On the Taxonomy of Pineapple Mealybugs in Hawaii, with a Description of a Previously Unnamed Species (Homoptera: Pseudococcidae)

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The pineapple mealybug, *Dysmicoccus brevipes* (Cockerell), long has been recognized as one of the most important pests of agriculture in the Hawaiian Islands where for many years it has constituted the most serious insect problem of the pineapple industry (Carter, 1932, 1933; Zimmerman, 1948). Evidence now at hand indicates that two closely related but quite distinct species which have been confused under this name are present in Hawaii. Both these mealybugs occur on pineapple as well as number of other hosts, and one, retained here under the name *D. brevipes,* is also a minor pest of sugar cane.

Zimmerman (1948) reported the presence in Hawaii of an unidentified species of mealybug from several hosts other than pineapple and stated that the species might have been confused previously with *D. brevipes.* While in Washington, D. C., during 1957, I was able to examine the slide-mounted specimens upon which Zimmerman's records were based and to compare them with specimens which I had collected on several additional hosts. The credit for the discovery of the morphological characters which separate this species from *D. brevipes* belongs to Dr. Harold Morrison of the U. S. Department of Agriculture, Agricultural Research Service, who pointed out these differences to me. I am indebted to Dr. Morrison for many helpful suggestions and criticisms of the manuscript, and to Dr. Walter Carter, Pineapple Research Institute, Honolulu, who provided specimens of both *D. brevipes* and the species here described as new.

Dysmicoccus brevipes (Cockerell)

Dactylopius brevipes Cockerell, 1893:267, fig. 1.
Pseudococcus brevipes (Cockerell), Zimmerman 1948:189, fig. 105.
Dysmicoccus brevipes (Cockerell), Ferris 1950:59, fig. 19.

Balachowsky (1957) has recently considered in detail the morphology and systematics of the pineapple mealybug as it occurs in Martinique.

Since his concept of the species differs somewhat from that of Ferris (1948, 1950) is seemed desirable to re-examine Hawaiian specimens of *D. brevipes* in the light of Balachowsky's treatment. Balachowsky states that the presence of dorsal "glandes discoidales" (the "sieve pores" of Mamet, 1957) on abdominal segments seven to nine, and the presence of two small pores ("glandes préoculaires") at the base of each eye are constant characters of *D. brevipes.* These structures are not mentioned by Ferris. Balachowsky also states that the anal lobe cerarii as well as those of the seventh and eighth abdominal segments are borne on somewhat sclerotized areas. This is contrary to Ferris' statement that none of the cerarii are borne on sclerotized areas.

All Hawaiian specimens of *D. brevipes* which I have examined possess the peculiar small disc pores found by Balachowsky. These structures are present not only on the dorsum of the posterior abdominal segments, but generally scattered over the entire body on both dorsum and venter. The pores sometimes show a noticeable variation in size on different portions of the body, those of the dorsum of the posterior abdominal segments being the largest (about 6 μ maximum diameter). One to three such pores were found around the base of each eye in nearly every specimen examined.

The interpretation of the microscopic structure of these small disc pores is still subject to question. The pores were first described by Mamet (1957) in his *D. pseudobrevipes* as having a sieve-like structure, and his figures indicate a large number of small, irregularly-arranged loculi inside a well-defined rim. On the other hand, Balachowsky (1957) has shown them as small multilocular discs with a regularly loculate arrangement. In specimens which I have studied (highest magnification: X950, oil immersion) most of the larger discs of the dorsum of the posterior abdominal segments appear to be irregularly sieve-like. However, some of the smaller discs on the anterior portion of the dorsum sometimes show what seems to be a loculate structure similar to that illustrated by Balachowsky. The septa of these pores are so very fine that it is difficult to be entirely certain of their arrangement at the magnifications available. In the related species here described as new, a regularly loculate structure similar to that figured by Balachowsky seems to be present in at least some of these pores on nearly every specimen studied (fig. 1, 0). However, determination of the exact structure of these pores must await detailed histological study.

