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TAXONOMIC ANALYSIS OF *PSEUDOCOCCUS AFFINIS* (MASKELL), A SENIOR SYNONYM OF *PSEUDOCOCCUS OBSCURUS* ESSIG, AND A COMPARISON WITH *PSEUDOCOCCUS MARITIMUS* (EHRHORN) (HOMOPTERA: COCCOIDEA: PSEUDOCOCCIDAE)

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Abstract.—Examination of type specimens of *Dactylopius affinis* Maskell, 1894, has demonstrated that it is the senior synonym of the obscure mealybug, *Pseudococcus obscurus* Essig, 1909; *P. affinis* now is the correct name for this taxon. A statistical analysis was made of the characters that best separate the pest mealybugs *Pseudococcus affinis* and *P. maritimus*. These characters are: the number of discoidal pores near the eye, the number and distribution of dorsal oral-rim tubular ducts, the length of the longest seta on the venter of abdominal segment VII, the number of translucent pores on the hind tibiae and femora, the number of multilocular pores on the venter of the thorax, the length of the apical setae, and the shape of the hind tibiae. These characters used in combination will allow accurate identification of these important agricultural pests for the first time. Lectotypes are designated for *P. obscurus, P. longispinus* var. *latipes* Green, *Dactylopius maritimus* (Ehrhorn), *P. bakeri* Essig, and *P. omniverae* Hollinger.

In 1900, Ehrhorn described *Pseudococcus maritimus* (Ehrhorn) from California. Between 1900 and 1961 several segregates of *P. maritimus* were described and synonymized and there was considerable confusion concerning the identity of the components of the complex. The United States National Museum of Natural History (USNM) contains approximately 1000 slides that were identified as *P. maritimus* between 1900 and 1961. This series contains no less than 10 different species, some of which are quite distinctive, but others that are very similar to one another.

In 1961 Wilkey and McKenzie studied a complex of species of *Pseudococcus* that they called the "*maritimus-malacearum* complex." Although several species were included, one important aspect of the research was that it provided the first basis for the separation of *P. maritimus* and *P. affinis* (Maskell) (= *P. obscurus* Essig). Although several characters were mentioned, the number of translucent pores on the hind femur and tibia was the basis of the separation. They briefly mentioned other differences but these characteristics were not used when separating species. In 1962 McKenzie mentioned the translucent pores again stating that *P. affinis* sometimes possessed fewer such pores than mentioned in his earlier paper with Wilkey. In 1967 McKenzie used the presence of discoidal pores near

the eye as a primary couplet in his key to the North American species of *Pseudococcus* and separated *P. maritimus* and *P. affinis* (= *P. obscurus*) on that basis. In the description of *P. affinis* he mentioned his data on the translucent pores on the hind legs, but he did not discuss other differences. In 1966 Beardsley presented a key that included *P. maritimus* and *P. affinis* (= *P. obscurus*) and separated them by the number of translucent pores, the shape of the hind tibia, and the length of the labium. Gimpel (1983) completed a dissertation on the systematics of the *P. affinis* group and used the number and distribution of oral-collar tubular ducts on the ventral submargin to separate several species including *P. affinis* and *P. maritimus*.

The purpose of this paper is to reexamine the taxonomic characters of *P. maritimus* and *P. affinis*, to present more detailed information on the characters that were mentioned only briefly in Wilkey and McKenzie (1961) and Beardsley (1966), to discuss a few additional characters, and to draw attention to new synonymy of *P. affinis* and *P. obscurus*.

It seems of value at this point to emphasize that no single character can be used to separate *P. maritimus* and *P. affinis* in all specimens. It is necessary to look at a combination of characters and a series of specimens to make a decision concerning the identity of an unknown population. A similiar situation was demonstrated in *Pseudaulacaspis pentagona* (Targioni-Tozzetti) and *P. prunicola* (Maskell) (Davidson et al., 1983).

