Descriptions of the First Instars of the North American Species of *Rugaspidiotinus* (Homoptera: Coccoidea: Diaspidiadae)[1]

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ABSTRACT First instars of three North Amercian species of the *Rugaspidiotinus* Balachowsky are described and illustrated. Based on descriptions of their first isntars, *Rugaspidiotus sculpturatus* Ferris and *R. nebulosus* Ferris are here transferred to the genus *Rugaspidiotinus*.

KEY WORDS Coccoidea, diaspididae, *Rugaspidiotus, Rugaspidiotinus,* armored scale, scale insect.

The genus *Rugaspidiotus* is defined by the type species *R. arizonicus* (Cockerell). A previous examination of the first instar of this species (Howell, et al., 1986) indicated that its placement in the tribe Diaspidini should be seriously questioned. The first instars of other species tentatively assigned to that genus by Ferris (*R. circumdatus, R. nebulosus,* and *R. sculpturatus*) also bear little resemblence to those in the Diaspidini, but are similar in several important characteristics with the Odonaspidinae. Both Takagi (1969) and Balachowsky (1953) considered *Rugaspidiotus* to be allied with the Odonaspidinae, and I concur with that hypothesis.

A serious problem exists, however, with the generic placement of 2 species which are presently assigned to *Rugaspidiotus*. When Ferris (1938) described the four additional species in this genus, he stated that there was a strong possibility these new species were not congeneric with the type. However, he made no attempt to elucidate his concerns. In 1953, Balachowsky proposed the genus *Rugaspidiotinus* for two of the aberrant species described by Ferris (*R. circumdatus* Ferris and *R. fuscitatis* Ferris), naming *R. circumdatus* as its type. He separated his new genus from *Rugaspidiotus* by the presence of microspores and macrospores of differing sizes on the pygidium. An examination of the first instars of *Rugaspidiotus sculpturatus* Ferris and *Rugaspidiotus nebulosus* show remarkable similarities with *R. circumdatus,* the type species of Balachowsky's *Rugaspidiotinus*. As a result of this work, both *R. sculpturatus* and *R. nebulosus* are here placed in *Rugaspidiotinus*. The first instars of these species differ significantly from *R. arizonicus* and from the subtribe Odonaspidinae as well. This evidence supports Balachowsky's 1953 work.

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Rugaspidiotinus Balachowsky
Type Species: *Rugaspidiotus circumdatus* (Ferris)

Characteristics of the First Instars:

First instars of all known species have the following characteristics in common which differ from the type of *Rugaspidiotus*, and from the Odonaspidinae:

1. Presence of gland spines (also present in the Diaspidinae)
2. Middorsal setae present on abdominal segments 2-7 (present in the Diaspidinae)
3. Absence of dorsal submedian ducts on abdominal segment 2 (also absent in the Diaspidinae)
4. Terminal antennal segment not annulate (variable in the Diaspidinae)
5. Sclerosis, or roughening of the derm ventrally near coxae of metathorax (possibly analogous to the "cruciform pore" of *Haliaspis* in the Chionaspidina:Diaspidinae)
6. Tibial length almost equal to that of tarsus (As presently understood, the tarsal length varies from about 1.7 to 3 times the tibial length in the Diaspidinae)

The following descriptions are based on 10 representative specimens for each species. All measurements are given in microns and represent the range. Each figure has a central drawing for the whole first instar, the left half representing the dorsal surface and the right half the ventral surface. Around this central drawing, certain taxonomic features are drawn to a much larger scale to show details of those morphological characteristics. Drawings are not made to the same scale, and the dermal structures and enlargements are not in direct proportion to each other.

Rugaspidiotinus circumdatus (Ferris)

Rugaspidiotus circumdatus Ferris: Ferris, 1938; *Rugaspidiotinus circumdatus* (Ferris): Balachowsky, 1953.

First Instar (Fig. 1)

Mounted specimens elongate oval. Length 362 - 411, width 197-219. Derm membranous. Anal opening small, removed ca. 3x its diameter from pygidial apex. On the venter, a roughened slightly sclerotized area is present on the derm between the metathoracic coxa and the margin of the body. In position, it is similar to the cruciform pores of *Haliaspis*, and Stickney's (1934) "undermined sclerite" of Parlatoria.