The apparent degree of sclerotizaton of the posterior cerarii of *D. brevipes* was found to be quite variable. Never were the cerarii borne on sharply defined and strongly sclerotized areas (such as those of the anal and penultimate cerarii of *Pseudococcus adonidum* (L.)). However, some evidence of sclerotization was evident on nearly every specimen examined. The degree to which this sclerotization was manifest appeared to depend primarily on the staining of the specimen. Freshly,

strongly stained specimens all showed some sclerotization, particularly of the anal cerarii. In weakly stained or faded specimens evidence of sclerotization was more difficult to see.

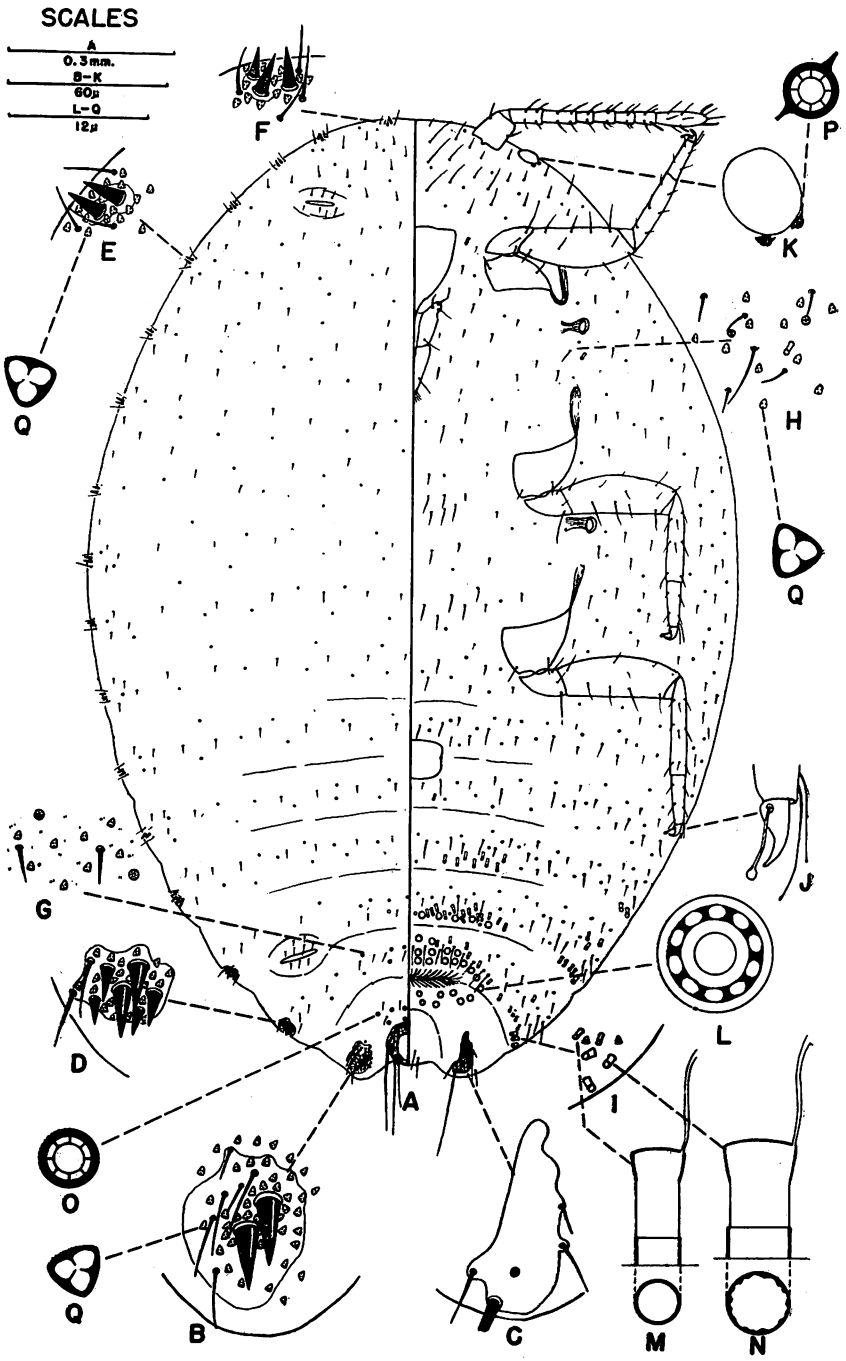
Mamet (1941, 1957) has described *Dysmicoccus pseudobrevipes* from pineapple in Mauritius. In his 1957 redescription he separated his species from *D. brevipes* on the basis of the presence of the peculiar small disc pores ("sieve pores"), the weak but evident sclerotization of the cerarii, and the presence of ventral tubular ducts in the mid-region of the fifth abdominal segment and on the head. Although small tubular ducts are largely restricted to the venter of abdominal segments six to eight in Hawaiian specimens of *D. brevipes,* a small number (2 to 6) may usually be found along the posterior margin of the mid-region of abdominal segment five, and a few such ducts are also present on the venter of the head in some specimens. The Hawaiian specimens which I have studied more nearly fit Mamet's *D. pseudobrevipes* than they do the Ferris concept of *D. brevipes.* However, Balachowsky (1957) examined the type of *D. pseudobrevipes* and concluded that it is probably no more than an extreme variant of *D. brevipes.* Until such time as these two species can be demonstrated to be definitely distinct, I prefer to use the older name for Hawaiian material.

