IDENTITY OF THE MEALYBUG DESCRIBED AS DACTYLOPIUS CALCEOLARIAE MASKELL[1]

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INTRODUCTION

The increasing importance of the elongate gray mealybug found in many parts of the world on sugar cane, both as a pest and as a subject for study as a possible carrier of the sugar-cane mosaic disease, has made it highly desirable to verify or correct the scientific name by which the species is recognized in technical literature. The specific name *calceolariae*, first applied to a mealybug more than 50 years ago, has in recent years been used very frequently in published references to this sugar-cane mealybug, although it has been recognized for some time that there was a legitimate question as to the correctness of the application.

In the course of preliminary studies on the large Maskell collection of scale insects, very generously loaned to the United States Bureau of Entomology by the New Zealand Department of Agriculture, a certain amount of material bearing on this subject was obtained, but nothing from which definite conclusions could be established. A recent appeal for additional specimens, made to J. G. Meyers, of the Biological Laboratory of the New Zealand Department of Agriculture, and transmitted by him to Gilbert Archey, of the Canterbury Museum, Christchurch, New Zealand, has resulted in the receipt from the latter of a few more specimens, some of which are mounted and accompanied by data indicating without question that they were before Maskell at the time he prepared his original description.

From the material thus accumulated it has been possible, after extended and careful study, to work out the identity of the species represented, if not completely, at least to an extent sufficient to meet the practical needs of the situation. This discussion attempts to restrict properly the use of the name *calceolariae*, and to segregate and correctly designate the different species which have been known by this name.[2]

HISTORY OF MASKELL'S USE OF NAME

The species was first described by Maskell in 1879 (*9, p. 218–219*),[3] who then stated that "this insect is effecting great destruction in the public gardens in Christchurch amongst the Calceolarias and upon several native plants such as Traversia, Cassina, etc." In the original description the color is given as pink covered with white meal, and the shape is indicated as oval in the accompanying figure. The body is said to be very oily.

[1] Received for publication October 25, 1924; issued October, 1925.

[2] The drawings illustrating the structural characteristics of the species described here have been prepared under the writer's direction, those for *boninsis* by Emily Morrison, and the others by Leola J. Kruger.

[3] Reference is made by number (italic) to "Literature cited," p. 499.

Maskell's second reference to the species was in 1884 (*10, p. 138–139*), when the insect was reported from Stewart Island, southern New Zealand, on Phormium and on a grass (Danthonia). The length of the Danthonia specimens, more than ¼ inch, was noted, and the species was considered to be indigenous.

The third reference was made in 1887 (*11, p. 100*), when the species was described again and reported as occurring on Calceolaria and *Phormium tenax* at Christchurch, and on Danthonia from Stewart Island. A colored figure of the species as it occurs on Phormium was given.

The species was next mentioned in 1890 (*12, p. 149–150*), when Maskell stated that examples received on sugar cane from Fiji were, to him, indistinguishable from *calceolariae*.

Another reference to the species was made in 1894 (*13, p. 89*), when specimens from Napier (New Zealand) on *Cordyline australis* were discussed. The same note suggested that a mealybug from northern Mexico is this species, since a drawing of the foot of this last exactly corresponds to that of *calceolariae* and since he (Maskell) has recorded this species from sugar cane.

In a "Synoptical list of the Coccidae reported from Australasia and the Pacific Islands up to December, 1894" (*14, p. 24–25*), Maskell recorded this species from New Zealand on *Calceolaria* sp., *Cordyline australis*, *Danthonia cunninghamii*, and *Phormium tenax*, and from Fiji on *Saccharum officinarum*.

Maskell's final reference to the species came in 1897 (*15, p. 322*) when he described as new a variety, *minor*, from Mauritius on roots of "onion grass."

MASKELL MATERIAL AVAILABLE FOR EXAMINATION

The following is a list of Maskell specimens, identified as this species, which have been available for examination:

(1) Original or type slides, "from Traversia, old female, June 1878"; "from Traversia, old females, June 1878"; "from Traversia, 2 young insects, June 1878"; "from Calceolaria, Female, 2nd stage, June 1878."

(2) Some slide mounts from specimens in formalin, received with the preceding slides from the Canterbury Museum, Christchurch, New Zealand, and labeled simply "*Dactylopius calceolariae*."

(3) Four slides from the Maskell collection, one each "From Danthonia (grass); (Stewart's Island), Adult female, Sept. 1880"; "adult females, 1886"; "larva, 1893"; "var. *minor*, adult female, 1896."

(4) Some slides of various stages prepared from the unmounted Maskell collection material.

(5) Two slides of different stages of var. *minor* prepared from the unmounted Maskell collection material.

STATUS OF THE MATERIAL LISTED

(1) It is obvious that only the first four slides listed can be positively considered as having been examined by Maskell at the time he described the species, and these, therefore, include the type.

(2) Of the four original slides, one, that from Calceolaria, bears only a poorly preserved second-stage female. This species is un-

doubtedly a close relative of *Pseudococcus citri* (Risso), differing from specimens of the same stage of that species, so far as the writer can determine, only in the possession of relatively large, short tubular ducts scattered adjacent to the cerarii, at least in the abdominal region. Since it is not possible to identify this definitely, it has been excluded from further consideration as part of the type material of the species.

(3) The three Maskell slides from Traversia therefore become the types of *Dactylopius calceolariae* of Maskell and the redescription given below under the name *Pseudococcus calceolariae* (Maskell) has been drawn up from the three adult females, all imperfect, present on these slides.