PYGIDIAL MARGIN - No clearly defined pygidial lobes. Only a slight, membranous swelling suggests the presence of lobe 2. Segment 9 apparently indicated by a minute ventral seta. Marginal setae as illustrated, ca. 5 microns long on pygidium, slightly longer anteriorly. Caudal seta ca. 1/3 body length.

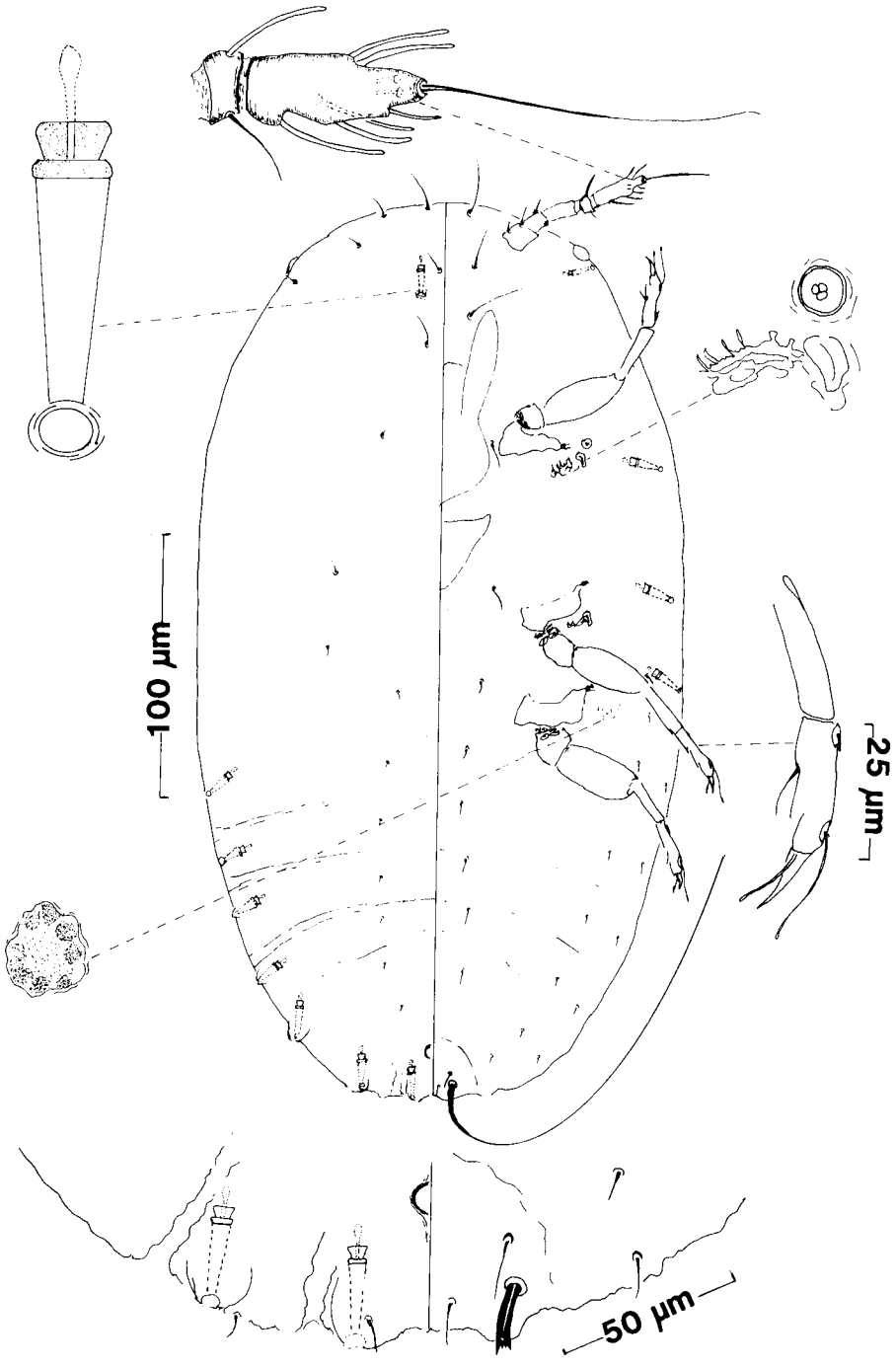

Fig. 1. *Rugaspidiotinus circumdatus* (Ferris), First Instar.

