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*Reprinted from* THE PAN-PACIFIC ENTOMOLOGIST
Vol. 50, April, 1974, No. 2
pp. 193–202
*Made in United States of America*

# Mealybugs of San Clemente Island, California

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In earlier papers (Miller, 1971, 1973) I described the mealybug faunas of Santa Cruz and San Miguel Islands and presented brief discussions relating to the Southern California Island biota.

In April 1973 Dr. Arnold Menke and I collected on San Clemente Island for eight days. Although this was an inadequate amount of time to thoroughly sample the island pseudococcids, the material obtained should allow some tentative comparisons of the mealybug fauna of this island with those of Santa Cruz and San Miguel Islands.

San Clemente Island is located approximately 49 statute miles from the nearest point on the mainland and is 21 miles from the closest island, Santa Catalina, which intervenes between the nearest mainland point and San Clemente. The island is approximately 21 miles long, about 4 miles across at its widest point, and approximately 56 square miles in land area (Philbrick, 1967). The long axis of the island is oriented approximately northwest, nearly parallel to the near mainland coast. Of the several geological studies of the island, two of the more detailed ones were published by Olmstead (1958) and Smith (1898). Geologically, San Clemente is the emergent portion of a tilted, slightly arched block of the earth's crust. A major fault is present on the sea floor at the northeastern edge of the San Clemente block, and, although movement of this fault is thought to be primarily horizontal, nearly the entire northeastern side of San Clemente Island is a single, large fault escarpment. The northeastern side of the island is very steep in contrast to the southwestern side which generally slopes gently. Both sides of the island are deeply cut by geologically young, often precipitous canyons. The highest point is Thirst (elevation 1,967 feet), located near the northeastern escarpment. The southwestern side of the island, up to 1,500 feet, shows some of the best examples of marine terracing on the Southern California Islands, with as many as 20 separate terraces visible on some slopes. The island is principally composed of volcanic rocks of probable Miocene age. Sedimentary marine deposits (Miocene), sand deposits (Pleistocene? and Recent), and alluvial deposits (Recent) overlying the volcanic rocks are scattered locally on the island. Normally the soil covering is deposited in relatively thin layers and has a high clay content. San Clemente is apparently

THE PAN-PACIFIC ENTOMOLOGIST 50: 193–202. APRIL 1974

no older than the Miocene and may be as recent as the Early to Mid-Pliocene. Most evidence suggests that this island has never been connected with the mainland or the other islands, although at times of lower sea levels, particularly during the Pleistocene, San Clemente undoubtedly was closer to other land masses than at present. As is evident from the lack of marine deposits and marine terraces above 1,500 feet elevation, the areas of the island above this level have probably been continually emergent since Miocene or Pliocene times.

Data on the weather of the island are scant, and have been summarized by Raven (1963) as follows: " . . . the east (northwestern) side of the island is apparently moister than the west (northeastern), and it is likely that the main tracks of the storms from north to south are often deflected down along the east side of the island. Generally the wind is from the sea, over the island and onto the mainland; but during the Santa Ana cycles of winter, violent and sustained winds blow off the mainland and from Santa Catalina Island toward the east side of San Clemente. These Santa Ana winds may obviously be of importance in transporting seeds (or first instar mealybugs) to the island." Most of the rainfall occurs during the winter months, but moisture producing fogs are common during rain-free times of the year. No permanent streams are present although intermittent flows are common during the rainy season. Olmstead (1958) stated that the deep plunge pools formed by intermittent waterfalls contain water throughout the year. Additional small impoundments have been constructed, but basically the island is without water during the dry months.

The predominant habitat types on the island are flat grassland areas, hilly cactus areas, deep precipitous canyons, steep cliffs, volcanic regions often with many small caves, recent sand dunes, fossil sand dunes, sand beaches, and shingle beaches.

The island reptile fauna includes only two lizard species, one belongs to an endemic genus known from San Clemente, San Nicolas, and Santa Barbara Islands; there are no amphibians (Savage, 1967). The indigenous terrestrial mammal fauna of the island is composed of four bat species, three mice species including one endemic sub-species, and one fox species which is an insular endemic with an endemic race on San Clemente (von Bloeker, 1967). The mammals introduced by man are pigs, goats, cats, and deer. The aquatic mammal fauna consists of three species of pinnipeds (Bartholomew, 1967) and the sea otter (von Bloeker, 1967). Diamond (1969) reported 24 species of land birds on San Clemente in 1968. To my knowledge no detailed study of the

insect fauna of San Clemente has been published, although several short papers have appeared in the series "Contributions from the Los Angeles Museum—Channel Islands Biological Survey."

Most of the native vegetation of the island has been ravaged by the feeding of a large population of feral goats. Because of this, the island is sparsely vegetated, and introduced herbs, mostly grasses, predominate. Plant species once apparently widespread are now either extinct or are restricted to small populations in areas inacessible to goats. Some of the best refuges on the island are located in the precipitous canyons, particularly on the northeastern side. The upper reaches of these canyons are of particular interest because they have not been inundated by the sea since Miocene or Pliocene times. A flora of the island published by Raven (1963) is the source of much valuable information. Additions to the flora have been published by Raven (1965, 1967) and Thorne (1969). Of the Channel Islands, San Clemente has the most interesting flora, despite the larger land area and seemingly greater habitat diversity of some of the other islands. It supports more insular endemics (43, 13 of which occur exclusively on San Clemente) than the other Channel Islands, evidently because its isolation has allowed little floral interchange with other land areas.

## SAN CLEMENTE ISLAND MEALYBUGS

Knowledge of the unusual San Clemente flora and of the similarities between the dispersal mechanisms of scale insects and plants (Miller, 1971), encouraged me to look to San Clemente as the most promising source of unusual mealybugs in the Southern Channel Islands. Unfortunately, collecting mealybugs on this island is difficult because most of the more interesting plants occur in nearly inaccessible areas and the heavy clay soil generally present is unsuitable for most pseudococcid species. The following list includes 9 genera and 11 species. No mealybugs have been reported from this island previously. Plant names are as listed by Raven (1963).

*Chorizococcus*

*abroniae* McKenzie

1. Shifting Sands, 14 May 1973, *Abronia umbellata* (roots and decumbent stems)

*Discococcus*

*simplex* Ferris

1. 0.25 mi. N. Boulder, 10 May 1973, *Stipa* sp. and *Avena* sp. (on crown)
2. canyon N. Boulder, 11 May 1973, *Stipa* sp. (in sheaths near crown)

3. China Canyon, 13 May 1973, *Stipa* sp. (in sheaths)
4. Eel Point, 8 May 1973, *Stipa* sp. (in sheaths near crown)
5. Pyramid Head, 12 May 1973, *Stipa* sp. (on crown)
6. Seal Cove, 9 May 1973, *Stipa* sp. (in sheaths)
7. near mouth of Wall Rock Canyon, 9 May 1973, *Stipa* sp. (on crown)
8. near White Rock, 10 May 1973, *Stipa* sp. and *Avena* sp. (in sheaths near crown)
9. Wilson Cove, 8 May 1973, *Avena* sp. (on crown)

*Distichlicoccus*

*salinus* (Cockerell)

1. China Point, 13 May 1973, *Distichlis spicata* (on leaf blade)
2. Shifting Sands, 14 May 1973, *Distichlis spicata* (on leaf blade)

*Heliococcus*

*clemente* Miller

1. Pyramid Head, 12 May 1973, under rock

*Paludicoccus*

*distichlium* (Kuwana)

1. China Point, 13 May 1973, *Distichlis spicata* (in leaf blade sheath)

*Phenacoccus*

*eschscholtziae* McKenzie

1. China Point, 13 May 1973, *Lotus argophyllus* subsp. *ornithopus* (?) (on main roots)

*solani* Ferris

1. S. West Cove, 7 May 1973, *Franseria chamissonis* (decumbent branches)
2. 2 mi. SE West Cove, 11 May 1973, *Astragalus miguelensis* and *Atriplex semibaccata* (roots)

*Puto*

*yuccae* (Coquillett)

1. Eel Point, 8 May 1973, *Suaeda californica* (on roots)

*Spilococcus*

*corticosus* McKenzie

1. canyon N. Boulder, 11 May 1973, *Artemisia californica* (under bark on stems)

*keiferi* McKenzie

1. China Point, 13 May 1973, *Lotus argophyllus* subsp. *ornithopus* (?) and *Suaeda californica* (on roots)
2. Eel Point, 9 May 1973, *Astragalus miguelensis*, *Atriplex semibaccata*, and *Suaeda californica* (on roots)
3. Pyramid Head, 12 May 1973, *Phacelia floribunda* (?) and, *Suaeda californica* (on roots), and under rock
4. near mouth of Wall Rock Canyon, 9 May 1973, *Suaeda californica* (on roots)
5. 2 mi. SE West Cove, 11 May 1973, *Suaeda californica* (on roots)

*Trionymus*

*smithii* (Essig)

1. Wilson Cove, 7 May 1973, *Avena* sp. (leaf sheath)

## DISCUSSION

Perhaps my most exciting find on San Clemente was the endemic mealybug, *Heliococcus clemente* Miller. I believe this is the first of several endemics which may be discovered when the canyons on the northeastern side of the island are intensively collected. *H. clemente* is most similar to *Heliococcus deserticola* Miller, a species that occurs in the deserts of the southwestern U. S. and is relatively close to another desert species, *Heliococcus atriplicis* McKenzie. *H. clemente* appears to be more similar to xeric southern desert species than to the more common and widespread mesic species (such as *H. adenostomae* Mckenzie, *H. osborni* (Sanders), or *H. stachyos* (Ehrhorn).

