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FIELD OBSERVATIONS ON THE MATING BEHAVIOR OF THE CHINESE ROSE BEETLE, *ADORETUS SINICUS* BURMEISTER (COLEOPTERA:SCARABAEIDAE) IN HAWAII

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ABSTRACT

Field observations on the mating behavior of the Chinese rose beetle, Adoretus sinicus Burmeister were made at the University of Hawaii, College of Agriculture Farm Laboratory, Panaewa, Hawaii. The mating activity period, which initiates with large numbers of beetles flying in host plant fields, begins about 30 minutes after sunset. Copulating pairs were found in highest numbers within the first three hours after sunset with the numbers of observed pairs decreasing through the remainder of the night. The most preferred mating site was the adaxial surface (underside) of host plant leaves. Courtship, prior to copulation, involves a series of male wing vibrations with reciprocal or no action performed by the female. Immediately following copulation, the male remains on top of the female's back in a "guarding" activity which apparently prevents other males from mounting the female.

KEYWORDS: *Chinese rose beetle, Adoretus sinicus Burmeister, mating behavior*

INTRODUCTION

THE CHINESE ROSE BEETLE, *Adoretus sinicus* Burmeister (Coleoptera: Scarabaeidae) is a pest of significant economic importance. The beetle was first discovered in Honolulu, Hawaii in 1891 and by the early 1900's it had become established on all major Hawaiian islands (Riley & Howard 1893, Habeck 1964). Plant damage is caused by adult feeding on host plant leaves which results in interveinal defoliation. The host range of *A. sinicus* has been reported to include over 500 plant species, many of which are of agricultural significance such as snap beans, corn, persimmons, and roses.

To provide greater control of this insect pest without adverse ecological effects, research studies are being conducted to develop control measures such as baited traps with synthetic lures and trap cropping which are an alternative to the traditional use of insecticides. However, in order to develop these control measures, a more detailed description of *A. sinicus* behavior is needed since history has shown that control measures/programs that have a sufficient understanding of the biology of the target species have been much more successful.

Preliminary field observations, in other studies (Arita et al. 1988, Furutani & Arita 1990, Furutani et al. 1990, Furutani et al. 1993), suggest that there are distinct courtship, copulatory, and post-copulatory actions in the *A. sinicus* mating system. In this paper we describe the courtship and mating behavior of *A. sinicus* based on field observations.

MATERIALS AND METHODS

All mating activity and mating behavior observations were made on the University of Hawaii at Hilo, College of Agriculture Farm Laboratory, Panaewa, Hawaii from September 1990 to May 1994. The observations were made with the aid of a flashlight fitted with a red filter similar to that described by Conner (1989). Observed beetles, when appropriate, were collected, frozen, and dissected to determine sex.

Mating Activity Data on Snap Beans. Data on the temporal period when mating activity occurs in *A. sinicus* were taken on snap bean, *Phaseolus vulgaris* L. cv Kentucky Wonder, plants. Snap bean seeds were sown in rows 13.0 m long. Plants were later allowed to climb onto 2.0 m tall trellis. Mating activity data were taken on 7-10 weeks old plants.

To determine the mating activity period, observations were made at 15 minute intervals from sunset to sunrise, all copulating and paired beetles present on the snap bean plants were counted.

Mating Behavior Description on Sweet Corn. Observations used in the description of the mating behavior were made on sweet corn, *Zea mays* Bonaf. cv UH Supersweet #9, plants. Sweet corn seeds were planted in 30 m rows (6 rows per observation plot), with a 1.5 m between row spacing. Plants were fertilized with (15-15-15) at a preplant rate of 0.7 kgs. per 13 m row, followed by post plant applications at 1/2 the preplant rate at 3 and 5 weeks after planting. Mating behavior observations were made on 4 to 10 week old plants .

Observations on the mating behavior were made on a continuous basis throughout the night from sunset until sunrise. Copulating pairs were tagged on the pronotum with paint (model craft) to distinguish them from other beetles that were in close proximity to the pair. Tagged beetles, when appropriate, were collected, frozen, and dissected to determine sex.

RESULTS

Mating Activity Period. *A. sinicus* activity begins approximately 30 minutes after sunset. For the next fifteen minutes, beetles enter the field in small numbers with a minimum amount of flying activity. Following this period, male beetles begin to swarm about the host plants in an attempt to locate available females. The greatest amount of copulating pairs are found within a three hour period, with the greatest number of pairs observed 1.5 hours after sunset (Fig. 1). After this period, the number of copulating pairs decreased.

Mating site. Upon entering the field, females search for a suitable plant leaf which serves as both a courtship and a mating site. Most females (98%) select the adaxial (lower) leaf surface though occasionally (2%) the abaxial (upper) leaf surface is selected. Abaxial leaf surfaces were selected when the leaf was oriented in a vertical angle. This behavior is described in the mating and copulation section below.

While females were selecting a courtship and mating site, males were observed swarming about the host plants. This behavior may suggest emittance of airborne volatiles from receptive females. These airborne volatiles appear to play a role in long-distance sex attractancy, and may lure males to courtship sites selected by females.

