

6. Gland tubercles: o — absent, 1 — present.
7. Dermal pattern on dorsosubmargin near lobe 5: o — present, 1 — absent.
8. Anal-opening position in relation to apex of second lobe paraphysis: o — posterior or at same level, 1 — anterior.

Adult females

9. Gland tubercles: o — absent, 1 — present.
10. Prepygidial lobes: o — absent, 1 present.
11. Dorsomedial microducts on prepygium: o — absent or few, 1 — abundant.
12. Anterior margin of pygidium: o — straight or nearly straight, 1 — convex.
13. Fifth lobes: o — membranous, 1 — well developed or a series of points.
14. Mean of length + width of body: o — 14 μm or less, 1 — more than 14 μm.
15. Lateral margin of segment 3: o — nearly straight, 1 — convex.
16. Position of anal opening in relation to apex of second-lobe paraphysis: o — posterior or at same level, 1 — anterior.
17. Ventral microducts on segment 5: o — absent, 1 — present.
18. Prepygidial ventral microducts: o — sparse or absent, 1 — abundant.
19. Transverse submarginal furrow connecting areas 4 and 6: o — absent, 1 — present.
20. Sclerotized area 2 with a thumb-like process: o — absent, 1 — present.
21. Medial-lobe paraphysis in relation to lobe 2 paraphysis: o — shorter, 1 — as long as or nearly so.

Using these characters, a character matrix (table 5) and a similarity matrix (table 6) have been formed. For each character "o" is the plesiomorphic state and "1" is the apomorphic state.

Initially all characters used to formulate the phenogram were considered as potentially useful for cladistic analysis. However, it soon became evident that we could not make reasonable assessment of the polarity of many character states. Therefore, we limited our analysis to those states that could be interpreted with reasonable certainty. Our judgements on polarity are based on what we believe to be general trends in the diaspidids and on the belief that *Melanaspis* is closely related to *Crenulaspidiotus*. We have not attempted to examine the latter assumption in detail but suspect that the two genera are sister groups. We do not believe

that "*Melanaspis*" *williamsi*, "*Crenulaspidiotus*" *phyllanthi*, *Pygidiaspis*, or *Greenoidea* are more closely related to *Crenulaspidiotus* than *Melanaspis*.

Two methods of analysis were undertaken in building the cladogram. The first is described by CAMIN and SOKAL (1965). The second is essentially a complete linkage analysis of shared apomorphic character states, except all members of a group must share the apomorphic state to be scored as similar (WISS method). The two methods give very similar results. The cladogram given in fig. 20 was developed using the modified complete linkage method. Placement of *C. cyrtus* and *C. greeneri* is based on analysis of relationship of third instars alone.

The cladogram has some obvious weaknesses but does suggest three groups of species, i. e., *dicentron-sinuatus*, *cyrtus-greeneri-maurellae-mini-portoricensis-russellae*, and *anticheir-truncus-monocentron*. Perhaps when additional species of *Crenulaspidiotus* are described and a better understanding of phylogenetic relationship of taxa within the *Diaspididae* is acquired, it may be possible to formulate a more definitive cladogram of *Crenulaspidiotus*.

COMPARISON OF SPECIES

The cladogram and phenogram respectively give graphic representations of phylogenetic and overall similarity relationships. In comparing species it is possible therefore to make objective statements relevant to apparent phyletic and similarity relationships based on the presented data. For example, *C. russellae* is apparently closely related to and most similar to *C. portoricensis*. In several cases statements of phyletic and phenetic relationship are dissimilar in *Crenulaspidiotus*. For example, *C. anticheir* is apparently closely related to *C. truncus* but is similar to *C. truncus* and *C. monocentron*. These dissimilarities may be the result of our somewhat deficient analysis or because of differences in the methods themselves. A system that has many convergent characters may give divergent phenetic and phylogenetic comparisons since convergent characters may be disregarded in cladistic analysis but are included in phenetic analysis. Also in cladistic analysis only apomorphic states are considered but in phenetics both apomorphic and plesiomorphic states are used. Since plesiomorphic states potentially can appear anyplace on a dendogram on clades radiating from the state's first appearance, plesiomorphic states behave similarly to convergences. Cladistic analyses would be uneffected by such plesiomorphic "convergences" whereas phenetic analysis might be greatly effected.