(4) The species mentioned by Maskell in 1883 as having been found on Danthonia at Stewart Island is distinct from both of the species already mentioned, and since it has not been recognized as identical with any of the described species in the group, it has been described here as new under the name *Trionymus danthoniae*.

(5) No specimens definitely known to have formed a part of the material on which the 1883 record on Phormium was based are available, so the actual status of this record is not determinable. However, in view of the widespread occurrence on Phormium of the species discussed in the next paragraph, it seems a reasonable assumption that the portion of Maskell's 1883 record referring to "*calceolariae* on *Phormium*" actually refers to the following species.

(6) Maskell's 1887 record on *Phormium tenax* from Christchurch is considered to be plainly represented by the single slide bearing two adult females, dated 1886. The specimens on this slide are specifically identical with some, without data other than name, mounted from the Maskell general collection, and with specimens on *Phormium tenax* from Berkeley, Calif., and despite certain apparent descrepancies, agree well with the description of *Pseudococcus diminutus* published by Leonardi. All the published records of *P. calceolariae* Mask. from the host *Phormium tenax* can therefore, in all probability, be referred to Leonardi's species *diminutus*.

(7) The specimens on sugar cane from Fiji, the record of which was published by Maskell in 1890, are not definitely represented by any of the specimens available for examination, and it is therefore impossible to establish with certainty the identity of the species to which this reference applies. In view of the wide distribution of the elongate gray mealybug of sugar cane, which has almost always been designated by the name *calceolariae* by other writers, it is a reasonable, although at present unverifiable, assumption that Maskell's specimens on sugar cane from Fiji were this species, that is, the *calceolariae* on sugar cane of authors. To this species the writer, in making identifications, has applied the name *boninsis* Kuwana, since the description given by Kuwana, so far as it extends, entirely coincides with specimens of this elongate gray sugar-cane mealybug already reported from so many parts of the world that its eventual discovery may be expected practically everywhere that sugar cane is grown extensively.

(8) The Maskell slide of a larva dated 1893 evidently is the species reported from Napier on *Cordyline australis*. None of the other specimens available can be definitely associated with this record, and the identity of the species can not be determined with

certainty from the larva. However, since the host is included in the same plant family as Phormium, since the general locality of the collection is identical with that of the species from Phormium, and since the larval characters, so far as they can be observed, do not contradict the conclusion, it is reasonable to assume that the species mentioned in this record is identical with that occurring on Phormium, and it is tentatively given such an association.

(9) After an examination of the type specimens, Maskell's *Pseudococcus calceolariae*, variety *minor*, has been placed as a synonym of *Pseudococcus citri* (Risso).

(10) Certain specimens, obtained from the unmounted portions of the Maskell and Canterbury Museum collections of "*calceolariae*," are not identical with any of the species already discussed and can not be positively associated with any of the Maskell records not represented by properly identified specimens. One of these species is characterized here, despite its lack of definite host or distribution records, in the hope that such description will expedite the discovery of its habitat and host relationships. The condition of the specimens of the other species is such as to preclude the possibility of accurate description, although it can probably be recognized by direct comparison if ever rediscovered.

DESCRIPTION OF SPECIES

Genus PSEUDOCOCCUS Westwood

Pseudococcus ambiguus, new species (fig. 1)

ADULT FEMALE.—(Described from a single mounted specimen.) Length 4 mm., width 2 mm., uniformly elongate oval; antennae broken, legs broken except coxae, the hind pair with a few large pores; beak small, elongate conical, length 153 μ, width 107 μ, somewhat obscurely 2-segmented; with the cephalic pair of cerarii present, each composed of 3 spines surrounded by a cluster of triangular pores without definitely associated setae; in addition with 4 more or less distinctly recognizable cerarii on each half of the posterior abdominal segments, the apical and preapical each with a densely crowded cluster of triangular pores, the remainder with scattered clusters, apical cerarii each with 4 long spines and 5 accessory setae, preapical with 6 to 8 spines of unequal size and 2 to 3 accessory setae, next two with 3 small spines and a few pores but no accessory setae, last (anterior) with 2 slender spines and a few pores only; remaining cerarii not definitely developed, but their location sometimes hinted at by presence of 1 or 2 well separated, slender spines accompanied by a slightly closer grouping of the adjacent triangular pores; anal lobes only slightly produced, no ventral chitinized thickening evident, apical setae broken, but, from diameter of base, apparently somewhat longer than anal ring setae; anal ring not unusual, with the usual inner and outer pore bands and 6 setae, the longest of these about 180 μ, pores of the usual types, the triangular widely scattered over both the dorsal and the ventral surfaces, the multilocular disk pores apparently limited to two small clusters, one anterior, the other posterior to the genital opening, plus a few in the middle of the segments just anterior to these; small tubular ducts present but rare, apparently confined to the posterior ventral abdominal area; body setae rather small and not conspicuous, the ventral averaging distinctly longer than the dorsal, more slender and varying considerably in size; ventral cicatrix moderately large, transverse, irregular in shape.

PREADULT FEMALE.—(Based on a single mounted specimen.) In general resembling the adult, but with somewhat smaller size or fewer numbers of various structures, and with multilocular disk pores wanting.

The holotype of this species was mounted from a pinned specimen included among the specimens of *Pseudococcus calceolariae* in the Maskell collection. As has already been demonstrated in this paper, the species is not *calceolariae*, and it is likewise possible to

reach the definite conclusion that it is not *Pseudococcus glaucus*, as originally described by Maskell, from the Maskell material of which the preadult female was obtained. The writer has not been successful in associating these specimens with any of the species described by Maskell or others, and although reluctant to describe it from the limited material available for study, he believes that it can be readily recognized from the description whenever it may be found in the future, owing to the apparently unusual and distinctive cerarian characters, and that its association with the species complex discussed in this paper makes its characterization practically necessary.

