

Notes on the Biology of the Pink Sugar Cane Mealybug, *Saccharicoccus sacchari* (Cockerell), in Hawaii (Homoptera: Pseudococcidae)*

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INTRODUCTION

The pink sugar cane mealybug, *Saccharicoccus sacchari* (Cockerell), is perhaps the most widely distributed of cane-infesting insects, having been reported from every cane growing nation of the world (Pemberton, 1960). In most areas it is generally considered a relatively minor pest, although damaging outbreaks are occasionally reported (Puttarudriah, 1954). Pemberton (1960) has suggested that this insect may serve as a vector of one or more virus diseases of sugar cane, and recommended the investigation of this possibility. Studies have therefore been initiated by the Entomology Department, Experiment Station, HSPA, to determine the possible role of this and other cane-infesting mealybugs in the transmission of sugar cane diseases. This paper reports upon certain aspects of the biology of the pink cane mealybug which have been investigated during the preliminary phases of these studies.

The biology of *S. sacchari* has been studied previously by Swezey (1913) in Hawaii, and by Uichanco and Villanueva (1932) in the Philippine Islands. Beardsley (1960b) has presented results of recent field studies and observations on this insect in Hawaii. Uichanco and Villanueva present a large amount of detailed morphological and biological data derived from their investigations. However, the findings of these authors differ in several important respects from those of Swezey in Hawaii, and for this reason, certain phases of the biology of *S. sacchari* have been re-examined.

MATERIALS AND METHODS

Laboratory cultures of the pink sugar cane mealybug may be rather easily reared on cut sections of sugar cane stalk. Uichanco and Villanueva utilized such cultures in their studies. In Hawaii it was found that, with proper preparation, excised sections of sugar cane will support mealybug colonies for six weeks

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or longer, more than sufficient time for completion of the insect's life cycle. The method for establishing laboratory colonies which has been employed in our laboratory is a relatively simple one. Cane stalks selected from the field are cut into sections about eight inches long, each section including two nodes. Selection of cane stalk sections of proper age and condition is important for proper establishment and development of mealybug colonies. The lower, older portions of mature stalks are unsuitable for mealybug establishment as apparently the mouth parts of the first instar nymphs (crawlers) cannot readily penetrate the hard rind of the cane. Conversely, the tender uppermost internodes are so succulent that they tend to dry out and shrivel rapidly, becoming unsuitable for continued colony development within a relatively short time. There are usually several internodes which lie between these extremes, so that two or three suitable sections may be obtained from each stalk.

The cut cane sections are dipped in a fungicide solution of phenyl mercuric acetate, wiped clean, and the cut ends sealed with paraffin to retard desiccation. Each piece is then wrapped with paper toweling secured with a rubber band, and placed in a wide-mouth gallon jar. To initiate colonies freshly hatched mealybug crawlers are dusted onto the prepared cane sections. The paper toweling replaces the cane leaf sheath, behind which mealybug crawlers normally settle when they commence feeding on stalks of field cane. It was found that unless this provision was made a relatively poor degree of crawler settling was obtained. After a colony is well established the paper toweling can be discarded without adversely affecting the mealybugs. Both field and laboratory observations have shown that pink mealybugs confine their feeding to relatively narrow zones on either side of the nodes of the cane stalk. The upper zone embraces the root band and meristematic bud (eye) above the node while the lower zone occupies a similar narrow band below the node.

For critical studies, individuals or small numbers of mealybugs were reared in small isolation chambers attached to the feeding zones of stalk sections. These chambers consisted of sections of 10 mm. inside diameter glass tubing about 20 mm. long, attached to the cane sections with paraffin, and closed with tight cotton plugs. Mealybugs developed normally within these chambers, although as the bugs approached maturity it was often necessary to remove the copious honeydew which they produced, to prevent inundation and retard the development of molds.