DISTRIBUTION

Species of *Crenulaspidiotus* occur on the Greater Antilles and on the mainland from Arizona and Mexico to Argentina. A comparison of distribution data with the cladogram suggests that invasion of the Greater Antilles has occurred on several occasions by alternative routes. The *sinuatus-dicentron* group is unsatisfactorily defined cladistically, hence no use-

20. Map of distribution of *Crenulaspidiotus*. Species legend as in fig. 19

ful statement can be made regarding its mainland-island vicariance or of the geographic relationships with other members of the genus. The *anticheir-truncus-monocentron* and *maurellae-cyrtus-greeneri-mini-russellae-portoricensis* groups seem to be largely vicarious Central American-South

American groups, the first entering the Greater Antilles via Jamaica from Central America, and the second via Puerto Rico from South America. The former group includes one species that occurs both on Jamaica and Central America, not an unusual or unexpected distribution pattern. In the latter the *Coccoloba*-infesting species conform to the suggested vicariance pattern, but the *Prosopis*-infesting species (*C. mini*) does not. Perhaps when more species are described or additional records of *C. mini* are recorded, this discrepancy will disappear.

HOSTS

Little can be stated about the hosts of *Crenulaspidiotus*. The presence of species on the seemingly unrelated genera *Coccoloba* (*Polygonaceae*) and *Prosopis* (*Leguminosae*) suggests that other hosts remain to be recorded, although *Prosopis* and *Coccoloba* may share some unusual characteristics unknown to us that allow *Crenulaspidiotus* species to invade them.

While checking the names of the *Coccoloba* hosts, Dr. Howard observed, "The insects seem not to occur on the paniculate inflorescence types of *Coccoloba*, or on the lianas or the pubescent leaves." This is an observation that deserves further investigation.

THE *C. MINI* PROBLEM

The placement of *C. mini* is a problem. In the cladogram it is well integrated into the *maurellae-cyrtus-greeneri-mini-russellae-portoricensis* group, whereas in the phenogram it is most closely associated with the *anticheir-truncus-monocentron-dicentron-sinuatus* group. It is further discordant by the fact that it occurs on a host other than *Coccoloba* and is ancestrally related to a group that is otherwise South American or Antillean in distribution. Hopefully additional information will solve this enigma.

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Table 1. Character matrix of adult females. +, − = structure present or absent or value greater than or less than mean. a — *Crenulaspidiotus anticheir*, c — *C. cyrtus*, d — *C. dicentron*, g — *C. greeneri*, ma — *C. maurellae*, mi — *C. mini*, mo — *C. monocentron*, p — *C. portoricensis*, r — *C. russellae*, s — *C. sinuatus*, t — *C. truncus*

Character	a	c	d	g	ma	mi	mo	p	r	s	t
$\bar{X}$ of body length	−	−	+	+	+	−	+	−	−	+	−
$\bar{X}$ of body width	−	−	+	+	−	−	+	−	−	+	−
Crenulations	−	+	−	+	+	+	−	+	−	+	−
Gland tubercles	+	−	−	−	−	−	+	−	−	−	+
Lateral margin of segment 3 conspicuously convex	−	+	−	+	−	+	−	+	+	−	−
Prepygidial lobes	−	−	−	+	−	+	−	+	+	−	−
Dorsomedial microducts (md) abundant	−	−	−	−	+	−	+	−	−	−	−
Ventromedial md abundant	−	+	−	+	+	+	+	+	+	−	−
Anterior margin of pygidium protruding	−	+	−	−	+	−	−	+	+	−	−
$\bar{X}$ of anal opening (ao) length	−	+	−	+	+	+	+	+	−	−	−
Ao anterior of apex of 2nd lobe paraphysis	−	+	−	+	+	+	+	+	+	+	−
Lobe 5 present or variable	+	−	+	+	−	+	+	−	+	−	+
Fourth-space processess knoblike	+	+	+	−	+	−	+	+	+	−	−
No. of 4th space processes	4	4 or 5	3	3	4 or 5	4	4	4	3	3	3
$\bar{X}$ no. md on segment 3	−	+	−	+	+	−	+	−	−	+	−
$\bar{X}$ no. md on segment 4	−	+	−	−	+	−	+	+	+	−	−
Md on segment 5	−	+	−	−	+	−	−	−	−	−	−
Longest 2 lobe paraphyses	2, 1	2, 3	2, 3	2, 3	2, 3	1, 2	2, 3	2, 1	2, 3	2, 3	2, 1 or 1, 2
Interlobular paraphysis formula 1–2–2	+	+	+	+	−	±	−	±	+	+	+

Table 2. Character matrix of second instars. +, − = structure present or absent or value greater than or less than mean. Species legend as in table 1