FIG. 1.—*Pseudococcus ambiguus*, adult female: A, apex of abdomen, ×96; B, posterior coxa, ×96; C, preapical cerarius, ×424; D, apical cerarius, ×424; E, apex of head, ×96

Although no definite distribution or host data are available, it is assumably a New Zealand species.

The types are in the United States National collection of Coccidae.

PSEUDOCOCCUS BONINSIS KUWANA (figs. 2, 3)

ADULT FEMALE.—External appearance well described by Fullaway (*3*), and others, and not treated here; size of body, as mounted, varying considerably; well-developed individuals about 4.5 mm. long by 2.5 mm. wide; derm entirely membranous; antennae normally 8-segmented, the average lengths of the segments of several individuals in microns as follows: I, 67; II, 68; III, 43; IV, 31.5; V, 41; VI, 34; VII, 41; VIII, 98; legs not unusual, hind coxae with a varying number of tiny and often rather indistinct pores on basal portion, hind femora with some

large, faint areolations, not always evident; tibia about twice length of tarsus, about two and one-half times in hind pair, claw without denticle, both pairs of digitules long, slender, knobbed, but those of claw stouter; beak elongate conical, fairly evidently 2-segmented; series of cerarii incomplete, one pair on head and the 5 or 6 posterior abdominal pairs only present, each of those on head composed of 2 spines, a few triangular pores and 1 or 2 accessory setae, rarely with one or both of the spines elongated and setalike, still more rarely with 3 spines, the apical abdominal pair each large, with 2 spines, a loose cluster of pores and several accessory setae, not underlaid by any definite chitinous thickening, the remaining pairs with the spines progressively smaller anteriorly, each with 2 spines, a few triangular pores and one or more accessory setae, spines in each of sixth or anterior developed abdominal cerarii most often elongate, setalike; anal lobes hardly protruding, apical seta fairly large, about 100 μ long when uninjured, longest anal ring seta about 64 μ; with the usual types of pores and ducts, triangular disk pores well distributed over body both dorsally and ventrally, apparently scattered or in very poorly defined broad segmental bands, multilocular disk pores confined to the ventral abdominal region, in a large cluster

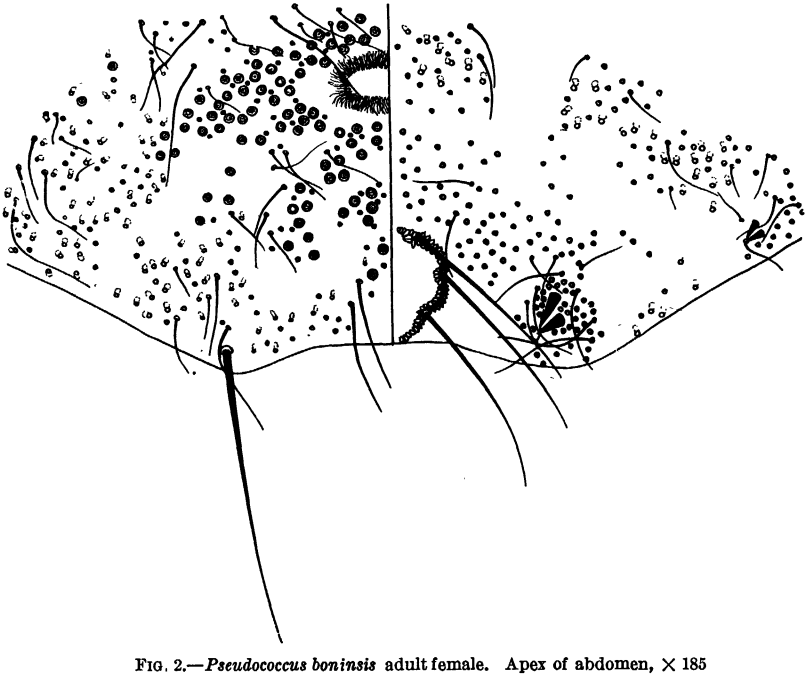

FIG. 2.—*Pseudococcus boninsis* adult female. Apex of abdomen, × 185

around the genital opening, and in two transverse rows or narrow bands on the two ventral segments anterior to the genital clusters, in no case, so far as has been determined, occurring in the head, thoracic, or anterior abdominal region, and none of the bands or clusters attaining the body margin at any point; only medium or rather small, short tubular ducts present, these, in the abdominal area, most abundant along the body margin adjacent to the cerarii, but present to some extent in the median area both dorsally and ventrally; body setae, both dorsally and ventrally, comparatively long and slender, showing considerable variation in length, those of ventral area actually and relatively longer; anal ring not unusual, with inner and outer single pore bands and 6 setae; ventral cicatrix of medium size, roughly quadrate, with rounded corners.

PREADULT FEMALE.—In general, rather closely resembling the adult except for smaller size and extent of development of the different structures; multilocular disk pores wanting.