DORSAL SURFACE

Setae.- Marginal, 2 on anterior margin of head, 1 on each thoracic segment, and on abdominal segments 1-8. Submarginal, 2 on head, one of these just posterior to eye; and one each on abdominal segments 7-8. Submedian 2 on head, one on meso- and metathorax, one on each of abdominal segments 1-7.

Ducts.- Marginal, one on each abdominal segment 1-8. Submedial one on head.

VENTRAL SURFACE:

Antenna.- Five-segmented, the third segment usually at least twice as long as fourth, 5th slightly elongate, but not annulate. Segment 1 with two slender setae, segment 2 with a slender seta and an apical sensorium, 4 with one slender and one stout "fleshy" seta, 5 with 6 fleshy setae and one elongate apical seta, and with 2 invaginated setae.

Legs.- Leg I: Coxa 13.4-14.7, trochanter 12.1-17.4, femur 30.8-40.2, tibia 22.8-26.8, tarsus 20.1-26.8, claw 12.1-16.1. Total length 107-121. Leg II: Coxa 12.1-14.7, trochanter 14.7-20.1, femur 33.5-40.1, tibia 22.8-29.5, tarsus 19.3-26.8, claw 12.8-17.4. Total length 121-141. Leg III: Coxa 13.4-14.7, trochanter 16.1-21.4, femur 34.8-42.9, tibia 26.8-30.8, tarsus 22.8-28.1, claw 16.1-17.4, total length 126-142. Tibia and tarsus about the same length; tarsal and ungual digitules slightly knobbed. Tarsus of each leg with proximal campaniform sensillum and one slender seta. Trochanter roughly triangular, with 1 slender seta and 2 basal sensilla. Coxa 1 with 2 slender median setae ventrally, coxae 2 and 3 with 1; all coxae with a minute seta near anterolateral margin.

Spiracles.- Well defined, on pro and metathorax. Prothoracic spiracle with an associated trilocular pore.

Setae.- One marginal and 2 submedial on head; Submarginal one on each thoracic segment and abdominal segments 1, 8, and 9, and 2 on other abdominal segments. Submedian, 2 on head, 1 on meso- and metathorax, 1 on each of abdominal segments 2-7.

Ducts.- 1 lateral tubular duct on each thoracic segment and on the head just posterior to the eye.

Material studied.- Type material, *Rugaspidiotus circumdatus* Ferris, 20 first instars on 20 slides, JOH-10-82, on *Franklinia,* Beach near Miller's Landing, Lower California, Northern District, March, 1934. 10 slides deposited in the R.M. Bohart Museum of Entomology, Department of Entomology, University of California, Davis. 5 slides deposited in the U.S. National Museum Collection, Beltsville, MD, 5 slides in the University of Georgia Collection in Griffin, GA Paratype material, *Rugaspidiotus circumdatus* Ferris, 11 first instars on 11 slides, JOH-04-82, on *Franklinia* (prob. *palmari*), Beach, Colnett Wash, Lower Calif., Mar. 1, 1934, Col. G.F. Ferris. 5 slides deposited in the R.H. Bohart Museum of Entomology, The University of California, Davis. 3 slides in the U.S. National Museum in Beltsville, MD., and 3 slides in the University of GA Collection in Griffin.