Character	a	d	ma	mi	mo	p	r	s	t
Gland tubercles	−	−	−	−	+	−	−	−	−
Prepygidial lobes	−	−	−	+	−	+	+	−	−
Pattern on dorsosub-margin near lobe 5	+	−	+	+	+	+	+	+	+
Pattern reaching posterior margin of lobe 5	−	−	+	+	−	−	−	+	+
Two sizes of dorsal microducts	+	+	+	−	+	±	+	+	+
$\bar{X}$ of distance from medial lobe to anal opening (ao)	−	−	+	−	+	−	−	−	−
Ao anterior of apex of 2nd lobe paraphysis	−	−	−	+	−	+	+	+	−
Lobe 5 membranous	−	−	−	+	−	−	+	+	−
Lobe 5 series of points	−	−	+	−	−	+	−	−	−
Lobes 1 and 2 with notches	+	+	+	−	+	+	+	+	+
Gland-spine formula	2-2	3-3	2-2	3-3	3-2	2-2	2-2	3-2	3-3
No. of 4th space processes	3	3	3	3	3	3	3	2	3
Fourth space processes of similar shape to 3rd space gland spines	+	−	−	+	−	−	+	+	−
Medial-lobe paraphysis about same length as 2nd lobe paraphysis	−	−	−	+	−	+	−	−	±

Table 3. Character matrix of first instars. +, − = structure present or absent or value greater than or less than mean. Species legend as in table 1

Character	a	d	ma	mi	mo	p	r	s	t
$\bar{X}$ of body length	−	+	−	+	+	+	−	+	−
$\bar{X}$ of body width	−	+	−	−	+	+	−	+	−
No. of lobes	2	2	3	2	2	3	2	3	2
Second lobes with medial notch	−	−	+	−	−	+	+	−	−
Second lobes with more than 1 notch	+	+	+	−	+	+	+	+	+
Plates between 2nd lobes	−	−	−	+	−	+	−	−	−
No. plates between 2nd and 3rd lobes	1	2	0	1	1	2	0	1	1

Character	a	d	ma	mi	mo	p	r	s	t
$\bar{X}$ of distance from medial lobe to anal opening	−	+	+	−	−	+	+	±	±
$\bar{X}$ of antennal length	−	+	−	+	+	+	−	+	−
$\bar{X}$ of length of apical antennal segment	−	+	−	−	−	−	−	+	−
$\bar{X}$ of length of hind tibia + tarsus	−	+	−	+	+	+	−	+	−
$\bar{X}$ of antenna length/ apical segment length	−	−	−	+	+	+	+	−	−
$\bar{X}$ length of hind femur + trochanter	−	+	−	+	+	−	−	+	+
$\bar{X}$ length of hind leg	−	+	−	+	+	−	−	+	−

Table 4. Similarity matrix of adult females, second instars, and first instars. Species legend as in table 1

Species	a	d	ma	mi	mo	p	r	s	t
a	×	30	25	23	25	22	31	25	39
d		×	19	21	29	25	23	34	32
ma			×	15	25	28	29	20	24
mi				×	20	29	26	25	27
mo					×	21	20	25	24
p						×	31	19	21
r							×	19	28
s								×	25
t									×

Table 5. Character matrix giving cladistic interpretation of character states. 0 — plesiomorphic, 1 — apomorphic. Species legend as in table 1

Character No.	a	c	d	g	ma	mi	mo	p	r	s	t
1	1		1		0	1	1	0	0	1	1
2	1		0		1	1	1	1	1	0	1
3	0		0		1	0	0	1	0	0	0
4	0		0		1	1	0	1	1	0	0
5	0		1		0	1	0	0	0	0	0
6	0		0		0	0	1	0	0	0	0
7	0		0		0	0	0	0	0	0	0
8	0		1		0	1	0	1	1	1	0
9	1	0	0	0	0	0	1	0	0	0	1
10	0	0	0	1	0	1	0	1	1	0	0
11	0	0	0	0	1	0	1	0	0	0	0
12	0	1	0	0	1	0	0	1	1	0	0
13	1	1	1	1	1	1	1	1	1	0	1
14	0	0	1	1	0	0	1	0	0	1	0
15	0	1	0	1	0	1	0	1	1	0	0
16	0	1	0	1	1	1	1	1	1	1	0
17	0	0	1	0	0	1	0	0	0	0	0
18	0	1	0	1	1	1	1	1	1	0	0
19	0	0	0	0	0	0	0	0	0	0	1
20	1	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	1	0	1	0	0	0

Table 6. Similarity matrix of apomorphic characters. Species legend as in table 1

Species	a	d	ma	mi	mo	p	r	s	t
a	×	2	2	3	4	2	2	1	4
d		×	3	3	3	2	2	2	2
ma			×	5	5	7	6	1	2
mi				×	5	9	8	3	3
mo					×	4	4	3	4
p						×	9	2	2
r							×	2	2
s								×	1
t									×

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