This species has been redescribed from a considerable series of specimens, all from sugar cane, from Argentina, Bermuda, Brazil,

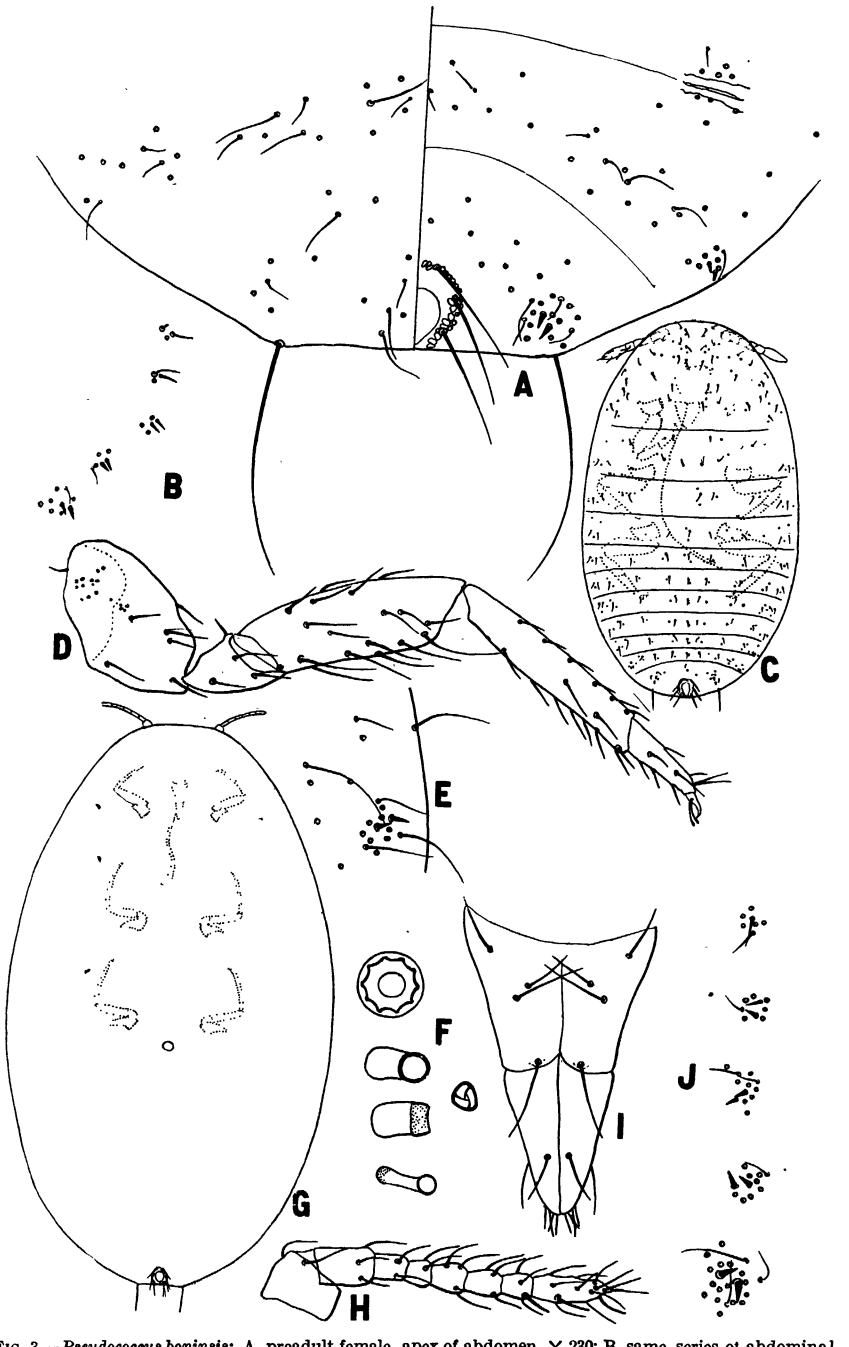

FIG. 3.—*Pseudococcus boninsis:* A, preadult female, apex of abdomen, × 230; B, same, series of abdominal cerarii, × 230; C, larva, outline, optical section, × 60; D, adult female, posterior leg, × 115; E, same, cerarius on head, × 230; F, same, types of pores on body, × 1275; G, same, outline of body, optical section, × 17.5; H, same, antenna, × 115; I, same, beak, × 230; J, same, series of abdominal cerarii, ×230

Canal Zone, District of Columbia (greenhouse), Dominican Republic, Florida, Georgia, Hawaiian Islands, Japan, Louisiana, and Panama. It has, unfortunately, not been possible to obtain specimens from the type material to prove absolutely the correctness of the association of these specimens with the species described by Kuwana on sugar cane from the Bonin Islands.

The only exceptions to the use of the name "*calceolariae*" for the gray sugar-cane mealybug in recent literature appear to be those found in the references of Kotinsky (*6*) and Ehrhorn (*1; 2, p. 237*). The first writer evidently confused and reversed the application of specific names to the two species *boninsis* and *sacchari* (Cockerell). The second author, on the basis of a comparison of specimens by E. E. Green, assigns the species *calceolariae* on sugar cane of authors to the species *saccharifolii* of Green. If one is to accept Green's original description as accurate, there is no possibility that the form here designated as *boninsis* can be identical with *saccharifolii*, since Green (*5, p. 23–24*) states very definitely that there is a group of about 8 stout pointed spines on each lobe of the apical abdominal segment and that the other segments, including both abdominal and thoracic, bear from 4 to 6 similar spines on processes on each margin. This description of the cerarian spines and that given of the distribution of the multilocular disk pores is so precise and so very different from the condition in *boninsis* (*calceolariae* on sugar cane of authors) that there would seem to be no possibility whatever of confusing the two species. Should the description prove to be seriously erroneous, and the type specimens actually identical with the species here designated as *boninsis*, Green's name will, from the dates of publication of the species, take precedence, since *boninsis* was described by Kuwana (*7, p. 161–162*) in 1909, more than one year later than the publication date of Green's species.

The latest contribution to this subject is that made from Hawaii by Fullaway (*3, p. 312–314*), where the name *Trionymus calceolariae* is used for the species under discussion. None of the specimens examined shows clearly the heavy ventral, chitinized anal lobe thickening emphasized by Fullaway in his drawing, although in many specimens the structure is vaguely suggested.

