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Timing of onset of evening activity of adult Chinese rose beetles (Coleoptera: Scarabaeidae)☆

Grant T. McQuate *

USDA-ARS, U.S. Pacific Basin Agricultural Research Center, 64 Nowelo Street, Hilo, HI 96720, USA

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ABSTRACT

Adult Chinese rose beetles, *Adoretus sinicus* (Burmeister) (Coleoptera: Scarabaeidae: Adoretini), present in China, Taiwan, Indonesia, Cambodia, Laos, Singapore, Thailand, Vietnam, the Marianas Islands, the Caroline Islands, and the Hawaiian Islands, are nighttime defoliators that feed on a wide variety of plant species. It has recently been demonstrated that illumination of plants at dusk has the potential to discourage feeding by adult Chinese rose beetles on the illuminated plants. To effectively use lighting to minimize defoliation of host plants, it is critical to know the timing of the initial host plant colonization by the beetles to ensure that illumination is initiated before host plant colonization begins. Adult Chinese rose beetles were observed to colonize host plants at dusk, with initiation of beetle colonization averaging more than 21 min after sunset, with the earliest observed beetle colonization occurring 11 min after sunset. These times corresponded to an average light level of 7.0 lux at the first colonization and the earliest first colonization occurring at 26.9 lux. Based on these results, use of lighting to minimize defoliation of host plants should be initiated at about sunset in order to discourage colonization (and associated defoliation) by adult Chinese rose beetles.

Introduction

Adult Chinese rose beetles, *Adoretus sinicus* (Burmeister) (Coleoptera: Scarabaeidae: Adoretini) (Figs. 1 and 2), are nighttime defoliators that feed on 250 to 500 or more species, encompassing approximately 56 plant families (Habeck, 1964; Hession et al., 1994). Host plants include many economically important plants (Habeck, 1964; Arita et al., 1993; McQuate and Jameson, 2011a,b) including cacao, *Theobroma cacao* L. (Malvaceae), where it is common to find stunting and even death of young plants because of Chinese rose beetle feeding. Chinese rose beetle is present in China, Taiwan, Indonesia, Cambodia, Laos, Singapore, Thailand, Vietnam, the Marianas Islands, the Caroline Islands, and the Hawaiian Islands (CAB International, 1981). Chinese rose beetle eggs are laid in the soil, but the resulting grubs are not pests because they do not attack living vegetable tissues, but, rather, apparently feed on humus and detritus (Mau and Kessing, 1991). During daylight hours, adult beetles stay in a resting state under leaves, loose bark, or are shallowly buried in the soil. At dusk, adults emerge, locate host plants, and then feed, typically leaving host plants before daylight hours (Mau and Kessing, 1991; Arita-Tsutsumi et al., 1994).

McQuate and Jameson (2011b) have recently demonstrated that illumination of plants at dusk has the potential to discourage colonization of adult Chinese rose beetles on the illuminated plants, with presumed associated reduced defoliation. Adult Chinese rose beetles emerge from their daytime shelter at dusk and fly to the host plant on which they will feed at night. Beetles tend not to choose host plants that are illuminated at the time of their decision of feeding location, making nighttime illumination of host plants a potential, environmentally friendly control method. Although adult beetle activity has been described as initiating at about 30 min after sunset (Tsutsumi et al., 1993), there has been no published data reporting on the variation observed among adult individuals in timing of evening colonization of host plants. To effectively use lighting to minimize colonization (and subsequent defoliation) of host plants, it is critical to know the timing of the onset of colonization in order to guide the selection of timing for the initiation of lighting, whether a timer is deployed using an alternating current (AC) electric source or if light initiation is triggered by a "dusk sensor" in a solar-powered light set-up.

Here, observed host plant colonization times by adult Chinese rose beetles are summarized relative both to sunset time and to incident light intensity. For these trials, castor bean [*Ricinus communis* L. (Euphorbiaceae)] was used as a test host plant because it is a readily used host plant of Chinese rose beetles, its large leaves and relatively open canopy permit ready observation of the presence of the beetles, and experimental plants can readily be grown from seed.

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* Tel.: +1 808 959 4339; fax: +1 808 959 5470.
E-mail address: grant.mcquate@ars.usda.gov.