Methods

Several hundred specimens were examined including type material of *P. affinis*, *P. capensis* Brain, *P. longispinus* var. *latipes* (Green), *P. malacearum* Ferris, and *P. maritimus*. Originally specimens were segregated to either *P. affinis* or *P. maritimus* based on the characteristics listed by Wilkey and McKenzie (1961), i.e., the occurrence of the tenth cerarius, the number of dorsal oral-rim tubular ducts, the size of the dorsal oral rims, the number of discoidal pores associated with each eye, the shape of the hind tibia, and the number of translucent pores on the hind tibia and femur. As stated by Wilkey and McKenzie, these characters are not always consistent with each other; therefore we grouped the specimens together if they possessed a majority, but not necessarily all, of the characteristics of one of the two species. After a preliminary analysis of each of the characters mentioned above, additional characters were added that appeared to conform to the original concept of the species. Some of the original characters were deleted because they were determined to be statistically identical. The data presented in Table 1 are based on 37 specimens of each species from a diversity of locations and hosts. The specimens are marked with a number and are deposited in the U.S. National Museum of Natural History (USNM). Terminology used in the text is that of McKenzie (1967) except that the cerarii are numbered from the posterior pair to the anterior pair with number one on the anal lobe and number 17 on the head. Abdominal segmentation follows that of Beardsley (1966) with the first visible segment being segment I and the segment containing the anal lobe being segment VIII.

Analysis of data was done using the Median Test, a nonparametric statistical test (Conover, 1971). Nonparametric statistical tests are used when the form of the sample distributions is not specified at the moment. The characters measured

Table 1. Comparison of characters of *Pseudococcus affinis* (aff.) and *P. maritimus* (mar.). For each character differences between species were detected with a median test. For each character significant differences were found. The symbol "n" represents the number of observations not the number of specimens.

Characters	Spp.	n	Range	Mean	Median	T Value	Signif. Level
No. discoidal pores near eye	aff.	69	0–5	2.3	2	91.28	$P < .001$
	mar.	71	0–2	0.4	0		
No. oral rims on dorsal abdomen	aff.	37	9–18	13.2	13	70.11	$P < .001$
	mar.	37	18–38	29.3	30		
Length longest seta on venter of VII	aff.	37	42–84	67.1	67	43.97	$P < .001$
	mar.	37	54–119	85.2	86		
No. translucent pores on hind tibia	aff.	37	47–137	82.3	75	42.41	$P < .001$
	mar.	37	15–68	34.7	30		
No. translucent pores on hind femur	aff.	37	18–97	50.4	49	40.91	$P < .001$
	mar.	36	2–73	23.5	24		
No. multilocular pores on venter of thorax	aff.	37	0–8	1.5	1	14.67	$P < .001$
	mar.	36	1–23	9.1	4		
Length of apical seta	aff.	31	106–153	128.2	128	8.75	$P < .005$
	mar.	30	128–173	150.1	153		

present several properties that preclude them from being normally distributed. One measure of a normal distribution is that the median and the mean are equal. Note in Table 1, that in *P. maritimus* the mean of the number of multilocular disk pores on the venter of the thorax is 9.1 and the median is 4. This difference may not seem large, however, an analysis of the frequency distribution of this character reveals that it is skewed to the lower values. The median is a more exact measure of central tendency. In *P. affinis* the discrepancy between the mean (82.3) and the median (75) numbers of translucent pores on the hind tibia is not as great in relative magnitude as the above mentioned character. A closer look at the frequency distribution, yields an extreme mode of 70, a slightly skewed distribution favoring the lower values, with a tendency to bimodality. Even those characters that have reasonably equal means and medians, at times present problematic distributions. For example, in *P. maritimus* for the number of translucent pores on the hind femur the values of the mean and the median are almost identical (23.5 vs 24.0), yet the frequency distribution consists of a clump of outliers for the larger values (45–73). This again may indicate the possibility of biomodality. With problems of this sort, the assumption of normality or the possibility of finding a perfect transformation in order to enforce normality, becomes less tenable. Therefore, nonparametric statistical tests for possible differences in the measured characters is the simplest resort.

Results

We have found the following characters to be useful in combination (Table 1): (the number in parentheses in the following comparison is the mean rounded off to the nearest whole number) *Pseudococcus affinis* has 0–5(2) discoidal pores associated with each eye; 9–18(13) oral-rim tubular ducts on the dorsal abdomen; longest seta on the ventral area of segment VII 42–84(67) μ long; 47–137(82) translucent pores on the hind tibia; 18–97(50) translucent pores on the hind femur;

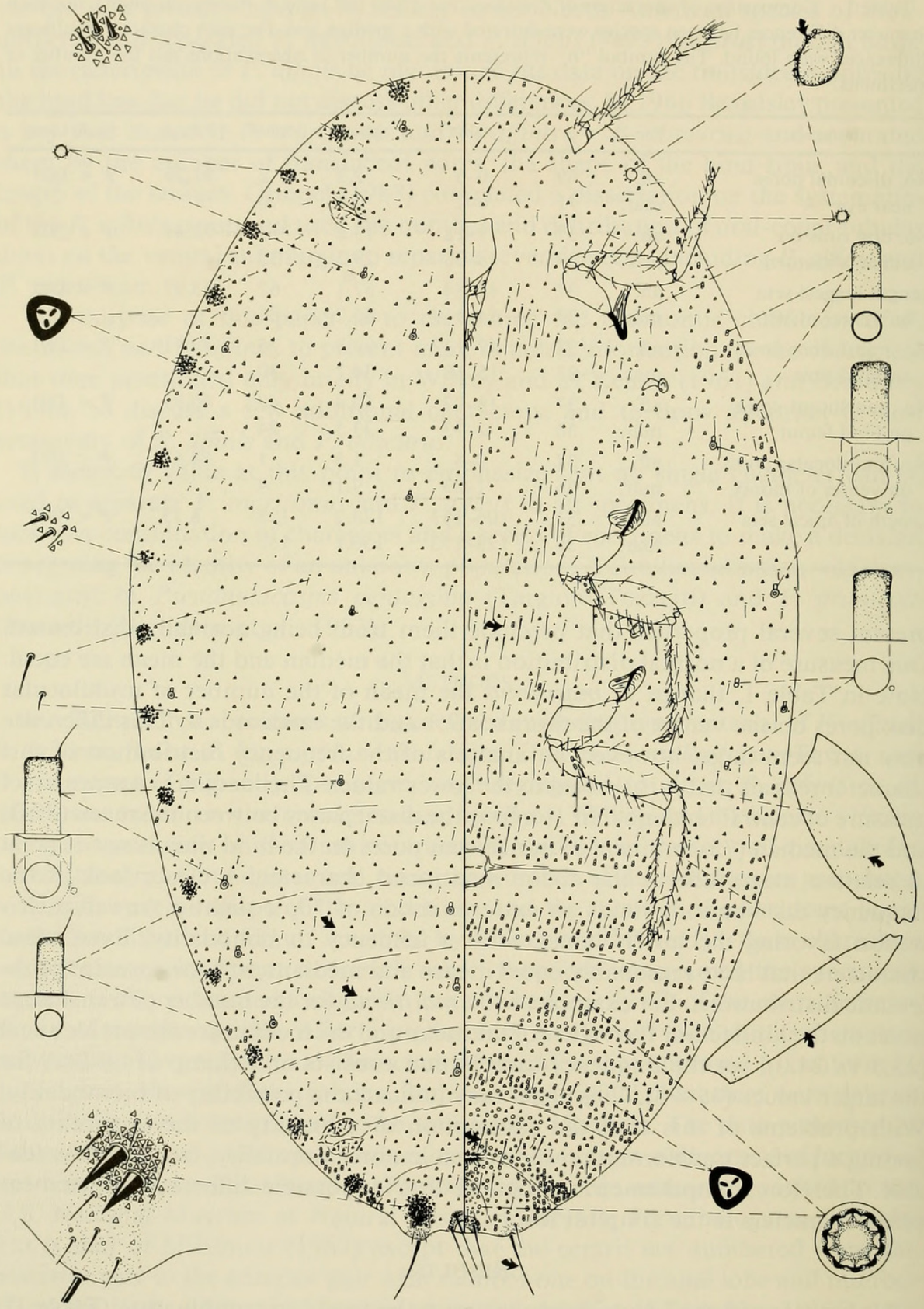

Fig. 1. *Pseudococcus affinis* (Maskell), Camberley, England, in greenhouse, November 10, 1916, on *Fuchsia* sp. Arrows point to diagnostic features.

0–8(2) ventral multilocular disk pores on the ventral thorax; longest anal-lobe seta 106–153(128) μ long (Fig. 1). *Pseudococcus maritimus* has 0–3(0) discoidal pores associated with each eye; 18–38(29) oral-rim tubular ducts on the dorsal abdomen; longest seta on the ventral area of segment VII 54–119(85) μ long; 15–68(35) translucent pores on the hind tibia; 2–73(23) translucent pores on the hind femur; 1–23(9) ventral multilocular disk pores on the ventral thorax; longest anal-lobe seta 128–173(150) μ long (Fig. 2).

We also examined the size and distribution of the oral rims on the abdomen, the occurrence and relative development of cerarius 10, the length of the labium, and the shape of the hind tibia. In *P. affinis* of the 37 specimens examined, only two possessed mediolateral oral rims on segment III, and mediolateral oral rims were absent from segments IV and V in all specimens. In *P. maritimus* the opposite was true; of the 37 specimens examined, three were without mediolateral oral rims on segment III, one was without mediolateral oral rims on segment IV, and five were without mediolateral oral rims on segment V, the remaining specimens had oral