I have examined specimens of *D. brevipes* from the stems and roots of several grasses (including sugar cane), from pineapple butts, and from the roots of a legume, *Melilotus indica* All. Zimmerman (1948) lists a number of other hosts for this species, but it seems probable that some of these records were based on misidentifications of the closely related species here described as new.

An encyrtid parasite, *Euryrophalus pretiosa* (Timberlake), was reared from specimens of *D. brevipes* collected in Honolulu on sugar cane.

Dysmicoccus neobrevipes, new species (fig. 1.)

Female. With 17 pairs of marginal cerarii. Anal pair each with two conical setae each about 24 μ long, plus about 6 slender accessory setae 15 to 30 μ long, borne on a slightly sclerotized area, and surrounded by about 40 to 50 trilocular pores (fig. 1,B). Penultimate cerarii each with two conical setae about 18 to 24 μ long, 1 to 5 smaller conical setae 9 to 12 μ long and 2 or 3 slender accessory setae about 20 to 24 μ long. These surrounded by about 25 trilocular pores and borne on a slightly sclerotized area (fig. 1, D.). Anterior cerarii each with at least 2 conical setae about 13 to 15 μ long, 0 to 4 smaller conical setae usually about 8 to 12 μ long, 2 or 3 slender accessory setae about 18 to 24 μ long, and surrounded by a concentration of about 12 to 20 trilocular pores. Cerarii of thorax and anterior abdominal segments each usually with but 2 or 3 conical setae (fig. 1, E); those of abdominal segments 5 to 7 usually with 4 to 6 conical setae. Cerarii of head with 3 to 6 conical setae (fig. 1, F). Anterior cerarii unsclerotized or, in well-stained specimens, with


SCALES
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0.3mm.
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a narrow area of weak sclerotization immediately surrounding the bases of the conical setae.

Dorsum evenly, fairly densely scattered with trilocular pores. Small disc pores (fig. 1, 0) sparsely scattered over entire surface; these usually 3 to 5 μ in diameter, but those of the mid-dorsal areas of abdominal segments 8 and 9 sometimes a trifle larger, with a maximum diameter of about 6 μ. Dorsal tubular ducts absent. Dorsum sparsely covered with short, spiniform setae, about 10 to 15 μ long, (fig. 1, G). Dorsum of posterior abdominal segments without longer setae. Two pairs of dorsal ostioles present.

