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The Mating Behavior of the Red Palm Weevil, *Rhynchophorus ferrugineus* Oliver (Coleoptera: Curculionidae)

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ABSTRACT

The mating behavior sequence of 1, 7, 21, and 45-day-old red palm weevils (RPW), *Rhynchophorus ferrugineus* Oliver, was observed and recorded including the pre-mounting, mounting, and copulation behavioral activities. The pre-mounting period was significantly longer for 1 and 7 d-old weevils than for 21 and 45-d-old weevils and ranged from 5.5 to 18.5 min. There was no courtship behavior prior to mounting. Mean mounting duration was not significantly different between age groups and ranged from 35.5 to 43.3 sec. Mean copulation period varied significantly with weevil age; length of copulation increased with increasing weevil age, and ranged from 3.8 to 9.8 min. Mean total number of eggs laid by females, eggs 30 d after one full copulation with males of similar age, and rate of egg hatching decreased significantly with increasing weevil age. The short copulatory period was adequate for insemination of the female during copulation. Several mating positions of adults RPW were observed.

The duration of pre-copulation and copulation was significantly affected by the mating status of 21-d-old males or females. Mated males with mated or unmated females started copulation sooner than unmated males. Unmated males began copulating with mated females sooner than unmated females.

In the sex recognition study, the male often attempted to mount and insert its genitalia into another male; males mounted by other males did no show any aggressiveness. The behavior of the

male RPW prior to copulation with the dead body of another weevil included the examination and manipulation of the dead body, mounting, and a copulatory attempt. Only young males attempted to mate with dead body (or part) of females or males.

Several strange behavioral activities of RPW were observed including the strong aggregation and mounting of adults regardless of sex and age, landing of the male sideway on another male (male-male side-side position), multiple-male mounting, wrong-side mounting position regardless of its sex, manipulation of a male to two dead females, and attempt of the male to copulate only with the female's abdomen. Also, studies for understanding the RPW-date palm tree interactions and factors affecting their behavior are discussed.

Key words: *Rhynchophorus ferrugineus*, mating behavior, palm trees, Copulation

INTRODUCTION

The red palm weevil (RPW), *Rhynchophorous ferrugineus* Oliver (Coleoptera: Curculionidae), is an economically important, tissue-boring pest of date palm in many parts of the world. The insect was first described in India as a serious pest of coconut palm (Lefroy, 1906) and later on date palm (Madan Mohan Lal, 1917; Buxton, 1918). The insect is a major pest of date palm in some of the Arabian Gulf States including Saudi Arabia, United Arab Emirates, Sultanate of Oman, and Egypt (Cox, 1993; Abraham et al. 1998). The agroclimatic conditions prevalent in this region and the unique morphology of the crop, coupled with intensive modern date palm farming, have offered the pest an ideal ecological habitat (Abraham et al., 1998).

The symptoms of red palm weevil attack to date palm was summarized by Abraham et al. (1998). Damage was categorized by the presence of tunnels on the trunk and base of leaf petiole, oozing out of thick yellow brown fluid from the tunnels, appearance of frass in and around the openings of tunnels, fermented odor of the fluid inside the infested tunnel, appearance of a dried offshoot, production of a gnawing sound by the grubs, presence of cocoon/adults in the leaf axiles, and breaking of the stem or toppling of the crown when the palm is severely infested.

Detailed life cycle of laboratory-reared RPW was reported by El-Ezaby (1997). The author stated that RPW had three generations per year; the shortest was the first generation (100.5 d) and the longest was the third generation (127.8 d). Average numbers of eggs laid per female were 283.3, 107.0, and 77.2 eggs for the first, second, and third generations, respectively. The author also stated that the number of eggs laid decreased with increase in temperature, but the rate of egg hatching increased as temperature increased; the fatal temperature limit of the eggs was 40°C. The average life span of males was 90.7, 89.8, and 66.6 d in the 1st, 2nd, and 3rd generation, respectively; while the average life of females was 111.7, 898.4, and 67.6 d in the 1st, 2nd, and 3rd generation, respectively (El-Ezaby, 1997).

The mating behavior of adults RPW has not been documented. Detailed descriptions of the mating behavior, however, have been published on many insects, some of which showed various behavioral similarities to the RPW. The current investigations were undertaken to study the mating behavior of adults RPW under laboratory conditions. Specific objectives were to (1) observe the behavioral characteristics between sexes including periods of pre-mounting, mounting, and copulation, (2) determine the effect of mating status of adults on subsequent mating behavior, (3) determine if adults recognize the other sex prior to mating (i.e., sex recognition), (4) observe if mating occurs between live adults and carcasses (at or after death), and (5) observe specific and strange aspects of mating behavior of adults RPW.

MATERIALS AND METHODS

Test Insects

Laboratory experiments were conducted in the Plant Protection Laboratory at the United Arab Emirates University. Insects were originally obtained from infested palm trees in Masafi area in the Sharja Emirate in 1997. Insect culture was maintained at 24±2°C, 70±5% RH, and a photoperiod of 12 : 12 (L:D) h. Larvae were provided with sugarcane for feeding, while the adults provided with cotton wicks saturated with a sugar solution for feeding and egg laying. