# Description and Bionomics of a New Species of *Puto* from Utah (Homoptera: Coccoidea: Pseudococcidae)[1]

R. I. WASHBURN[2]
Entomologist, U. S. Forest Service, Ogden, Utah

ABSTRACT

Descriptions and illustrations of the adult female and winged male of *Puto sandini,* a mealybug infesting *Picea engelmannii* Parry, are given, and the more prominent morphological changes occurring during development are discussed. *P. sandini* requires 4 years to complete its life cycle. It overwinters in the duff, feeds on the needles of the Engelmann spruce, mates and produces young on the main stem of its host.

In 1939, a serious mealybug infestation was discovered just east of Loa, Utah, in an Engelmann spruce stand on the eastern slopes of Thousand Lake Mountain, Fishlake National Forest. A second and much larger infestation was discovered in 1953 east of Widtsoe, Utah, on the Aquarius Plateau of the Dixie National Forest. Both spruce forests occur at an elevation between 10,000 and 11,200 ft. The Fishlake infestation covered about 10,000 acres and the one on the Aquarius Plateau more than 60,000 acres.

In 1955, the Division of Forest Insect Research, U. S. Forest Service, began a research study of this pest. As a first step a large series of mealybug specimens was sent to the U. S. National Museum for taxonomic determination. Dr. Harold Morrison determined the specimens to be an undescribed species of the genus *Puto.*

The purpose of this paper is to describe the species and report its life history and habits in the high-altitude Engelmann spruce stands of southern Utah.

The following terminologies are used in this paper: General Morphology, Torre-Bueno (1937), Morrison (1945). Adult female, Ferris (1950), and McKenzie (1960). Adult male, Beardsley (1960) (1962), and Theron (1958).

## *Puto sandini,* new species

Suggested Common Name: Spruce Mealybug

ADULT FEMALES.—Appearance in life ovaliform, robust; white waxy secretion abundant on dorsal surfaces and along body margin. Color greyish. As mounted, elliptical; average length 4.44 mm, width 2.48 mm (avg of 5) (Fig. 1-A). Compound eyes on sclerotized pedestal, diameter of lens 75.6 $\mu$ (avg of 10). Antennae 9-segmented, segments in microns: I, 112; II, 105; III, 152; IV, 90; V, 94; VI, 80; VII, 74; VIII, 88; IX, 153; total length 948; width of base segment 150 (avg of 10). Beak basically triangular, width at widest point 155.0 $\mu$, length 313.1 $\mu$ (avg of 10), apical margin covered with several stout, long setae, 3–5 long setae on surface of beak. Circulus present, elongate oval, and not restricted with crenulated margin. Margins of ostioles sclerotized. The 6–8 setae of the anal ring (6 being commonest) may be increased by 2 supernumerary smaller setae. Trilocular pores distributed over dorsal and ventral surfaces (Fig. 1-H). On the dorsum, cerarii appear basically as 18 pairs and formed upon a sclerotized plate. Cerarian plates oval to round, not large. Anal ring cerarii more than twice the size of the remaining cerarii, containing a definite thickening, bearing 4–5 long setae (Fig. 1-F). Oral collar ducts associated with cerarii except numbers X, XII, XIII, XV, XVII. On a few specimens a single duct formed in head region near cerarii XVIII. Characters of cerarian plates are shown in Table 1. Dorsum widely beset with short spines except for medial patch of larger spines arising from sclerotized areas (Fig. 1-G). Dorsal spines few, 8–9–10 abdominal segments. Posterior leg maximum longitudinal dimensions in microns: Trochanter, 232.5; femur, 564.4; tibia, 686.4; tarsus, 234.1; claw, 75.3; claw digitules, 51.8 (avg of 7). Coxae with a few slender setae near base. Leg setae stiff, those on tarsus shorter and stouter than on other leg segments. Claw with distinct spur on plantar surface. Pair of short, stout spines base of claw. Digitules present, lanceolate (Fig. 1-D). Three sensoria borne on each side of trochanter in triangular pattern. Spiracles stout, nearly twice as long as wide, bar sclerotized (Fig. 1-B). Ventral side abdominal segments covered with many minute scalelike spines arranged in short rows of 2–5 or more spines. On thorax and head blunt spines numerous but not arranged in rows, scattered as singles and pairs. Multilocular disc pores ventral side of body about vulva basically in 5 rows with following number per row counting from posterior row: I, 13–19; II, 27–32; III, 43–60; IV, 7–9; V, 7–9; average diameter 11.7 $\mu$ (Fig. 1-E). Two to six smaller multilocular disc pores near spiracles, average diameter 9.3 $\mu$. Vulva oval with radiating delicate dermal folds. Four conical apoplyses present. Venter with many lanceolate setae, each arising from well-developed sclerotized base, separate and distinct. These setae mostly smaller, shorter, and more delicate than anal cerarian plate setae, arranged in transverse bands on abdominal segments.