Venter of each anal lobe with an elongate sclerotized area, two or more times as long as wide (fig. 1, C). About 30 to 50 multilocular pores of the normal pseudococcid type (fig. 1, L) present about the vulva on the venter of abdominal segments 8 and 9, plus about 6 to 20 additional along the posterior margin of abdominal segment 7. Small disc pores, of the type occurring on the dorsum, sparsely scattered over the entire venter. Two such pores present along the margin of each eye in most specimens (fig. 1; K, P). Tubular ducts confined largely to the venter of abdominal segments 6 to 8, these mostly small (about 3.5 μ diameter) (fig. 1; I, M); a few slightly larger ducts (about 4.8 μ diameter) present near the lateral margins on segments 6 to 8 in most specimens (fig. 1, I, N). Tubular ducts of both sizes with very slight oral collars. An occasional small tubular duct present on the venter of the head, thorax or anterior abdominal segments of some specimens (fig. 1, H). Trilocular pores scattered on the venter at about the same density as on the dorsum. Venter sparsely covered with scattered setae of two principal size groups; the longer about 27 to 48 μ long, and the shorter about 12 to 15 μ long (fig. 1, H). Longer setae of the venter of the head anterior to the rostrum about 54 to 64 μ long. Apical setae of anal lobes slightly longer than anal ring setae (anal lobe setae about 150 μ long, anal ring setae 125 to 130 μ long).

Circulus moderately large, distinct, about 110 μ long by about 125 μ wide. Rostrum two-segmented, about 180 μ long by about 120 μ wide at base. Antennae eight-segmented in all specimens at hand, about 435 μ long. Legs of moderate size, the femora stout (hind femora about 200 to 270 μ long by about 90 μ maximum width). Femora and tibiae of

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FIG. 1. *Dysmicoccus neobrevipes* n. sp.: A, dorsal and ventral aspects of mature female (trilocular pores have been omitted); B, anal cerarius; C, ventral sclerotized area of anal lobe; D, penultimate cerarius; E, anterior thorasic cerarius; F, interantennal cerarius; G, portion of derm of eighth abdominal segment; H, portion of derm of venter of thorax; I, portion of derm at margin of venter of eighth abdominal segment; J, claw of hind tarsus; K, eye and associated marginal disc pores; L, detail of large multilocular pore of venter; M, detail of small ventral tubular duct; N, detail of larger ventral tubular duct; O, detail of small dorsal disc pore showing the apparently loculate structure; P, detail of small disc pore associated with eye; Q, detail of trilocular pores.

hind legs with numerous translucent dots on upper surfaces (fig. 2).

Body form broadly oval. The type specimen measures 1.68 mm. long by 1.13 mm. maximum width. The largest slide-mounted specimen studied measured 3.5 mm. long by 2.8 mm. wide.

Described from 27 specimens. Holotype and 5 paratypes on 2 slides, Honolulu, January, 1958, Walter Carter collector, on tuberose (*Polianthes tuberosa* L.); 11 paratypes on 5 slides, Honolulu, January, 1958, Walter Carter collector, on *Agave;* 1 paratype, Honolulu, January 10, 1958, Walter Carter collector, ex laboratory colony on pineapple leaf; 3 paratypes on one slide, Honolulu, May 22, 1958, Walter Carter, collector, ex laboratory colony on pineapple leaf; 6 paratypes on 2 slides, Aina Haina, Oahu, April, 1958, J. W. Beardsley collector, on *Agave sisalana* (Engelm.) Perrine.

Holotype and paratypes deposited in the U. S. National Coccid Collection, U. S. Department of Agriculture, Washington, D. C. Additional paratypes placed in the collections of the Bernice P. Bishop Museum; Experiment Station, HSPA; and the Pineapple Research Institute; all in Honolulu.