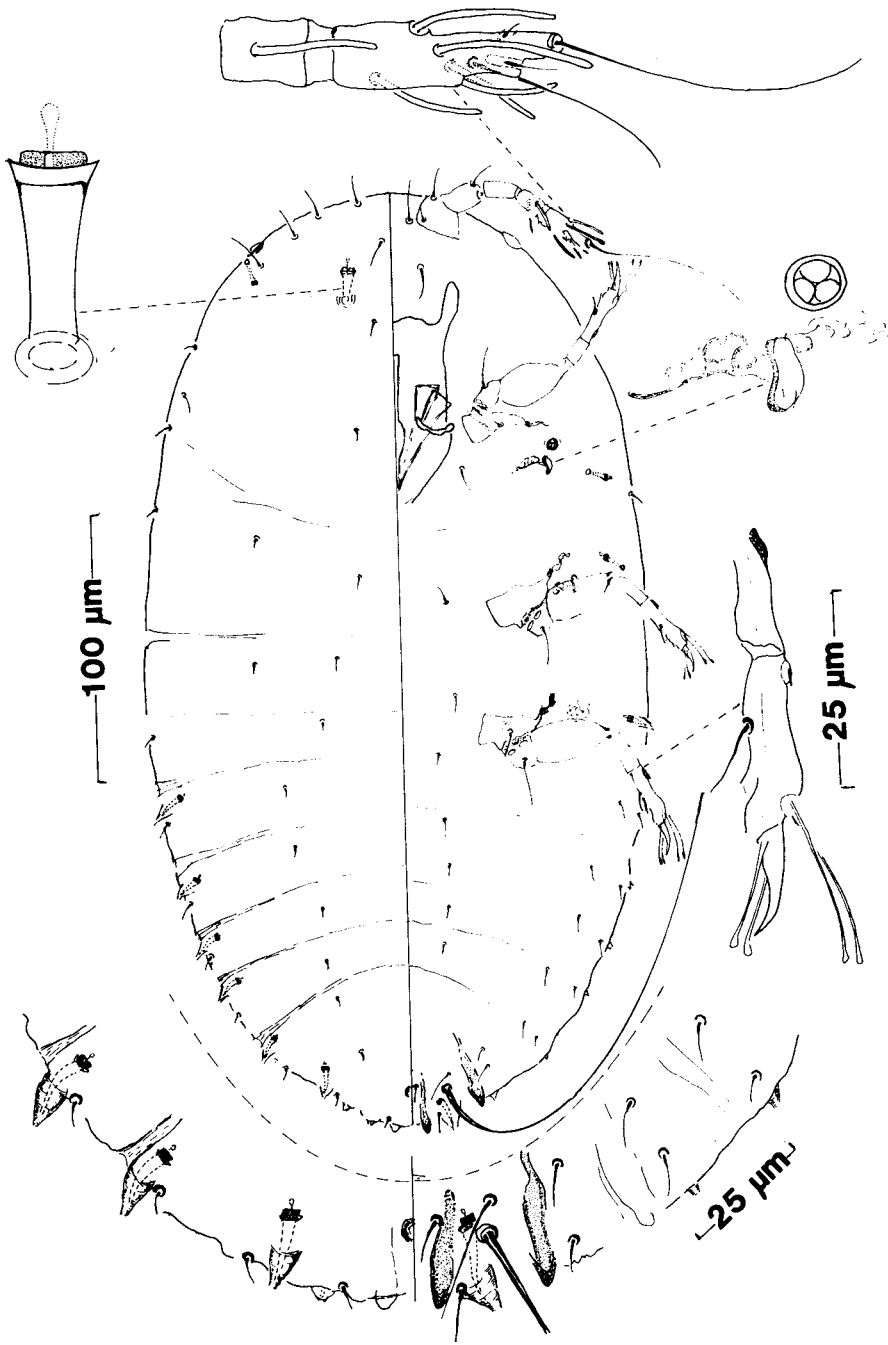

Fig. 2. *Rugaspidiotinus sculpturatus* (Ferris), First Instar.

Rugaspidiotinus sculpturatus (Ferris)
Rugaspidiotus sculpturatus Ferris: Ferris, 1938.

First Instar (Fig. 2)

Mounted specimens elongate oval. Length 370-442, width 188-241. Derm membranous. Anal opening small, removed ca. 3 x its diameter from pygidial apex. On the venter, a roughened slightly sclerotized area on first abdominal segment between the metathoracic coxa and body margin.

PYGIDIAL MARGIN- Lobes 2 and 3 well developed, sclerotized. Segment 9 apparently indicated by a minute ventral seta. Marginal setae as illustrated, ca. 8 microns long on pygidium, slightly longer anteriorly. Caudal seta ca. 1/3 body length.

DORSAL SURFACE:

Setae.- Marginal, 2 on anterior margin of head, 1 on each thoracic segment, and on abdominal segments 1-8. Submarginal, 2 on head, one of these just posterior to eye; and one on abdominal segment 8. 1 mesolateral on meso- and metathorax; Submedian 2 on head, one on meso- and metathorax, one on each of abdominal segments 1-7.

Ducts.- Marginal, one on each abdominal segment 1-8. Submedial one on head.