ADULT MALES.—Mature males winged. As mounted, body length approximately 2.6 mm. Wing span 6.5 mm (Fig. 2-A). Head with 6 pairs of conspicuous simple eyes within a heavy sclerotized area, plus a single lateral ocellus on each side behind ocular sclerite. Ocular sclerites not fused ventrally or dorsally.

[1] Accepted for publication September 16, 1964.
[2] Present address: Forestry Sciences Laboratory, Intermountain Forest and Range Experiment Station, Moscow, Idaho.

Table 1.—Characteristics of cerarian plates showing number of spines and trilocular pores within cerarii and number of oral collar ducts associated with each (average of 7).

| Cerarii | Spines | Pores | Ducts | Remarks |
|---|---|---|---|---|
| I | 14.4 | 40.6 | 4.1 | Anal ring cerarii |
| II | 8.6 | 19.0 | 3.4 | |
| III | 9.0 | 14.6 | 2.6 | |
| IV | 10.4 | 14.0 | 1.4 | |
| V | 10.6 | 13.0 | 1.0 | |
| VI | 11.7 | 13.1 | 1.0 | |
| VII | 12.1 | 14.0 | 1.0 | |
| VIII | 12.9 | 14.1 | 1.0 | Tends to be divided |
| IX | 9.0 | 10.8 | 1.0 | Tends to be divided |
| X | 10.1 | 9.9 | 0 | |
| XI | 10.7 | 13.3 | 1.0 | |
| XII | 5.6 | 3.9 | 0 | |
| XIII | 11.3 | 12.3 | 0 | |
| XIV | 11.6 | 16.7 | 1.0 | |
| XV | 9.1 | 8.2 | 0 | |
| XVI | 8.3 | 7.3 | 1.0 | |
| XVII | 12.2 | 12.5 | 0 | |
| XVIII | 19.7 | 15.7 | — | Divided into 3 parts. Occasionally duct in general area of cerarii. |

Diameter of the eyes counting from ventral to dorsum 45, 38, 30, 30, 38, 53 μ (avg of 5). Single ocellus with average diameter of 37 μ. Antennae 10 segmented, about 2.07 mm long overall. Scape relatively short and thick: 100 μ long by 87 μ maximum width at base. Pedicels, dome- or bell-shaped, shorter and narrower than scape, length 87 μ, width 87 μ. Segments 3 through 10 measure 274:271:283:271:228:193:162:183 μ long respectively; all about the same width, 53 μ at widest point. Segments 3 through 10 warty, bearing many long, filamentlike setae. Setae as long or nearly as long as antennal segments. Forewings well developed, with radial and medial veins visible. Surfaces of wings densely covered with microtrichia. Hindwings reduced to a pair of halteres, fingerlike, about 266 μ long. Each bears at its apex 2–4 hamuli, usually 3. Hamuli hooked and nearly as long as halteres. Pocket in a semicircular lobe on posterior margin of forewing serving as a receptacle for hooks of the hamuli. Two pairs of thoracic spiracles, similar to those on female. Legs well developed, elongated and slender. Lengths of parts of posterior leg in microns: trochanter 152, femur 483, tibia 681, tarsus 245, claw 62; maximum width of femur 106. Tarsi 2 segmented, basal segment small, little more than triangular band widest along posterior margin. Tarsal claw similar to that of female, with plantar tooth, digitules present, lanceolate, pair of short spines at base. Except for strongly sclerotized apical penial sheath, abdomen largely unsclerotized. Cerarian area not sclerotized but characterized by presence of 4–8 spines around 91 μ long and cluster of multilocular pores about 7.6 μ in diameter (Fig. 2-E). Multilocular pores in cerarian region of 2 distinct types, differentiated by division within pore, some with 4 loculi and an equal number with 5. Sternite segments 2 through 8 bearing transverse bands of spines, spines about 76 μ long; 6 multilocular disc pores of same types as in cerarian area associated with spines in each band. Venter of abdomen bearing short scalelike microtrichia arranged in small lateral patches following transverse lines. Patches containing from 2 to 10 microtrichia on entire abdomen. On dorsal surface of abdomen transverse band of spines accompanied by 4 multilocular disc pores per segment on segments 2 through 8. Penial sheath triangular, heavily sclerotized, divided longitudinally, tending to fold under apical region to form loose tube, apical tips hooked (Fig. 2-B). Short spines on caudal end of plates increasing in length toward base. Sclerotized portion of aedeagus stout rod 334 μ long, tapering slightly last one-third of length. Prominent aedeagal apodeme. Conspicuous group of circular pores in and around a depression on postero-lateral margin each side ninth abdominal segment (Fig. 2-D). Each depression containing from 80 to slightly more than 100 individual pores. Pores average 8.4 μ in diameter and of 3 types having either 4, 5, or 6 loculi (Fig. 2-C), those with 6 loculi most abundant. Inner apex of each cerarial pocket bearing 2 stout setae about 258 μ long.