PSEUDOCOCCUS CALCEOLARIAE MASKELL (fig. 4)

ADULT FEMALE.—(Described from slide mounts only. Nothing available regarding external appearance, color, or secretion. See Maskell description for this.) Length as mounted averaging about 3 mm., width a little more than 1.5 mm., derm clearing completely except for appendages, and a tendency towards a thickening underlying each anal cerarius; antennae normally 8-segmented; measurements in microns about as follows: I, about 64; II, 40 to 78, average about 65; III, 57 to 93, average about 72; IV, 33 to 57, average about 46; V, 36 to 64, average about 48; VI, 36 to 43, average about 40; VII, 43 to 50, average about 47; VIII, 93 to 117, average about 107; legs not unusual, hind pair, so far as can be determined, without pores, except possibly a few large faint ones, femur slightly longer than tibia, claw stout, somewhat curved, without denticle, claw digitules rather stout, swollen at apices, exceeding claw, tarsal digitule slender, only slightly knobbed, likewise very slightly exceeding claw; beak elongate conical, appearing distinctly 2-segmented; with 17 pairs of cerarii made up of spines, triangular pores, and accessory setae, all, except the two or three anterior pairs, with 2 spines in each, these with 3, the spines of the posterior cerarii much larger than the others, intermediate cerarii with, on the average, about 10 pores and 2 accessory setae, but these numbers varying, each posterior cerarius with as many as 10 large accessory setae and around 50 triangular pores, these scattered, each posterior cerarius underlaid by a chitinous thickening, fairly distinct in stained mounts; apical seta about 200 μ long, without any definite ventral thickening accompanying it; anal ring typical for the genus,

with inner and outer pore bands and 6 setae averaging about 196 μ long; body with the usual type of pores, the small triangular sort occurring both dorsally and ventrally in loose and indistinct transverse bands in the abdominal region, apparently indiscriminately scattered anteriorly, multilocular disk pores present ventrally in 5 transverse segmental rows in the abdominal region; large tubular ducts apparently confined to 1 opposite or nearly opposite and dorsad of each cerarius, and 1 or perhaps sometimes more on the median line anterior to the anal ring, small tubular ducts present in a loose cluster beneath each of the posterior 5 or 6 pairs of abdominal cerarii, the size of the clusters diminishing anteriorly, number and arrangement of these pores apparently showing con-

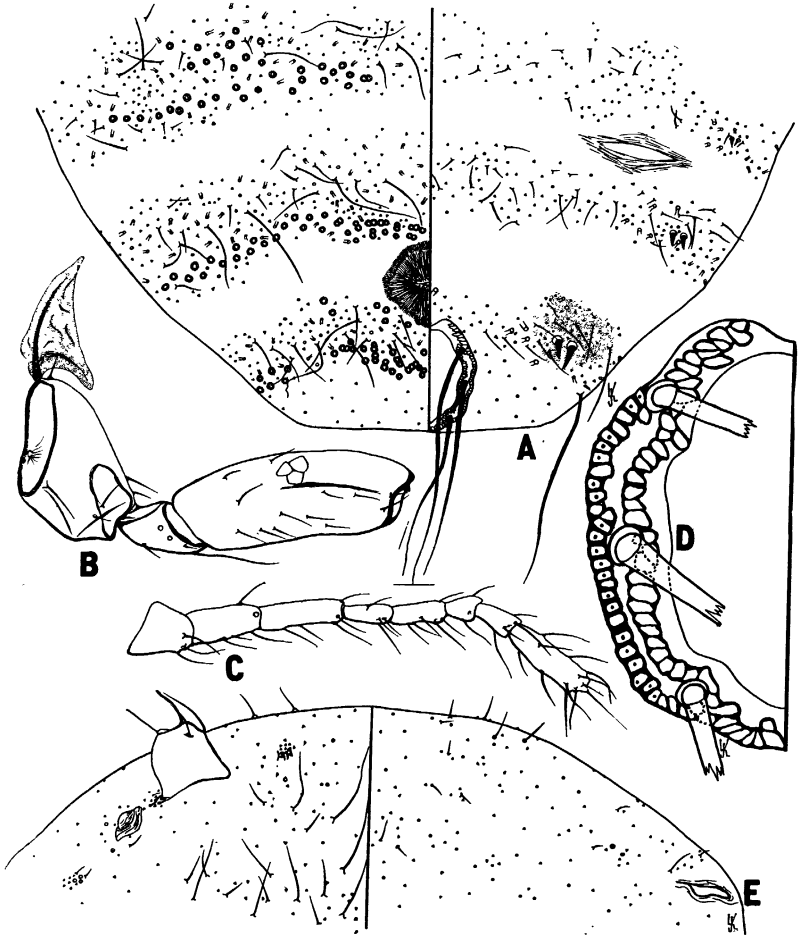

FIG. 4.—*Pseudococcus calceolariae*, adult female: A, apex of abdomen, × 120; B, portion of leg, × 120; C antenna, × 120; D, anal ring, × 530; E, apex of head, × 120

siderable variation, and in indefinite transverse ventral rows accompanying the large disk pores; dorsal setae small, in scattered transverse bands, ventral setae varying, but mostly much longer and relatively more slender, quite conspicuous, particularly anterior to the mouth parts; with a single, unusually large, quadrate ventral cicatrix.

This species has been redescribed from the three imperfect adult females from the original Maskell slide mounts having the following data: "from *Traversia*, June 1878."

This insect should be added to the group of species including *maritimus* (Ehrhorn), *adonidum* (Linnaeus) and *comstocki* (Kuwana). It resembles the last more closely than any other mealybug that the writer is familiar with, having the general organization of the pores and ducts and the posterior cerarii almost identical, but differing in apparently lacking a ventral chitinized thickening, and, on the head, in having the dorsal body setae shorter and more conspicuously

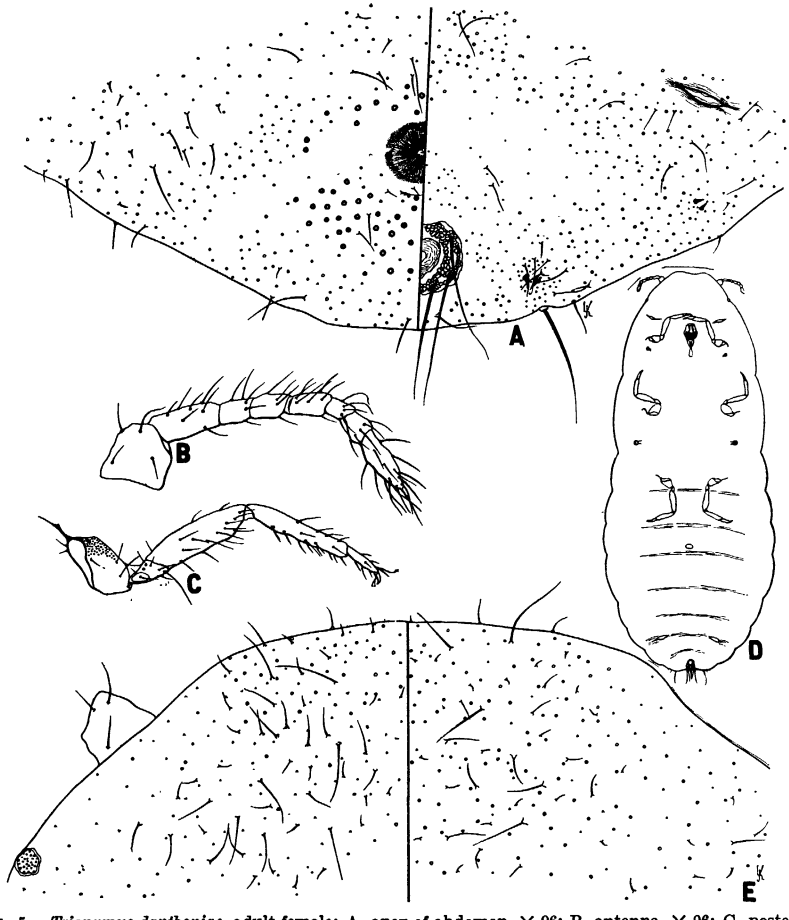

FIG. 5.—*Trionymus danthoniae*, adult female: A, apex of abdomen, × 96; B, antenna, × 96; C, posterior leg, × 96; D, outline of body, optical section, × 10; E, apex of head, × 96

contrasted with the ventral in size, and finally in having fewer multilocular disk pores and ventral tubular ducts than are present in *comstocki*.

Genus TRIONYMUS Berg

Trionymus danthoniae, new species (fig. 5)

ADULT FEMALE.—(See Maskell paper (*10, p. 138–139*) for all available information regarding external appearance; described here from slide mount only.) Length 5.75 mm., width 2.5 mm., nearly parallel-sided with ends of body rounded, segmental constrictions more or less evident; antennae normally 8-segmented, average length of the segments in microns about as follows: I, 80; II, 89; III, 52;

IV, 45; V, 57; VI, 34; VII, 43; VIII, 86; the second segment thus the longest; legs not unusual, hind coxae with pores near base, at least, claw rather stout, somewhat curved, claw digitules stouter than those of tarsus, both pairs exceeding the tip of the claw, tibia and femur about equal in length, tibia about three times length of tarsus; beak stout conical, about as broad at base as length; with only the two posterior pairs of cerarii with the spines developed, these with 2 stout conical spines accompanied by several triangular pores in each, and with a loose cluster of 4 to 5 setae outside the spines; location of some additional cerarii indicated by presence of 1 or 2 larger setae at appropriate place on body margin, but no other definite cerarii present; anal lobes, as such, not indicated, apical seta large, about 196 μ long, without ventral chitinous thickening but with a ventral subapical seta about 90 μ long; body with small triangular disk pores of the normal type, occurring both dorsally and ventrally in indistinct transverse bands of widely scattered pores, with circular multilocular disk pores in indefinite transverse bands of scattered pores in the posterior abdominal region, with a few pores distributed apparently indiscriminately over the midventral area as far anteriorly as around the base of the mouth parts, and with numerous short tubular ducts distributed much in the same fashion as the triangular pores, but most numerous and conspicuous along the body margin; body setae scattered, varying considerably in size, with large setae both dorsally and ventrally, more conspicuous on the head than elsewhere; anal ring not unusual, with the usual inner and outer bands of pores and normally 6 setae, the longest about 183 μ; with a single, small, transversely oval, ventral cicatrix placed on the median line well back of the posterior legs.

This species has been described from two specimens from the Maskell collection, one, the holotype, one of Maskell's slides bearing the notation "*Dactylopius calceolariae.* From Danthonia (grass) (Stewart's Island). Adult. Sept. 1880, W. M. M.," the other mounted from the bottle of miscellaneous specimens labeled "*Dactylopius calceolariae,*" but without further data, received from the Canterbury Museum.

The holotype has been returned to New Zealand, and the paratype has been retained in the United States National collection of Coccidae.