VENTRAL SURFACE:

Antenna.- Five-segmented, the third and fourth about equal in length, 5th slightly elongate, but not annulate. Segment 1 with two slender setae, segment 2 with a slender seta and an apical sensorium, 4 with one slender and one stout "fleshy" seta, 5 with 5 fleshy setae and one elongate subapical and apical seta, and with two invaginated setae.

Legs.-Three pairs, Leg I: Coxa 13.4-17.4, trochanter 14.7-16.1, femur 30.8-33.5, tibia 16.1-20.1, tarsus 21.4-22.8, claw 12.1-13.4, total length 105-112. Leg II: Coxa 13.4-14.7, trochanter 12.1-18.8, femur 33.5-36.2, tibia 17.4-20.1, tarsus 16.1-25.5, claw 14.7. Total length 118-126. Leg III: Coxa 13.4-16.1, trochanter 14.7-17.4, femur 33.5-38.7, tibia 18.8-21.4, tarsus 24.2-28.1, claw 16.1. Total length 118-129. Tibia and tarsus roughly equal in length. Each tarsus with proximal campaniform sensilum and one slender seta. Trochanter with 1 slender seta and 2 basal sensilla. Coxa 1 with 2 slender median setae ventrally, coxae 2 and 3 with 1; all coxae with a minute seta near anterolateral margin.

Spiracles.- Well defined, on pro- and metathorax. Prothoracic spiracle with an associated trilocular pore.

Setae.- One marginal and 2 submedial on head; submarginal, one on each thoracic segment and abdominal segments 1, 8, and 9 and 2 on other abdominal segments. Submedian, 2 on head, 1 on meso- and metathorax, 1 on each of abdominal segments 2-7.

Ducts.- 1 lateral tubular duct on each thoracic segment and on the head just posterior to the eye.

Material Studied.- *Rugaspidiotus sculpturatus* Ferris, 15 first instars on 15 slides, JOH-07-82, on *Franseria dumosa,* Yuma, Arizona, July 7, 1939, Col. R.C. Dickson; 5 slides deposited in the R.H. Bohart Museum of Entomology, The University of California, Davis, 5 slides in the U.S. National Museum, Beltsville, MD, and 5 slides in the University of Georgia collection at Griffin. *Rugaspidiotus sculpturatus* Ferris, JOH-08-82, on *Encelia californicus*, Granite camp, E. of Rosario, Lower California, 10 first instars on 10 slides, 5 slides deposited in the R.H. Bohart Museum of Entomology at the University of California, Davis, 3 slides in the U.S. National Museum at Beltsville, MD, and 2 slides in the University of GA collection at Griffin.

Rugaspidiotinus nebulosus (Ferris)
Rugaspidiotus nebulosus Ferris: Ferris, 1938.

First Instar (Fig. 3)

Mounted specimens elongate oval. Length 359-381, width 187-201. Derm membranous. Anal opening small, removed ca. 3 x its diameter from pygidial apex. On the venter, a roughened slightly sclerotized area is present on the first abdominal segment between the metathoracic coxa and the body margin.

PYGIDIAL MARGIN- Lobes 2 and 3 well developed, sclerotized. Segment 9 apparently indicated by a minute ventral seta. Marginal setae as illustrated on pygidium, about 6 microns long, slightly longer anteriorly. Caudal seta ca. 1/3 body length.

DORSAL SURFACE:

Setae.- Marginal, 2 on anterior margin of head, 1 on each thoracic segment, and on abdominal segments 1-8. Submarginal, 2 on head, one of these just posterior to eye; and one on abdominal segment 8. 1 mesolateral on meso- and metathorax; submedian 2 on head, one on meso- and metathorax, one on each of abdominal segments 1-7.

Ducts.- Lateral, one on each abdominal segment 1-8. Submedial one on head.

VENTRAL SURFACE:

Antenna.- Five-segmented, the third and fourth about equal in length, 5th slightly elongate, but not annulate. Segment 1 with two short slender setae, segment 2 with a slender seta and an apical sensorium, 4 with one slender and one stout "fleshy" seta, 5 with 5 fleshy setae and one elongate subapical and apical seta, and with 2 invaginated setae.