Courtship. The male usually lands on the abaxial surface (90%) and walks to the adaxial surface, where the female is located. Less frequently (10%), the male lands directly onto the surface occupied by the female. When the male is in close proximity (approximately 5 cm) to the female, he stops and vibrates his elytra. The female responds by vibrating her elytra, or remaining motionless. The male then moves closer to the female and will attempt to mount her. Non-receptive females will move away from males a distance of a few centimeters, or as far away as the adaxial leaf surface. The male usually follows the female and again initiates elytra vibration. This series of reciprocal actions is repeated until the female accepts the male, or the male leaves in search of another, more receptive female. The courtship sequence lasts approximately 5 minutes. In a small percentage of cases (5%), no visible courtship sequence between the male and female was observed, however, successful copulation did occur.

Mounting and Copulation. Once the male attempts mounting, the female can still choose to reject the male by raising her elytra, thereby, preventing him from mounting. If the female accepts the male up to this point, the male moves around the female and mounts her by climbing onto her abdomen. However, even after the male is on top of the female, the female can still choose to reject the male by releasing all but one of her hind legs from the leaf and suspending herself over the leaf edge. The male's weight and the female's movement usually results in separation.

If the female is receptive, the male moves completely over the female with his head positioned forward and begins to stroke the occipital area just above the compound eyes of the female with his forelegs. This stroking behavior just prior to copulation is very similar to that described in the horned beetle, *Bolitotherus cornutus* (Panzer) (Coleoptera: Tenebrionidae) (Brown et al. 1985) and appears to stimulate copulation. The posterior abdominal region of the male beetle arches underneath the female's abdomen to facilitate copulation. During copulation both beetles are positioned facing the same direction. Copulation then occurs and lasts approximately 15 minutes.

Post copulatory activity. After copulation, the male remains on top of the female for the duration of the night engaged in "guarding" activity. This guarding behavior appears to serve the purpose of preventing the female from mating with other males since during the copulatory and post-copulatory period, other males were observed in close proximity to mating pairs. Occasionally during or after copulation, other males would attempt to dislodge the male from on top of the female in what appeared to be attempts to mate with the female. The guarding male successfully kept intruder males away from the female by pushing the intruder with his forelegs. For the duration of the night, the pair remained together and additionally fed on the leaf that served as the courtship and mating site. Thus as shown in Fig. 1, the number of pairs observed throughout the night was consistent while the number of copulating pairs were only high in the initial hours after sunset.

DISCUSSION

The mating period for *A. sinicus* begins approximately 30 minutes after sunset; with most copulation's occurring within the next three hours. The primary mating strategy used by males was to seek out females at specific courtship sites. Upon finding the female, the male would initiate a series of wing vibrations which, if accepted by the female, would lead to successful copulation. However, the female was still able to exercise mate choice (due to her initial selection of courtship site) when encountering an unwanted male by suspending herself and the male over the leaf's edge to dislodge him. This is possible due to the initial selection by the female of the courtship site. An alternate mating strategy used by males was to seek out females that were in the copulating process or who had already mated. These males were observed in close proximity to the copulating pair during and subsequent to copulation. As a result, the successful male remained with the female for the duration of the night to prevent additional matings.

From a practical standpoint, the information obtained indicates the probable existence of a pheromone sex attractant. This could be used in the development of synthetic lures, much like those currently available for the Japanese beetle. Secondly, any control measure that needs to be applied to the host field should be used near or at sunset to insure maximum effectiveness.

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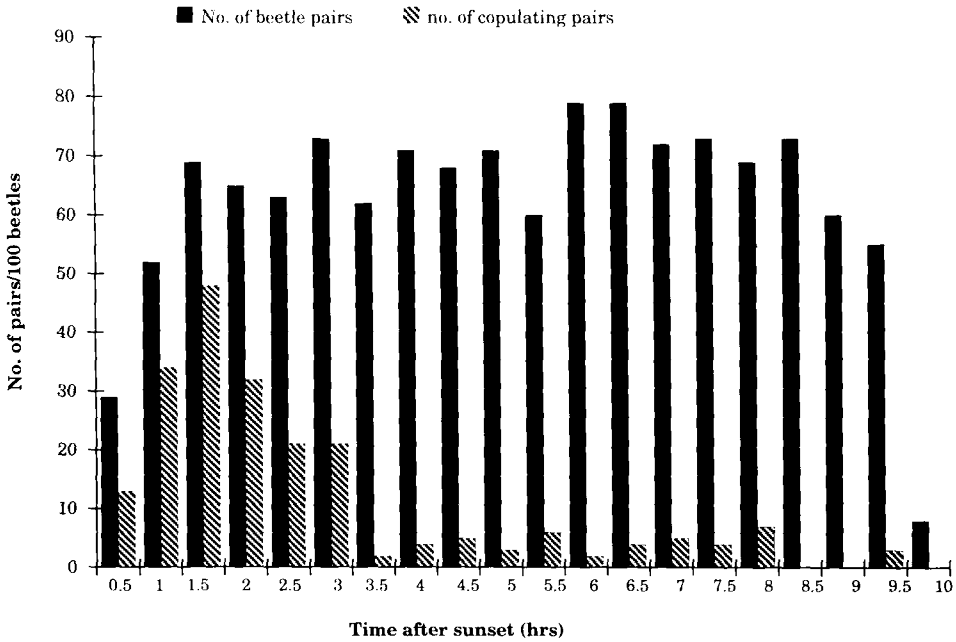

Figure 1. Number of beetle pairs and copulating beetle pairs per 100 beetles observed from sunset to sunrise (in hrs) at the University of Hawaii at Hilo Farm Laboratory, Panaewa, Hawaii.