*Morphological Changes During Development.*—Young are ejected in August or early September and for the next 10 months have 7 antennal segments, 16–17 pairs of cerarian plates; the anal plate contains 2–3 spines and 3–6 trilocular pores. At about age 11 months the number of trilocular pores on the anal cerarii increases to about 15. The cerarian plates increase to 18 pairs and the trilocular pores on the anal cerarii to 20–27 at age 18 months. The number of spines increases gradually until there are 8–10 per anal cerarii by age 2 years. When the young become 2 years old, the number of antennal segments changes from 7 to 8. When they reach age 3 years, the antenna has 9 segments and tubular ducts begin to show in the cerarian plates. From age 3 years until maturity no major change is evident until the males pupate and the females develop a visible vulva at about age 3½ years.

*Host and Distribution.*—Occurs on Engelmann spruce, *Picea engelmannii* Parry, at an altitude of 10,000 to 10,500 ft near Escalante, Garfield County, Utah, and at about the same altitude near Loa, Wayne County, Utah.

*Type-Material.*—Holotype female (1 specimen mounted on 1 slide) IX-13-58, paratypes and allotypes in collection of Coccoides at the United States National Museum, Washington, D. C. Paratypes, author's collection, U. S. Forest Service reference collection, Ogden, and Colorado State University, Fort Collins, Colo.

*Remarks.*—This species will key to *Puto pricei* McKenzie, in McKenzie's key to North American members of this genus (1960). The new species differs from *pricei* by having the first 8 antennal segments shorter; the ninth segment is nearly equal in length to that of *pricei*. Total antenna length nearly 240 μ shorter than in *pricei*. Both hind femur and tibia more than 100 μ shorter than in *pricei*. New species

with 5 rows of multilocular disc pores ventral side of abdomen. Multilocular disc pores in spiracle area smaller than on *pricei*.

The male differs from Beardsley's (1962) description of the male *Puto yuccae* (Coquillett) by having ocular sclerites separated ventrally and dorsally. In *sandini*, hamuli are nearly as long as halteres. Aedeagus of *sandini* shorter and stouter than found on *P.*