Legs.- Leg I: Coxa 10.7-12.1, trochanter 14.7, femur 29.5-33.5, tibia 16.1-17.4, tarsus 19, claw 12.1-13.4, total length 88-91. Leg II: Coxa 10.7-13.4, trochanter 16.1-18.8, femur 29.5-32.2, tibia 13.4-16.1, tarsus 20.1, claw 13.4-14.7, total length 94-101. Leg III: Coxa 10.7-14.7, trochanter 17.4-20.1, femur

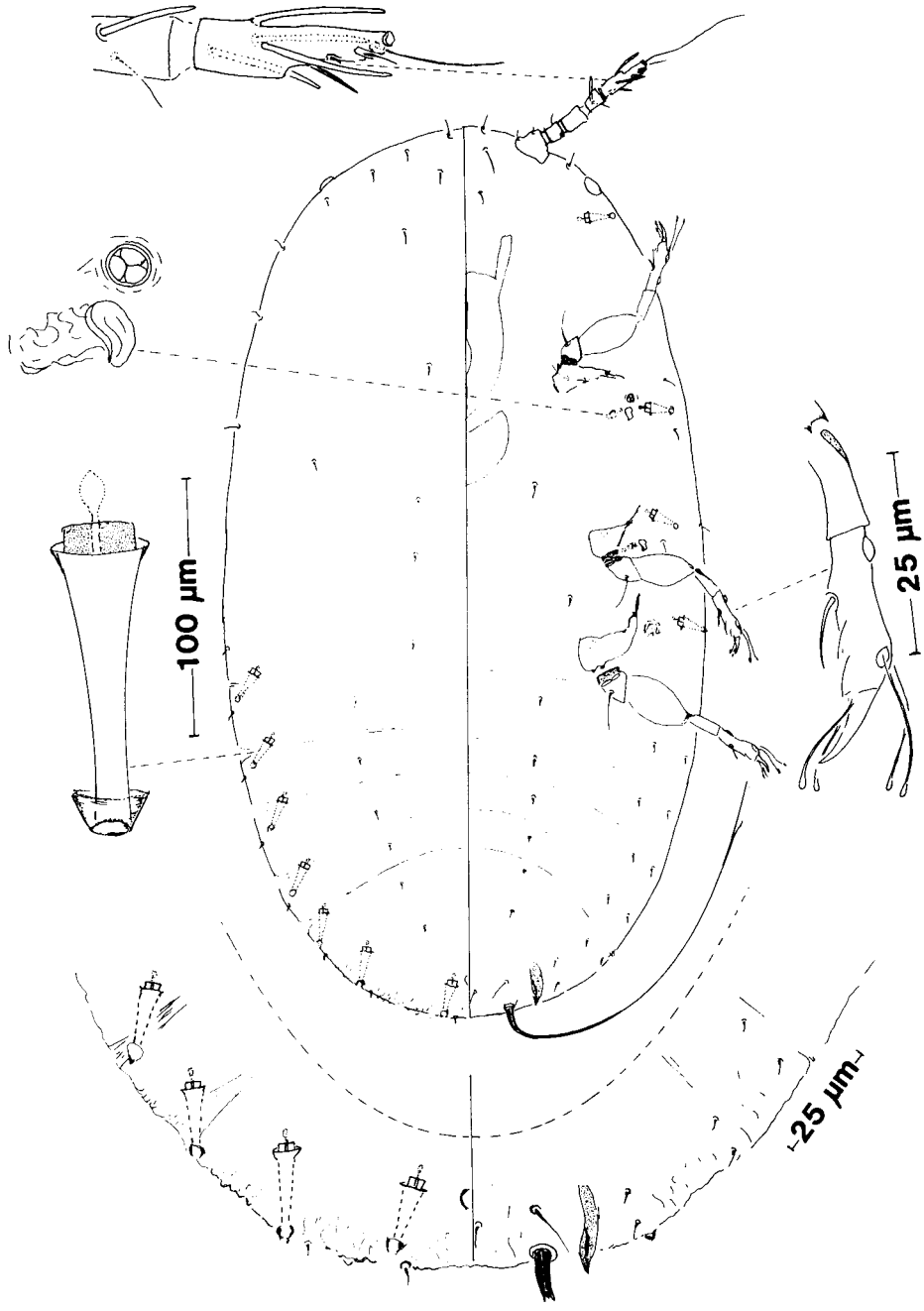

Fig. 3. *Rugaspidiotinus nebulosus* (Ferris), First Instar.