rims in these positions. We could detect no consistent difference in the relative sizes of the oral rims, although the border of the rims on *P. affinis* tended to be less evident than on *P. maritimus*. Differences were slight at best in the occurrence of the tenth cerarius. In *P. maritimus*, of 37 specimens, 29 had definite cerarii with two conical setae, seven had indefinite cerarii with a single conical seta or one or two slender setae, and one specimen lacked cerarii in this position. In *P. affinis*, of 37 specimens examined, 19 had definite cerarii, 10 had indefinite cerarii, and eight had no tenth cerarius. Although we measured the labium length of 36 specimens of each species, we could find no difference in the length of this structure ($P < 0.250$). The hind tibia of most specimens of *P. affinis* is swollen, while in *P. maritimus* it only occasionally is swollen. Unfortunately, this character could not be quantified sufficiently to demonstrate an obvious difference.

Synonymy

Pseudococcus affinis (Maskell)

Dactylopius affinis Maskell 1894:90.
Pseudococcus affinis (Maskell); Fernald 1903:97.
Pseudococcus obscurus Essig 1909:43 **New Synonymy.**

Based on our examination of primary types of both *P. affinis* and *P. obscurus* and on other pertinent specimens, we are confident that these species are synonyms. Both possess the diagnostic characters of the species including the unusual features of having few dorsal oral-rim tubular ducts and large numbers of translucent pores on the hind femur and tibia. The only feature that is different on the adult female syntype of *P. affinis* is that there are about 150 translucent pores on the hind tibia. We do not consider this to be sufficient to distinguish it from *P. obscurus* considering the large range of variation that we have observed in other material (47–137).