The following additional Hawaiian material, definitely assignable to this species, also has been studied: Honolulu, Oahu, April 27, 1904, D. L. Van Dine collector, on *Agave sisalana;* Kunia, Oahu, May 14, 1947, A. Suehiro collector, ex pineapple; Honolulu, July 17, 1945, E. C. Zimmer-

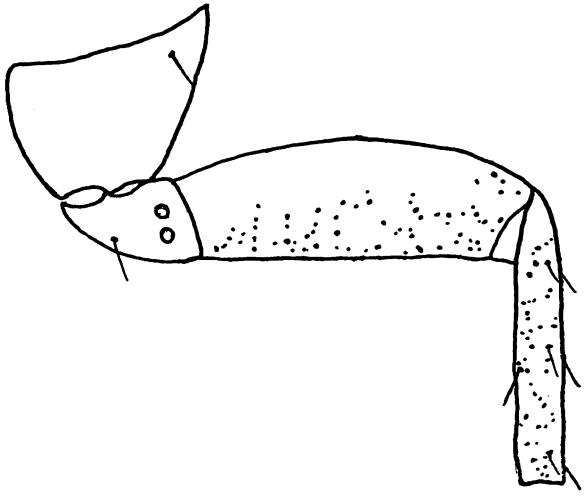

FIG. 2. Hind leg of *Dysmicoccus neobrevipes* (tarsus omitted) showing the distribution of the small translucent spots on the upper surface of the femur and tibia.

man collector, on *Pandanus* aerial roots; Manoa, Honolulu, August 11, 1947, E. C. Zimmerman collector, on sunflower; Hawaii (no exact locality), May 22, 1952, H. A. Woolford collector, on *Alpinia purpurata* (Vieill.) K. Schum. (red ginger); Kailua, Oahu, March, 1956, L. Chilson collector, on leaves of *Nothopanax* sp. (panax); Wailupe Valley, Oahu, August 6, 1955, J. W. Beardsley collector, under loose bark of *Acacia koa* Gray; Hanauma Bay, Oahu, June, 1956, J. W. Beardsley collector, on terminal leaves of *Thespesia populnea* (L.) Sol., and on flower and fruit clusters of *Messerschmidia argentea* (L. f.) Johnston; Wiliwilinui Ridge Road, Oahu, May, 1958, J. W. Beardsley collector, on pads of *Opuntia megacantha* Salm-Dyck; Mapulehu, Molokai, Jan. 24, 1957, J. W. Beardsley collector, on leaves and petioles of *Acacia farnesiana* (L.) Willd; Waimea, Kauai, Jan. 6, 1944, N. L. H. Krauss collector, on *Samanea saman* (Jacq.) Merr. (monkeypod).

The specimens of *D. neobrevipes* which have been studied show a considerable range of variation in some characters. The maximum size of mature females appears to be dependent somewhat upon the host on which the mealybugs develop. (e.g.: females which develop on *Agave* frequently are considerably larger than those which develop on pineapple). There is also some variation in the number of conical setae in the cerarii anterior to the anal pair, sometimes even in corresponding cerarii on opposite sides of the same specimen. In some examples there is little apparent differentiation of the tubular ducts of the lateral margins of the venter into two size groups, but in others such differentiation is quite marked (fig. 1; I, M, N). The numbers of both ventral tubular ducts and multilocular pores vary somewhat from specimen to specimen, as do the lengths of the appendages.

Dysmicoccus neobrevipes differs from *D. brevipes,* as that species has been defined by Balachowsky (1957), primarily in the form of the ventral sclerotization of the anal lobes and in the absence of long setae on the dorsum of the abdomen. In all specimens of *D. brevipes* which I have examined, the ventral sclerotized area of each anal lobe is roughly quadrate. In *D. neobrevipes* these sclerotized areas are conspicuously elongate, usually two or more times as long as wide. In *D. brevipes* there is a small but conspicuous group of several long setae on either side of the mid-dorsal axis of the ninth abdominal segment. These setae range from about 45 μ to about 80 μ in length. In *D. neobrevipes* the longest setae in this region measure about 15 μ, and are not conspicuously longer than other dorsal setae. In the specimens which I have studied there also appears to be slight differences in the relative lengths of the apical setae of the anal lobes and the anal ring setae in the two species. In *D. brevipes* the apical setae are about 1.4 times as long as the anal ring setae, whereas in *D. neobrevipes* the apical setae are about 1.2 times as long.