NUMBER OF INSTARS IN *S. SACCHARI*

Published life history studies of various mealybug species (Basinger, 1934; James, 1937; Matheson, 1909; Myers, 1932) indicate that the usual number of instars in this group is four in the female and five in the male. Uichanco and Villaneuva (1932), however, reported finding seven instars in both sexes of *S. sacchari*. To determine the number of instars of this species in Hawaii, careful counts were made of cast exuviae of individual mealybugs reared in the small

isolation chambers described above. The isolated bugs were examined at two-day intervals and suspected exuviae were examined in xylol, which served to dissolve wax and prevented the globs of excess wax, which are occasionally shed, from inadvertently being counted as exuviae. Some 35 females and 20 males were studied in this manner. In every case the females molted three times before attaining maturity and the males four times. Males ceased feeding at the end of the second stadium and passed the third and fourth instars ("prepupa" and "pupal" stages) within a loose cocoon of fine wax filaments. The third and fourth exuviae of males are without functional mouthparts. These data indicate that the normal number of instars of *S. sacchari* in Hawaii is four in the female and five in the male, as is the case in other species of mealybugs which have been carefully studied.

REPRODUCTION OF *S. SACCHARI* IN HAWAII

Uichanco and Villanueva found that in the Philippines *S. sacchari* may reproduce either bisexually or parthenogenetically, but that parthenogenesis appeared to be the usual mode of reproduction. Furthermore, these authors suggest a correlation between parthenogenesis and "ovoviviparity," as they term the normal habit of this species to deposit fully developed embryos ("vermiform larvae") which emerge from the chorion usually within a few minutes after deposition. Facultative parthenogenesis yielding female progeny, which is what these authors' findings suggest, has been shown to occur in a few coccids (see Hughes-Schrader, 1948) and an attempt was made to determine whether such a mode of reproduction occurs in *S. sacchari* in Hawaii. Ten females, reared in isolation chambers from the crawler stage, lived for over 11 weeks without producing offspring, whereas control females, allowed to mate upon attaining maturity, reproduced normally. Although the test females developed normally to maturity, all failed to deposit eggs. Ten other females were reared in isolation for 8 weeks, after which they were allowed to mate. These females produced no eggs until approximately 7 to 10 days after mating when they commenced to oviposit normally, the eggs yielding viable crawlers. Control females allowed to mate freely upon attaining maturity commenced oviposition at ages of from 28 to 36 days, or about 7 to 12 days after the last molt. Of the mated females studied, all but one produced eggs which hatched within a short time after deposition, as reported originally by Swezey (1913). The exceptional female produced inviable eggs which collapsed without hatching after a day or two.

These results indicate that the Hawaiian race of *S. sacchari* studied is not parthenogenetic, and the "ovoviviparous" habit of depositing fully developed embryos is the normal occurrence in mated females.

In Hawaii, adult males of *S. sacchari* are of two relatively distinct morphological forms, apterous and winged, which are produced in varying proportions in a given colony. Apterous males lack all vestiges of wings and associated thoracic sclerotization, as well as the large dorsal and ventral eyes possessed by winged

individuals. Both forms of *S. sacchari* males have been described in detail elsewhere (Beardsley, 1960a). Apterous males of this species have also been reported from India (Rao, 1943). In the Philippines, however, Uichanco and Villanueva reported only small numbers of winged males in their colonies, and made no mention of the apterous male form.

Although the sex ratio of *S. sacchari* in Hawaii has not yet been subject to detailed study, counts of small isolated colonies, and rough estimates of larger colonies indicate a ratio of adults of about 3 females to 2 males, and the ratio appears to be much nearer unity in Hawaii than that indicated by the figures of Uichanco and Villanueva for the Philippines.

An interesting facet of the biology of *S. sacchari* and one which may partially explain difficulties encountered in earlier attempts to control these insects with systemic insecticides is the cessation of feeding of mature females. It was found that at, or shortly before, the beginning of oviposition the mature females usually cease feeding and withdraw their mouthparts from the host plant. Since mature females may produce viable young for a period of three weeks or more, and since the systemic insecticides tested do not remain at toxic levels in the plant for more than a week or so, a single application does not completely eliminate mealybug infestations, as the non-feeding gravid females continue to produce crawlers during and after the effective life of the insecticide in the plant. In a small test with potted cane plants mealybugs were completely eliminated with two applications of a systemic (Shell OS 1836) made at 21-day intervals.