TRIONYMUS DIMINUTUS (LEONARDI) (fig. 6)

ADULT FEMALE.—External appearance extensively described and figured by Maskell (*11, p. 100*) (as *calceolariae*) and by Leonardi (*8*); size apparently variable, maximum length as mounted 5 mm., maximum width 2.5 mm., but most examples smaller than this; antennae normally 8-segmented, average lengths of segments in microns about as follows: I, 72; II, 76; III, 50; IV, 41; V, 49; VI, 34; VII, 45; VIII, 96; legs not unusual, hind coxae with pores near base, lengths of this leg in microns: Coxa 215, trochanter 125, femur 243, tibia 268, tarsus 115, claw 35, without denticle, claw digitules thickened somewhat, tarsal slender, both expanded at apices and exceeding tip of claw; beak short conical, about 125 μ long and 118 μ wide at base, indistinctly 2-segmented; without recognizable cerarii anterior to the 3 or 4 posterior abdominal pairs, the two posterior each with 2 spines, the antepenultimate with 2 spines or 1 spine and 1 spine-like seta or 2 spine-like setae, the next with 2 spine-like setae or not evident; none of cerarii underlaid by chitinized thickenings, triangular pores somewhat more numerous around each pair of spines, but hardly definitely clustered; apical cerarii each with as many as 11 setae above and around the spines, possibly to be considered as associated with it, but not intimately, remaining developed cerarii with as many as 4 or 5 setae adjacent to, but not intimately associated with, the spines; anal lobes not protruding, apical setae stout, about 175 μ long, somewhat longer than those of anal ring (these about 130 μ), without any ventral chitinized thickening; anal ring normal, with inner and outer pore rows and 6 setae; ventral cicatrix small, transversely oval, the posterior side often bulging more or less distinctly; with the usual types of pores present, the triangular type more or less uniformly distributed over both surfaces, the multilocular disk type likewise present on both surfaces, very abundant in the posterior ventral abdominal region, less abundant but still numerous over the whole of the remainder of the ventral surface, much fewer and more widely scattered over the dorsal surface; ducts reduced to a few of the short, small tubular sort along the body margin; body setae fairly large and conspicuous for the genus, longest near body margins, and longer beneath than above, varying considerably in size.

This species has been redescribed from several specimens mounted from the Maskell material of "*calceolariae*," but without precise data, and from specimens from California on Phormium, with reference to Leonardi's description of *diminutus*. It appears from this material that there is definite variation in the number and development of the posterior cerarian spines, or perhaps more precisely, in the extent to which the tendency toward reduction and modification has affected these structures. The outstanding characteristic of the

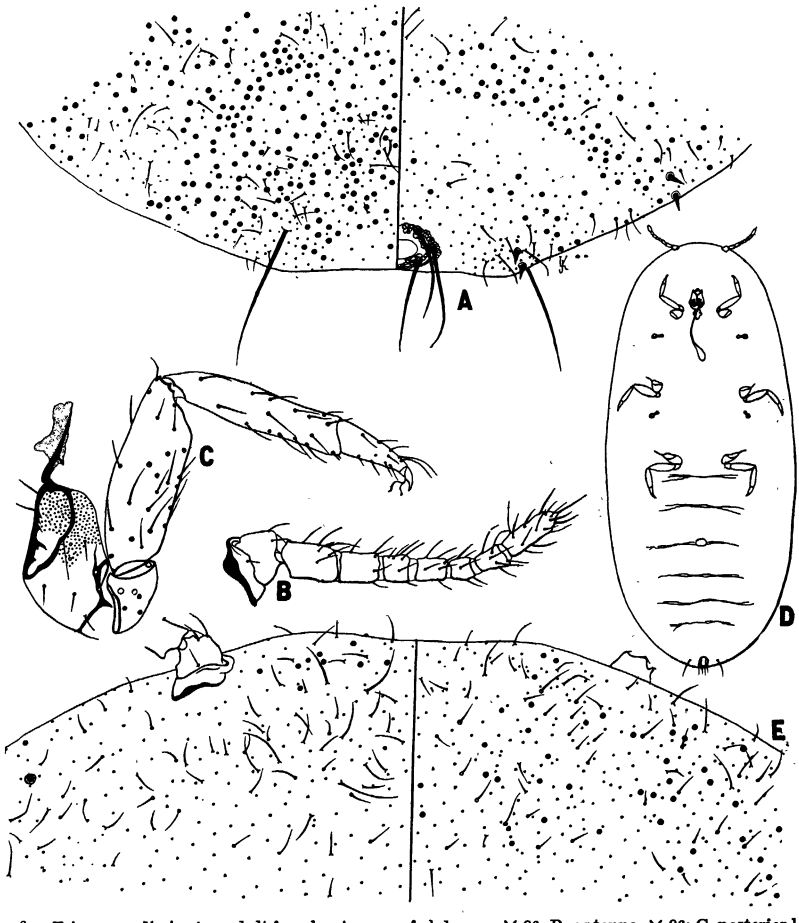

FIG. 6.—*Trionymus diminutus*, adult female: A, apex of abdomen, × 96; B, antenna, × 96; C, posterior leg, × 96; D, outline of body, optical section, × 10; E, apex of head, × 96

pecies, in connection with the cerarian reduction, is the profuse development of the, normally, ventral abdominal, multilocular disk pores and their occurrence on the dorsum as well as over the whole ventral surface.

So far as positively known, the species is normally confined to Phormium as a host, although, as pointed out in discussing the intricacies of Maskell's utilization of the name *calceolariae*, the specimens recorded by him from *Cordyline australis* in 1893 may reasonably be given a tentative assignment here.