Pseudococcus capensis Brain 1912:182 **New Synonymy.**
Pseudococcus longispinus var. *latipes* Green 1917:264 **New Synonymy.**
Pseudococcus malacearum Ferris 1950:185 **New Synonymy.**
Pseudococcus latipes Green; Williams 1962:40 **New Synonymy.**

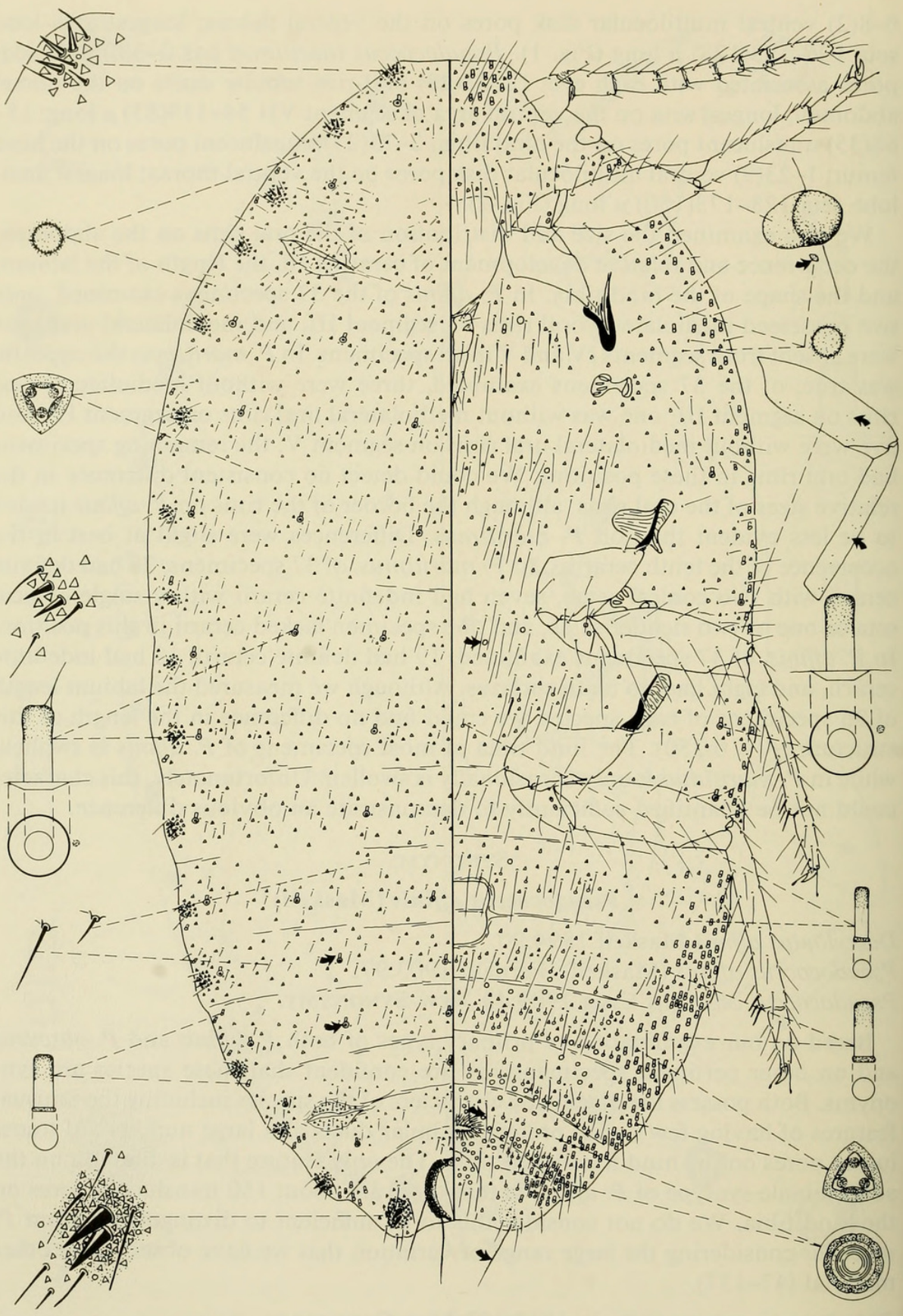

Fig. 2. *Pseudococcus maritimus* (Ehrhorn), Santa Cruz, California, July 1899, on *Eriogonum* sp. Arrows point to diagnostic features.