In several respects *D. neobrevipes* appears to be more closely related to *D. probrevipes* (Morrison) (1929) than to *D. brevipes.* I have not

seen specimens of the former species, but Dr. Harold Morrison has kindly compared type material of *D. probrevipes* with paratypes of *D. neobrevipes*. *D. probrevipes* possesses an elongate sclerotized area on the venter of each anal lobe and lacks the group of long preanal dorsal setae, both characters in common with *D. neobrevipes*. The small disc pores found in both *D. brevipes* and *D. neobrevipes* also occur in small numbers on the dorsum of *D. probrevipes*. *D. probrevipes* possesses six- or seven-segmented antennae, whereas all specimens of *D. neobrevipes* studied have eight-segmented antennae. Also, *D. probrevipes* has considerably fewer of the large perivulvar multilocular pores (Dr. Morrison found only about 15) than does *D. neobrevipes*. The appendages of *D. probrevipes* were found by Dr. Morrison to be somewhat shorter than those of D. *neobrevipes* (e.g.: the hind femora of *D. probrevipes* measured about 168 μ as compared to a range of about 200 to 270 μ in the type material of *D. neobrevipes*).

D. neobrevipes colonies differ, both in their biology and in general appearance, from all colonies of Hawaiian *D. brevipes* which I have studied. *D. neobrevipes* is apparently ovoviviparous. The normal mode of reproduction appears to be bisexual as winged males developed in all the colonies studied. Males were never found in colonies of Hawaiian *D. brevipes*. The fully mature female of *D. neobrevipes* is broadly oval in shape, and the dorsum is quite heavily coated with white mealy wax which is usually formed into tiny tufts. A series of short wax filaments extends from the margin of the body completely around the insect. The length of most of these filaments is equal to about one-third the maximum width of the dorsum. The caudal pair of filaments is longer, being equal to about one-third to one-half the length of the body. The general color of mature female specimens is grayish. When the wax is removed the body color is found to be a grayish-orange. A small amount of cottony wax extends from the vulvar region in reproducing females.

In the *D. brevipes* colonies which were examined the color of the individual mealybugs was definitely more of an orange or pinkish-orange than that of mature *D. neobrevipes* females. The apparent color difference in fully mature females of the two species seems largely due to the thicker covering of dorsal wax in *D. neobrevipes* which more effectively obscures the orange color of the body contents. Young last-instar individuals of *D. neobrevipes* which have not yet developed the heavy covering of dorsal wax are very similar in color to *D. brevipes* females.

Although both *D. brevipes* and *D. neobrevipes* are rather polyphagous, it appears that each normally inhabits a different portion of its host plant. *D. neobrevipes* has been found only on aerial parts of its hosts; on leaves, stems, aerial roots, and flower and fruit clusters. *D. brevipes* colonies are usually found near the base of their host plants. They oc-

cur normally on the butts of pineapple plants, on the lower stalks of sugar cane and on lower portions of stems or on the partially exposed roots of various grasses and herbaceous plants. Although *D. brevipes* is commonly found infesting graminaceous plants, *D. neobrevipes* has not yet been found on grasses.

Since specimens from pineapple from Oahu are definitely assignable to *D. neobrevipes,* it seems likely that one of the two "strains" of *D. brevipes* studied by Ito (1938) actually was this species. Ito states that the gray "strain" of *D. brevipes* normally reproduces bisexually, whereas the pink "strain" is strictly parthenogenetic, no males ever being produced. These findings, as well as the color differences, are in line with my observations of colonies of the two species here considered.

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