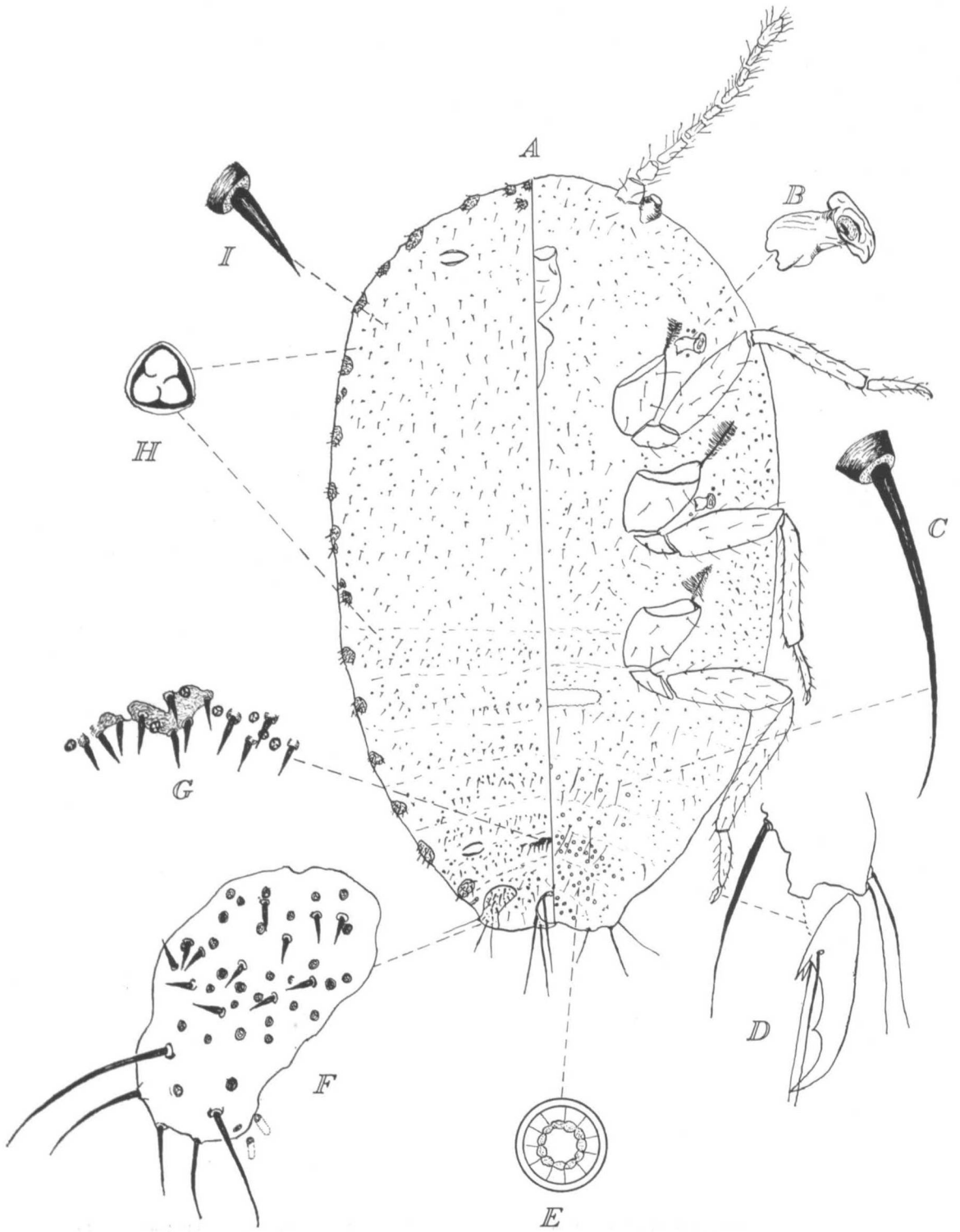


FIG. 1.—*Puto sandini*, n. sp., adult female. A, Dorsal and ventral aspect. B, Spiracle. C, Body setae. D, Claw of posterior leg. E, Multilocular disc pore. F, Anal cerarius. G, Medial patch of spines and sclerotized area. H, Trilocular pore. I, Dorsal body spine.