An unidentified species, apparently a second endemic, has been encountered on both San Clemente and Santa Cruz Islands. On Santa Cruz it was collected at several localities ranging from the higher elevations of the north ridge to the coastal areas near Coches Prietos. It has been collected in spring on a varied range of hosts, on rootlets in heavy, clay soil. On San Clemente, the apparent same species was found near Boulder, in heavy, clay soil on small roots of *Malacothrix foliosa* (Compositae), *Lupinus bicolor* (Leguminosae), and other small dicotyledonous plants. I found only first instar nymphs at both locations, and suspect that adults occur much later in the year. Until adult females can be found, this pseudococcid should remain unnamed, but it is so different from the known first instar nymphs of any other North American mealybug, that I am fairly certain it is a Channel Island insular endemic. It is quite probable that this mealybug represents an endemic genus.

Using the work of McKenzie (1967) as a source for California pseudococcid distribution patterns, the 10 nonendemic species occurring on San Clemente are distributed on the mainland as follows: one is present throughout most of continental California, three occur exclusively in coastal mountain ranges, one occurs in the coastal ranges and the southern California deserts, two occur in the coastal ranges and the ocean beach areas, two occur in saline areas, and one occurs exclusively on ocean beach areas. These data suggest that most mealybug species known to occur on San Clemente Island are most closely allied to the aggregation of species found in coastal areas on the California mainland; in fact, all of the known San Clemente species except *H. clemente* are known to inhabit coastal areas in part.

One species shows a disjunct distribution pattern. *Discococcus sim-*

*plex* is not known on the portion of the mainland closest to San Clemente Island but occurs approximately 190 miles to the north. With the limited amount of material available, it has not been possible to make general statements concerning the number of species on San Clemente compared to a similarly sized area on the mainland. However, the absolute number of individual specimens on the island is small compared to the mainland because an average of only three mealybug collections per day was made on San Clemente, whereas I find an average of about ten mealybug collections per day on the California mainland.

*Discococcus simplex* is unusually abundant on San Clemente. Previously, this species was known by less than 10 specimens from two mainland localities. On San Clemente, with some diligence, *D. simplex* can be collected in most grassland areas on the island; it is normally quite common on *Stipa* spp. The same species was collected once on another island (Santa Cruz), where apparently it is rare.

*Spilococcus keiferi* is also unusually abundant. It is a fairly common coastal mainland pseudococcid which seems to prefer the roots and decumbent branches of *Franseria chamissonis* in sandy soils. It has occasionally been found on a few other hosts and has been collected inland in two instances. Under normal circumstances only one or two specimens of *S. keiferi* are collected at mainland localities, and they usually are mixed with specimens of *Chorizococcus abroniae*. On San Clemente this species seems to behave differently. Next to *Discococcus simplex*, it was the most commonly encountered mealybug on the island. It was collected on five plant species which are all new host records. Although populations of *Franseria chamissonis* were examined extensively, *S. keiferi* was never found on this host. Infestations of *S. keiferi* normally were very large, and they never were mixed with *Chorizococcus abroniae*. On San Miguel and Santa Cruz Islands *S. keiferi* did not show characteristics of the San Clemente populations.

Similar insular differences in relative abundance and host preference are known to occur in island populations of *Puto yuccae*. On the mainland *P. yuccae* occurs on a variety of hosts and is common in many habitats including the Sierra Nevada up to 6,000 feet, in chaparral areas of the coastal mountain ranges, and in sand areas near the ocean. On San Clemente the species was collected only once, even though preferred hosts were examined extensively. On San Miguel *P. yuccae* was much more abundant. Although it apparently is restricted to sandy

beach situations, it occurs on a variety of hosts and is quite common. On Santa Cruz it is more abundant than on the other two islands. It occurs in several types of habitats and has been recorded on seven different host plant species.

The mechanisms affecting differences in habitat preference, host diversity, and relative abundance of mealybug species on islands appear to be complex. A study of these mechanisms would undoubtedly give insight into aspects of pseudoccid biology and ecology not presently understood.