***Pseudococcus maritimus* (Ehrhorn)**

Dactylopius maritimus Ehrhorn 1900:316.
Pseudococcus bakeri Essig 1910:339.
Pseudococcus omniverae Hollinger 1917:271.
Pseudococcus maritimus (Ehrhorn); Ferris 1918:48.

TYPES

1. *Dactylopius affinis* Maskell.—According to Deitz and Tocker (1980) there are three original slides of this species each containing a single specimen. We have examined these slides and under normal circumstances we would designate a lectotype. Unfortunately, the best specimen from the series has been misplaced by Miller at the facilities at Beltsville, and the remaining two specimens (an immature and a portion of the head of an adult female) are inappropriate for lectotype designation unless no other material is found. Therefore we have decided to delay designating a lectotype at this time. Two of us (Miller and Williams) have examined the lost adult female; in fact, Williams studied the specimen in his analysis of data for this paper while the specimen was still in London. Based on these observations, we have no doubt about the correct identity and characteristics of the type series of *Dactylopius affinis.* The specimens were collected in Australia on tubers of dahlia and potato by Mr. Olliff in 1893. The three slides are the property of the Department of Scientific and Industrial Research, Auckland, New Zealand Collection of Arthropods.

2. *Pseudococcus obscurus* Essig.—There are 16 syntype specimens on two slides that are deposited in the California Academy of Sciences, San Francisco (CAS). From the series we have selected as lectotype an adult female that is one of eight mounted on a slide. The lectotype is located on the bottom, right side of the coverslip. The slide has the right label "Pseudococcus/obscurus/CoTypes Essig"; left label "Cactus/Opuntia/sp."; on the back of the slide the right label gives a map showing the position of the lectotype and states "Pseudococcus/obscurus Essig/paralectotypes/Lectotype/designated 1984/Miller, Gill, Williams"; left label "California Academy/of Sciences/Entomology Type/No.11420." The remaining syntypes are considered to be paralectotypes.

3. *Pseudococcus capensis* Brain.—We have examined the holotype and four paratypes of this species. The holotype is in the USNM and has the right label under a square coverslip "*Pseudococcus/capensis* Brain./on *Phytolacca dioica/* Piper./Rosebank. C. P./July, 1911./-Type-"; the left label is under a round coverslip "54./C.K.B." There are 3 additional paratypes from the same locality collected May 12, 1910 that are in the USNM. A single paratype from the same locality collected July 11, 1911 is in the British Museum (Natural History), London (BM).

4. *Pseudococcus longispinus* var. *latipes* Green.—There are five syntypes of this species mounted on a single slide deposited in the BM. From the series we have selected as lectotype an adult female that is the center specimen in the row of three specimens at the bottom of the coverslip. The slide has the right label "Pseudococcus/longispinus (longispinus is marked through with a pen)/maritimus Targ (Targ is marked through with a pen)/on Fuchsia/(underglass)/Camberley, Surrey/England. 10-XI-1916/ (see Journal p.ub.e)"; left label "Pseudococcus/lon-

gispinus var. latipes/Green/LECTOTYPE./PARALECTOTYPE" and a map showing the position of the Lectotype. The remaining syntypes are considered to be paralectotypes.