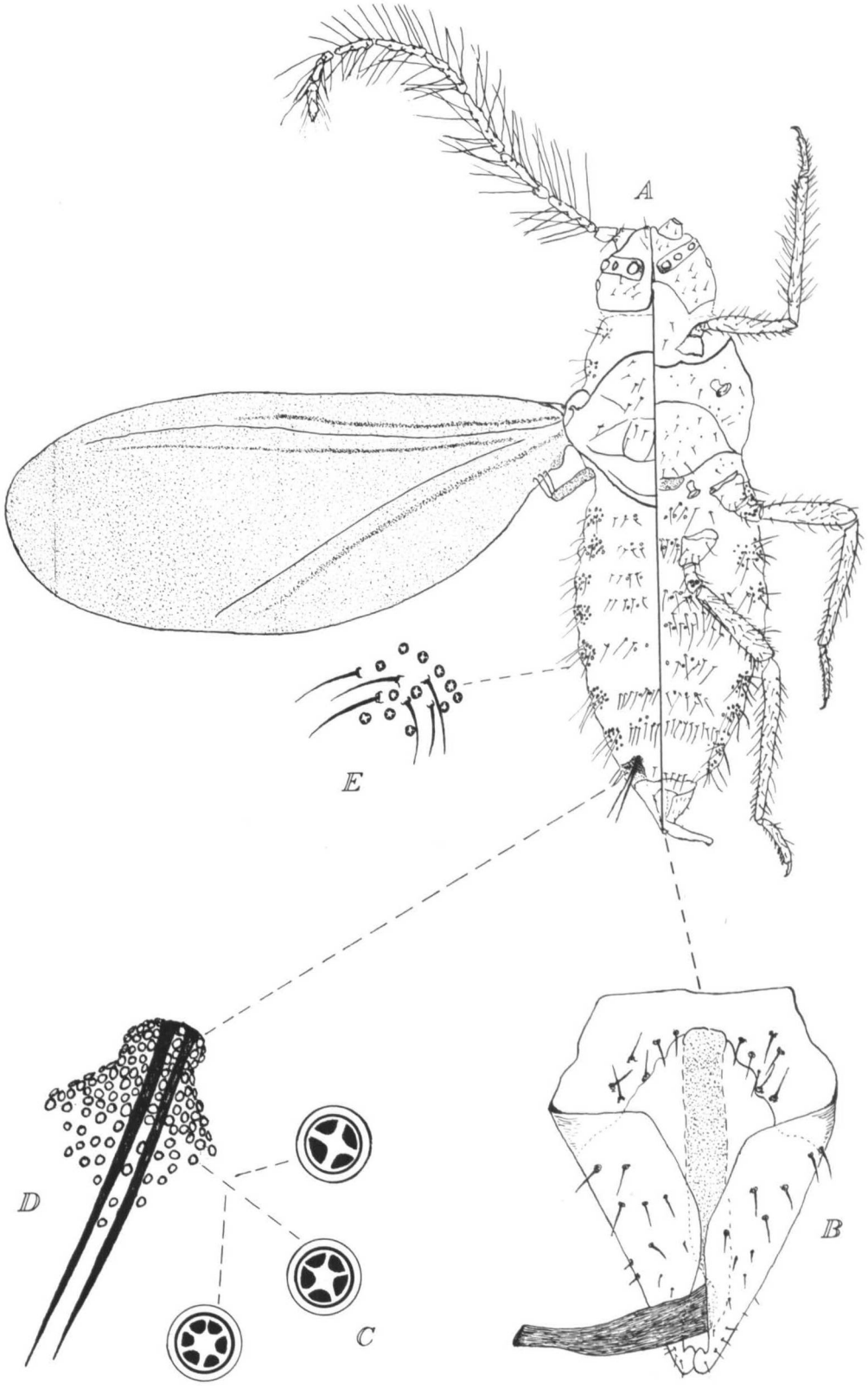


FIG. 2.—*Puto sandini,* n. sp., adult male. A, Dorsal and ventral aspect. B, Penial sheath with aedeagus extended. C, Types of multilocular pores. D, Dorsal aspect of cerarial pocket. E, Cerarian area.

*yuccae*. All segments of hind leg and antenna except pedicel shorter than those of *P. yuccae*.

## LIFE HISTORY AND HABITS

The spruce mealybug has a 4-year life cycle with progeny being produced ovoviviparously by mature females under bark flakes on the bole of Engelmann spruce trees. Young are born in late August or early September. An average of 30.4 progeny is produced by each female, but the number varies by individual from 19 to 67. Dissection indicates the average female contained 57.9 progeny just before deposition of young. Production of young appears to be tied to daily accumulation of temperature above 42°F. Progeny do not appear before the accumulated temperature reaches approximately 650° and may not appear until daily accumulated temperatures reach 800°. Females die after progeny production is completed. Young remain under bark flakes until late September, when they migrate to the base of the tree where they overwinter in the duff.