In previous papers on the Southern California Islands, I have not mentioned morphological variation of insular pseudococcid species, although some island populations are highly variable. At times this variation has caused problems in placing the island species, but this problem was anticipated. If the Southern California Islands possess endemic forms at generic and specific levels, then they should contain examples of endemism at intraspecific levels. In fact, this endemism should be more common than at higher levels. Variation observed in three mealybug species bears mention. Material identified as *Puto yuccae* has shown considerable variation from island to island and from island to mainland. Some insular specimens possess features of both *Puto echinatus* McKenzie, a coastal mainland species, and *P. yuccae*. The greatest amount of variation was noted on specimens from San Miguel Island where typical representatives of both *P. echinatus* and *P. yuccae* were found, in addition to many intermediate individuals. On Santa Cruz variation was less marked, but still considerable. On San Clemente *P. yuccae* possessed key characters of both species. Without more material, particularly from the mainland coastal areas, the identity of this species must remain tentative.

There are a number of possible explanations for this type of insular variation. For example, *P. echinatus* may be a recent coastal derivative of the inland species *P. yuccae*, or vice versa, with intermediate forms persisting on the islands; *P. echinatus* and *P. yuccae* may be the same species; annectant forms may be hybrids; and there are other possibilities. Variation seen in insular populations of *Spilococcus keiferi* and *Trionymus smithii* show the same general pattern as mentioned above. *S. keiferi* varies between typical *S. keiferi* and individuals approaching *S. atriplicis* (Cockerell) or *S. nototrichus* Miller and McKenzie. *T. smithii* varies between specimens typical of California forms of *T. smithii* and material approaching *T. winnemucae* McKenzie or *T. nanus* Cockerell. Although annectant specimens cause concern to

the taxonomist, they point out possible relationships which otherwise might go undetected.

## COMPARISON OF THE MEALYBUG FAUNAS OF SAN CLEMENTE, SAN MIGUEL, AND SANTA CRUZ ISLANDS

Notable similarities exist in the three pseudococcid faunas. (1) All are depauperate aggregations of species similar to the pseudococcid fauna on the adjacent southern California mainland. (2) All are primarily composed of coastal or coastal mountain species. (3) All contain representatives of the following species: *Chorizococcus abroniae*, *Distichlicoccus salinus*, *Paludicoccus distichlium*, *Puto yuccae*, and *Spilococcus keiferi*.

The mealybug fauna of San Clemente most closely resembles the fauna found on Santa Cruz. Of the 12 species (including the undescribed form) known to occur on San Clemente, nine occur on Santa Cruz while only six are known on San Miguel. The pseudococcids of both San Clemente and Santa Cruz, with the exception of *Discococcus simplex* on San Clemente, occur in localized areas; whereas on San Miguel, several species are widespread and common. Both San Clemente and Santa Cruz have representative species which do not occur on the adjacent mainland but are found farther north in California, and both islands have specimens of the apparent insular endemic known only from immatures.

A feature found within the mealybug faunas of San Clemente and San Miguel, but not within the Santa Cruz fauna, is the presence of species which show more diversity in habitat and host preference than they do on the mainland.

The San Clemente pseudococcid fauna is unique in the presence of an endemic species. Its resemblance to species occurring in the desert areas of the southwestern U. S. suggests the presence of southern xeric elements within the San Clemente fauna.

## SUMMARY

Nine genera and 11 species of mealybugs are known on San Clemente Island. *Heliococcus clemente* is endemic, and another probable insular endemic known only from immatures, is reported from San Clemente and Santa Cruz Islands. The pseudococcid fauna of San Clemente is most like the aggregation of mealybug species found on the adjacent mainland, but contains elements of both northern and southern faunas.

The flora and mealybug fauna of San Clemente have many similar attributes. Both show affinities to their respective counterparts on the

adjacent mainland, both contain endemics, both possess species with disjunct distribution patterns, and both contain small components of northern and southern biotas.

## ACKNOWLEDGMENTS

I am grateful to Lt. Commander W. G. Kay, Officer in Charge, San Clemente Island Facility, for his assistance and cooperation during my stay on San Clemente. Thanks are also due to Chief West who made some of the arrangements for transportation on the island, pointed out areas which might be of special interest, and allowed us to collect in normally inaccessible regions.

Special appreciation is expressed to Dr. Arnold S. Menke for his assistance in collecting scale insects while on the island.

I also thank my wife Judy Miller for her help in typing the drafts of this article and for her comments on its content. I appreciate the help of Louise M. Russell, Raymond J. Gagné, Douglas C. Ferguson, and Ronald W. Hodges, Systematic Entomology Laboratory, ARS, USDA, for their careful criticisms of this manuscript.

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