5. *Pseudococcus malacearum* Ferris.—The lectotype of this species was designated by Wilkey and McKenzie (1961). This specimen originally was mounted on a slide with four other syntypes including four adult females and one immature. While preparing the 1961 paper, Wilkey remounted the specimens and placed each on a separate slide. The adults were numbered from one to four and the immature was labelled as "immature paratype." Unfortunately, we have been unable to locate the lectotype, but we have examined the remaining paralectotypes and it is clear to us that they are conspecific with *P. maritimus*. Presumably, the lectotype slide is number three and has a label identical with the paralectotypes excluding the type designation; therefore we are giving label information from one of the paralectotypes. The left label is as follows: "Pseudococcus/malacearum/ Ferris/'*paratype*' #1/Det. by/*remounted from/type slide*/9-X-61 RFW C^4H^8O/Piccolyte"; right label "No. 46K 139 Cal. Dept. Agr./Loc. Santa Clara/California/ 21-X-1946/ex. pear/H. S. Smith coll." The lectotype, when found, should be deposited in UCD; an additional adult female paralectotype and the immature paralectotype are in UCD. The remaining two paratypes are deposited in the collections of the California Department of Food and Agriculture, Sacramento and the USNM.

6. *Dactylopius maritimus* Ehrhorn.—There are 10 syntypes deposited in the USNM and seven deposited in the BM. From the series we have selected as lectotype an adult female mounted alone on a slide. The slide has the right label "remounted from a/slide labeled as follows/Dactylopius maritimus/Ehrh/Type/ on Eriogonum roots/Santa Cruz Cal/3 of 5 drawn"; left label "Pseudococcus/ maritimus/(Ehrhorn)/Lectotype/designated by/Miller, Gill, and/Williams." The lectotype is deposited in the USNM and is one of five syntypes that originally was mounted on a slide containing five specimens; these syntypes were remounted and placed individually on separate slides.

7. *Pseudococcus bakeri* Essig.—There are four syntype specimens mounted on two slides deposited in the CAS. Slide number one contains three specimens; the specimen on the left is circled in red and is here designated as the lectotype. The slide has the right label "LECTOTYPE/1/Pseudococcus/bakeri/Co*Types Essig*/ PARALECTOTYPE"; left label "*Eng. Walnut*/Juglans/regiae"; a label on the back of the slide states "California Academy/of Sciences/Entomology Type/No. 11419." Slide number two contains one specimen and has the same labels and data as given above except there is no left label.

8. *Pseudococcus omniverae* Hollinger.—One slide mounted specimen is the only type material known to us. The specimen is in good condition and is here designated as lectotype. The label on the right side of the slide states "*Pseudococcus/ omniverae* Hol./On *Tilia/americana.*/Columbia, Mo/Aug. 1916/From A. H. Hollinger/Entomological Laboratory/Stanford University"; left label "LECTOTYPE." The lectotype slide is deposited in UCD.

Distribution

We have examined specimens of *P. affinis* from the following locations: Argentina, Australia, Azores, Belgium, Brazil, Canada, Canary Islands, Chile, Costa Rica, Denmark, Easter Island, Ecuador, England, France, Germany, Guatemala,

Holland, Italy, Korea, Madeira Island, Mexico, Morocco, Netherlands, New Zealand, Panama, People's Republic of China, Portugal, Scotland, Sri Lanka, Spain, Sweden, South Africa, United States (California, Connecticut, Delaware, District of Columbia, Georgia, Hawaii, Illinois, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, Washington, Wisconsin), Uruguay, Venezuela.

We have examined specimens of *P. maritimus* from the following locations: United States (Arkansas, California, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Maryland, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia). Outside of the United States we have seen specimens of this species only from two collections from Mexico. We have been unable to substantiate the many literature records from the rest of the world and suspect that most of them are based on misidentifications.

Key

The key presented by McKenzie (1967) does not work for all specimens of either *P. affinis* or *P. maritimus*. The key should be modified as follows: (Items italicized are new modifications to the key).