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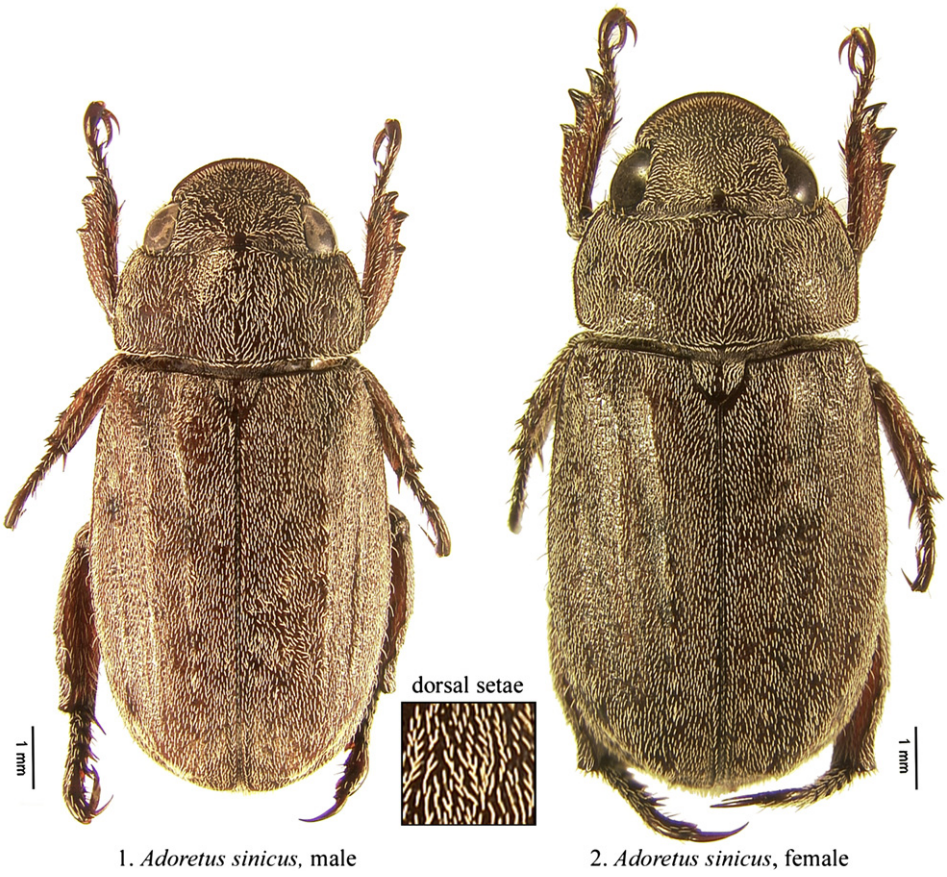

Figs. 1 and 2. Habitus of *Adoretus sinicus*: 1) Male. 2) Female. Inset shows close-up of dorsal setae.

Materials and methods

General methods

Chinese rose beetles were collected at night in the vicinity of Pepeekeo, HI (19° 42′ 9″ N, −155° 5′ 38″ W), from copperleaf, *Acalypha wilkesiana* Muell.-Arg. (Euphorbiaceae). On each collection night, at least 100 beetles were released into a 1.8×1.8×1.8 m screened cage (BioQuip Products, Rancho Dominguez, CA, USA), located at the Waiakea Agricultural Research Station in Hilo, Hawaii (19° 38′ 28.86″ N, −155° 4′ 53.32″ W), that held one potted, approximately two month old, castor bean plant. The beetles had access to feed on the same plant over 5 consecutive nights, the first two nights being within the screened cage. The beetle number to foliage ratio was sufficient that ample undamaged foliage was available for the beetles throughout the five day period, so there was no danger of the beetles leaving the host site area for insufficient supply of leaves on which to feed. On the 3rd night, the plant was removed from the cage at 1.5 h after sunset, being careful to minimize disturbance of beetles established on the plant, and placed approximately 9 m away from the opening of the cage (in an open grassy field). After allowing about 5 min for settling of any disturbed beetles, the total number of beetles present on the plant was counted. On the 4th night, again at 1.5 h after sunset, the total number of beetles on the plant was again counted. Counts made on the 3rd and 4th nights were made to document satisfactory colonization (at least 30 beetles) on the test host plant. On the 5th night, counts were made of any beetles on the plant every 5 min from an hour before sunset up until sunset and then every minute from sunset until ½ h after sunset. At the time of each of these counts, a light reading (using a SPER Scientific 840022 Advanced light meter, SPER Scientific, Scottsdale, AZ, USA) was taken of ambient light conditions above the plant. Additional beetle counts were taken at 1, 1.5 and 2 h after sunset, after which further colonization was unlikely (Tsutsumi et al., 1993). No light readings were taken at these latter times because it was already dark (no measurable light). On the 6th day, the plant was removed from the area during the day. Because there was no longer a host plant, adult beetles that had sought shelter in the ground near the castor bean plant would be expected to disperse to other areas where suitable host plants were present. This behavior minimized the possibility that beetles in earlier replications could also be involved in subsequent trial replications, providing independence of beetle populations among trial replications. The six day process detailed above was replicated for a total of 7 times, extending from March to July, 2010 in order to include trials over a range of sunset

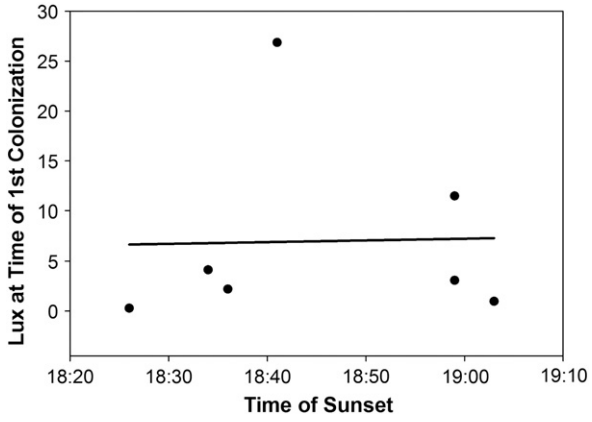

Fig. 3. Ambient light intensity value (in lux) at the time of the first colonization of adult Chinese rose beetles relative to sunset time for each of the seven trials. The best fit linear regression line (not significant) is also shown ($r^2 = 0.00071$).