The young crawlers migrate from the duff sometime in May, long before the winter's snow has melted. They move up the bole of the tree and onto the branches to feed on the needles. The crawler population is distributed evenly throughout the crown of the tree. This is true on mature trees as well as on seedlings. Feeding continues until about mid-July when the crawlers start to migrate back to the bole of the tree. Crawlers on seedlings migrate to the duff. Some time in September the crawlers migrate back to the needles and feed. However, during this period feeding is intermittent and some crawlers can be found on the bole under bark flakes. The crawlers continue feeding through September, then once again migrate; but this time they move down the bole of the tree to the duff where they overwinter.

The next spring, the crawlers once again migrate up the bole of the tree and onto the needles. The feeding, migration, and overwintering pattern is identical to that of the previous year.

Migration in May from the duff to the foliage is repeated the third year. However, feeding is discontinued in the latter part of June, when the crawlers migrate from the needles. Females migrate to the bole of the tree and form a transparent pupal case behind bark flakes. The females emerge about July 1, nearly 30 days earlier than do the males. Male pupation occurs near July 1. Most pupal cases can be found under bark flakes, along dead branches, and near the fascicle of older green needles. The pupal cases are conspicuous, white, cottony, elliptical pods, open at the posterior end. They occur singly or in masses. Males remain as pupae for approximately 30 days. Several days prior to emergence, wing tips and wax tails protrude from the open end of pupal cases. Winged males emerge near August 1, seek out females that have remained on the bole of the tree, mate, and die. Winged males can be found for only about 10 days.

By the first of September many of the females have migrated onto the needles to feed until the latter part of September. They then migrate to the duff and overwinter; the following May they crawl from the duff, migrate to the needles, and feed. The females remain on the needles until mid-June when they start their migration to the bark flakes on the main stem of trees. The gravid females rest under the bark flakes until the young are born, some time in late August or early September, thus completing the life cycle.

During the first 3 years of the 4-year life cycle, migration back to the bole of the tree starts between the 12th and 17th of July and is completed in 15 days. This migration is not related to daily accumulated temperature, but may be related to length of daylight and intensity of sunlight. Temperature records taken within the infestation for 5 consecutive years show maximum summer temperatures occurred in mid-July for all years. It is probable the July migration is the result of the insects' intolerance to direct exposure to the July temperatures.

*Effect on Host.*—Several years of successive feeding by epidemic populations of mealybugs can cause tree mortality. In addition to tree mortality, crooked terminals and limb mortality, particularly in smaller trees, may be widespread in epidemic infestations.

The first visible indication of feeding by the spruce mealybug is copious sap flow from branches during the summer of the second and third year of feeding. Conspicuous yellowing of needles on branches scattered throughout the tree occurs the third feeding season. Male pupal cases remain on trees for several years and therefore may accumulate to the extent that they become useful indicators in detecting old outbreaks as well as new.

In persistent epidemics most of the limbs and twigs become black from the formation of black sooty mold. The mold apparently does not form on the needles.

## REFERENCES CITED

**Beardsley, J. W.** 1960. A preliminary study of the males of some Hawaiian mealybugs (Homoptera: Pseudococcidae). Proc. Hawaiian Entomol. Soc. 17(2): 199–243.

1962. Descriptions and notes on male mealybugs (Homoptera: Pseudococcidae). Proc. Hawaiian Entomol. Soc. 18(1): 81–98.

**Ferris, G. E.** 1950. Atlas of the Scale Insects of North America. Vol. 5. Stanford Univ. Press. 278 p.

**McKenzie, H. L.** 1960. Taxonomic study of California mealybugs with descriptions of new species (Homoptera: Coccoidea: Pseudococcidae). Hilgardia 29(15): 681–770.

**Morrison, H. M.** 1945. The mealybug genus *Heterococcus* Ferris and some of its relatives (Homoptera: Coccidae) J. Wash. Acad. Sci. 35(2): 38–55.

**Morrison, H. M.** 1945. The mealybug genus *Heterococcus* Ferris and some of its relatives (Homoptera: Coccidae). J. Wash. Acad. Sci. 35(2): 38–55.

**Theron, J. G.** 1958. Comparative studies on the morphology of male scale insects (Hemiptera: Coccidae). Ann. Univ. Stellenbosch 34, Sec. A(1). 71 p.

**Torre-Bueno, J. R. de la.** 1937. A Glossary of Entomology. Brooklyn, N. Y.: Brooklyn Entomol. Soc. 336 p., 9 pl.