THE DIFFERENTIATION OF THE SPECIES INVOLVED

The key offered below, which will, it is hoped, facilitate the recognition of the species under discussion, is enlarged to include all of the species of mealybugs that have been recorded as occurring on sugar cane, in the belief that its usefulness will be greatly increased thereby. These additional species, so far as the available records show, are *Ferrisia virgata* (Cockerell), *Pseudococcus brevipes* (Cockerell) (*bromeliae* of most authors), *citri* (Risso), *saccharifolii* (Green), *Ripersia sacchari* (Green), and *Trionymus sacchari* (Cockerell). One record for *Pseudococcus maritimus* (Ehrhorn) is available, but here the species was taken in a greenhouse where the host was closely associated with a number of other plants capable of serving as hosts for it, so it is not considered a sufficiently normal record to justify the inclusion of the species in the key. Some other species of mealybugs have been reported from sugar cane in literature, but since the correctness of the identifications is not certain they are not included here. Usable descriptions and illustrations of the species *Ferrisia virgata* (Cockerell) (as Pseudococcus), *Pseudococcus brevipes* (Cockerell) (as *bromeliae*), and *Trionymus sacchari* (Cockerell) (as Pseudococcus) have been given by the writer (*16, p. 171–175*); *Ripersia sacchari* was described and figured in 1900 by Green (*4, p. 37–38*), as was *Pseudococcus saccharifolii* in 1908 (*5, p. 23–24*). Unless otherwise indicated, authentic specimens of each species included in the key which follows have been examined.

Key for separation of the species of mealybugs previously discussed

a. Cerarian spines and indications of cerarii entirely wanting---------- *Ripersia sacchari* Green [4]

aa. At least the apical abdominal pair of cerarian spines present, and that cerarius more or less distinctly developed.

b. Body with numerous large tubular ducts, each opening in a circular chitinized plate bearing setae, these ducts more or less clustered and in part replacing in position the anterior abdominal cerarii; only the apical pair of abdominal cerarii developed---------- *Ferrisia virgata* (Cockerell)

bb. Without such large ducts opening through plates.

c. With only the apical cerarian spines present, these cerarii indistinctly developed; margins of abdominal segments, anterior to apical, each bearing a long seta approximating the apical seta in length; body very stout at maturity---- *Trionymus sacchari* (Cockerell)

cc. With two or more apical pairs of cerarii developed; without large marginal setae anterior to the apical pair; body more elongate.

d. No cerarian development on head; not more than four pairs of abdominal cerarii developed.

e. Only the two posterior pairs of cerarii developed; multilocular disk pores scattered very sparsely over ventral surface of body, numerous around genital opening only-- *Trionymus danthoniae*, new species.

ee. With three or four posterior pairs of cerarii more or less developed; multilocular disk pores relatively very abundant over whole ventral surface and also sparingly present dorsally---------- *Trionymus diminutus* (Leonardi)

[4] Included from a study of the original description only; no specimens examined.

dd. At least one pair of cerarii present on head between antennae; at least four, and usually more, distinctly developed pairs of abdominal cerarii present.
f. Apical abdominal cerarii each normally with more than two spines.
g. Apical abdominal cerarii each normally with four spines; series of cerarii incomplete, one cephalic and five abdominal pairs present---------- *Pseudococcus ambiguus*, new species
gg. Apical abdominal cerarii each normally with eight spines; series of cerarii complete, present on both thorax and abdomen---- *Pseudococcus saccharifolii* (Green).[5]
ff. Apical abdominal cerarii each normally with only two spines.
h. Series of cerarii incomplete, only one pair on the head and the five or six posterior abdominal pairs developed, all the abdominal with not more than two spines---------- *Pseudococcus boninsis* (Kuwana)
hh. Series of cerarii complete, at least 17 pairs present.
i. With 18 pairs of cerarii, each with two spines; ventral chitinized thickening of anal lobes elongate, nearly linear, apical seta of anal lobes about twice length of anal ring setae---------- *Pseudococcus citri* (Risso)
ii. With 17 pairs of cerarii, some of these with more than two spines; apical seta of anal lobes not much longer than anal ring seta.
j. Some, at least, of intermediate abdominal cerarii with more than two spines in each; ventral chitinized thickening present, irregularly quadrate---------- *Pseudococcus brevipes* (Cockerell)
jj. All abdominal cerarii normally with two spines in each; ventral chitinized thickening not noticeably developed---------- *Pseudococcus calceolariae* (Maskell)

SUMMARY

The specific name *calceolariae* has, through misidentifications, been used in literature to designate several different species of mealybugs. Properly, its use must be restricted to specimens identical with those collected by Maskell at Christchurch, New Zealand, on Traversia, in 1878. The name *Trionymus danthoniae*, new species, should be applied to specimens from Danthonia from New Zealand previously identified as *calceolariae;* the name *Trionymus diminutus* (Leonardi) should be applied to specimens from *Phormium tenax* from several

[5] Included from a study of the original description only; no specimens examined.

localities throughout the world, previously identified as *calceolariae;* the name *Pseudococcus boninsis* (Kuwana) should be applied to specimens of an elongate gray mealybug already known to occur on sugar cane in many parts of the world and previously identified as *calceolariae.* Some references in literature to the species *Pseudococcus saccharifolii* (Green) and *Trionymus sacchari* (Cockerell), both of which, from the information available, are distinct and valid species, actually refer to *Pseudococcus boninsis* (Kuwana). The variety *minor* (Maskell) of the species *calceolariae* is identical with *Pseudococcus citri* (Risso).

The various species involved under the name *calceolariae* may be recognized from the detailed descriptions and from the key given in the body of the paper, while all of the mealybugs definitely known to occur normally on sugar cane may be separated by this same key.

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