33.5, tibia 16.1-20.1, tarsus 20.1-21.4, claw 14.7, total length 101-103. Tarsal and ungual digitules slightly knobbed, tarsus only slightly longer than tibia. Tarsus with proximal campaniform sensilum and one slender seta. Femur about 2x as long as wide, trochanter roughly triangular, with 1 slender seta and 2 basal sensilla. Coxa I with 2 slender median setae ventrally, coxae II and III with 1; all coxae with a minute seta near anterolateral margin.

Spiracles.- Well defined, on pro- and metathorax. Prothoracic spiracle with an associated trilocular pore.

Setae.- One marginal on head; submarginal one on each thoracic segment and abdominal segments 1, 8, and 9 and 2 on other abdominal segments. Submedian, 2 on head, 1 on meso- and metathorax, 1 on each of abdominal segments 2-7.

Ducts.- 1 lateral tubular duct on each thoracic segment and on the head just posterior to the eye.

Material studied.- *Rugaspidiotus nebulosus* Ferris, JOH-05-82, on *Erigonum fascicularium,* a few miles north of Kingman, Ariz., June 30, 1940, Col. G.F. Ferris, 10 first instars on 10 slides, 5 slides deposited in the R.H. Bohart Museum of Entomology at the University of California, Davis, 3 slides in the U.S. National Museum at Beltsville, MD., and 2 slides in the University of Georgia Collection at Griffin.

Notes: Superficially, this group resembles other members of the Diaspididae. But a closer examination reveals that some rather serious differences exist. The following characters are common to the Odonaspidinae, but are not generally common to the Diaspidinae (with some exceptions in the Lepidosaphidini): Each has 1) a dorsal submarginal duct on the head and mesothorax, 2) dorsal submedian setae on abdominal segments 3-6, and 3) a well-developed seta on each tarsus.

The three species are easily separable from each other. *R. sculpturatus* has two pair of pygidial lobes and fairly well-developed gland spines, as well as a large submedian duct on the head. *R. circumdatus* also has a large submedian head duct, but has no pygidial lobes, and the trilocular pore is structurally different from the other two. *R. nebulosus* has no large duct on the head, and has only one pair of pygidial lobes. In addition, the gland tubercles are very short, and appear almost plate-like in places.

These three species present a serious problem with regard to their placement. They do not fit well within the rudimentary system of Howell and Tippins (1989) because of the divergences mentioned above. For the present, it would appear that they form a separate branch between *Comstockiella* Cockerell (Group III) and Groups I and II.

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References Cited

Balachowsky, A. S. 1953. Les Cochenilles de France, d'Europe, du Nord de l'Afrique et du Bassin Mediterraneen. VII.- Monographe des Coccoidea; Diaspidinae - IV, Odonaspidini-Parlatorini. Actualites Sci. et Indus. Ent. Appl. 1202: 725-929.

Borchsenius, N. S . 1966. A Catalogue of the Armoured Scale Insects (Diaspidoidea) of the World. Acad. Nauk SSSR Zool. Inst. Leningrad. 449 p.

Ferris, G.F. 1938. Atlas of the Scale Insects of North America. Series 2. Stanford University Press. p. 63-73.

Howell , J. O ., R. J. Beshear, and H. H. Tippins. 1986 . Descriptions of first instars of type-species of the nominal genera of three subtribes of the Diaspidini. J. Entomol. Sci. 21:1-9.

Howell, J. O. and H. H. Tippins. 1989. Immature Stages and Sexual Dimorphism. *In* Armored Scale Insects, David Rosen, Editor. Elsevier Science Publishers. Amsterdam, p. 29-42.

Stickney, F. S. 1934. The External Anatomy of the Parlatoria Date Scale, *Parlatoria Blanchardi* Targioni Tozzetti, with Studies on the Head Skeleton and Associated Parts. U.S.D.A. Tech. Bul. 421, p. 4-6.

Takagi, S. 1969. Diaspididae of Taiwan based on material collected in connection with the Japan-U.S. Cooperative Science Programme, 1965 (Homoptera: Coccoidea). Part I. Insecta Matsumurana 32:1-110.