6(5). *Femur of hind leg with translucent pores* 6a
– Femur of hind leg without translucent pores 7
6a(6). *Tibia of hind leg with 35–135(82) translucent pores; with 9–18(13) dorsal oral-rim tubular ducts on abdomen; dorsal oral rims usually absent from mediolateral areas of segments IV and V* ..... *affinis (Maskell)(in part)*
– *Tibia of hind leg with 15–68(35) translucent pores; with 18–38(29) dorsal oral-rim tubular ducts on abdomen; dorsal oral rims usually present on mediolateral areas of segments IV and V* ..... *maritimus (Ehrhorn)(in part)*
9(8). With not more than 7 oral-rim tubular ducts on dorsum of abdomen 10
– With at least 9 oral-rim tubular ducts on dorsum of abdomen 12
19(18). *Dorsal oral rims usually absent from mediolateral areas of segments IV and V* 20
– *Dorsal oral rims present on mediolateral areas of segments IV and/or V* ..... *maritimus (Ehrhorn)(in part)*
20(19). *Without oral-collar tubular ducts in ventral submarginal cluster between cerarii 10 and 11, occasionally with 1 or 2 such ducts in this area* ..... *affinis (Maskell)(in part)*
– *With cluster oral-collar tubular ducts in ventral submarginal area between cerarii 10 and 11* ..... *kingii (Cockerell)*

Discussion and Conclusions

It seems clear to us that *P. affinis* is the senior synonym of *P. obscurus*. The type specimens of each name possess the unique characters that we believe are important in separating the species from the remaining members of the *P. affinis* complex.

We have no doubt that *P. affinis* is distinctive when compared with *P. maritimus*. Characteristics that distinguish them are the number of discoidal pores associated with the eye, the arrangement and number of dorsal oral-rim tubular ducts, the absolute length of the apical setae, the length of the longest ventral body setae on segment VII, the number of translucent pores on the hind tibia and femur, the number of multilocular disk pores on the ventral thorax, the development of the tenth cerarius, and the shape of the hind tibia. Unfortunately, no single character can be used to separate these species in all specimens. It is necessary to look at a series and to use a diversity of diagnostic characters.

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NOTE

An Overlooked Generic Name in Chloropidae (Diptera)

While scanning the volume "Indian Insect Life" (1909) by H. Maxwell-Lefroy, I chanced upon the generic name *Merochlorops* for a chloropid fly. This generic name has never been noticed by specialists in the family, nor in nomenclators.

Figure 4 on colored Plate LXVI, between pp. 616 and 617, shows the egg, larva, posterior spiracles, puparium, and the adult fly with wings spread so that the venation shows clearly. There is no description, but before 1931 the publication of a name "in connection with an illustration" is an "indication" sufficient to make the name available ("International Code of Zoologial Nomenclature," Art. 16a.vii). The appearance of the imago, thorax stocky and predominantly shining black with yellow scutellum and a yellow area on each side (probably notopleuron plus mesopleuron), long veins slightly concave anteriorly, discal cell strongly widened distad to the small (r-m) crossvein and the longer outer crossvein slightly oblique, and the short and broad abdomen, readily identify the species as belonging to the genus long known as *Formosina* Becker (1911), of which *Merochlorops* is the senior synonym (**N. syn.**).

No species name is given and the species cannot be identified positively from the figure, although it appears to be *Formosina ceylanica* Duda. I hereby designate *F. ceylanica* as the type species of *Merochlorops*. If the species figured is specific to or common in the recorded niche, it might some day be confirmed by rearing. The author comments (pp. 627–628) that "The larva lives in the watery tissue of the swathing leaves round the stem of plantain-trees and under sissoo bark." The only locality mentioned is "Pusa," i.e., Darbhanga, in Bihar State, in connection with his description of a native 'doctor's' use of the larvae.

The 18 specific names listed by Sabrosky (1977, in Delfinado and Hardy, "A Catalog of the Diptera of the Oriental Region," vol. III, pp. 309–310) become new combinations with *Merochlorops*, 10 with the same spelling and 8 changed to masculine endings (*atratus, ceylanicus, cinctus, impavidus, nigrolimbatus, ochraceus, perplexus,* and *tumidus*).

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