CONCLUSIONS

The differences in the biology of *S. sacchari*, as reported from the Philippines and in Hawaii, are not easily explained. The data obtained from the detailed and apparently carefully conducted studies of Uichanco and Villanueva suggest that important biological differences may exist between Philippine and Hawaiian races of this mealybug. Facultative parthenogenesis yielding female progeny, as is suggested by the findings of Uichanco and Villanueva, has been demonstrated for a few coccids, and parthenogenetic and non-parthenogenetic races of a few species are known (Hughes-Schrader, 1948). However, I believe that the biology of *S. sacchari* in the Philippines and elsewhere should be subject to further study. It seems possible that Uichanco and Villanueva may have been dealing, at least in part, with a mixture of species, or that they may have overlooked the apterous male form of *S. sacchari* in their cultures. If present, these tiny creatures (1.25 mm. long) could easily have been missed, and possibly may have contaminated supposedly male-free cultures.

LITERATURE CITED

- BASINGER, A. J. 1934. Reproduction in mealybugs. ANN. ENT. SOC. AMERICA 27:17-20.
- BEARDSLEY, J. W. 1960a. A preliminary study of the males of some Hawaiian mealybugs (Homoptera: Pseudococcidae). PROC. HAW. ENT. SOC. 17(2):199-243, figs.
- 1960b. Observations on sugar cane mealybugs in Hawaii. PROC. 10TH CONG. INTERNATIONAL SOC. SUGAR CANE TECHNOLOGIST pp. 954-961.
- HUGHES-SCHRADER, S. 1948. Cytology of Coccids (Cocciodea-Homoptera). ADV. IN GENETICS 2:127-203.
- JAMES, H. C. 1937. On the pre-adult instars of *Pseudococcus longispinus* Targ., with special reference to characters of possible generic significance. TRANS. ROY. ENT. SOC. LONDON 86:73-84, figs.
- MATHESON, R. 1909. Number of moults of the female of *Dactylopius citri*. CANAD. ENT. 39:284-287.
- MYERS, L. E. 1932. Two economic greenhouse mealybugs of Mississippi. JOUR. ECON. ENT. 25:891-896, figs.
- PEMBERTON, C. E. 1960. The possible role of insects in varietal yield decline of sugar cane. PROC. 10TH CONG. INTERNATIONAL SOC. SUGAR CANE TECHNOLOGISTS pp. 59-62.
- PUTTARUDRIAH, M. 1954. The status of mealybugs on sugar cane with special reference to Mysore State. INDIAN JOUR. ENT. 16(1):1-10.
- RAO, S. R. 1953. A note of the discovery of apterous males in the pink mealybug of sugar cane, *Trionymus sacchari* Ckll. (Coccidae, Homoptera). CURRENT SCIENCE (India) 12: 208, fig.
- SWEZEY, O. H. 1913. Sugar cane mealybugs in the Hawaiian Islands. HAW. PLANTERS' REC. 8(4):200-208, figs.
- UICHANCO, L. B. and F. E. VILLANUEVA. 1932. Biology of the pink mealybug of sugar cane, *Trionymus sacchari* (Cockerell) in the Philippines. PHILIPPINE AGRICULTURIST 21(4): 205-267.

PUBLICATION ANNOUNCEMENT

The Siphonaptera of Japan, by K. Sakaguti and E. W. Jameson, Jr. PACIFIC INSECTS MONOGRAPH 3. May 1962. 170 pp., 66 figures. \$4.00 bound. \$3.25 unbound (Japan: ¥1400, ¥1100). Entomology Department, B. P. Bishop Museum, Honolulu 17, Hawaii. This is a thorough, up-to-date treatment of the fleas of Japan. Distribution, host relationships, ecology, seasonal occurrence, taxonomy and evolution are treated in detail. There is considerable discussion of the nature of host relations, and its significance in speciation. The spread of fleas and their hosts in relation to land and ice connections is discussed. The species are mostly illustrated with detailed drawings, and keys permit ready identification.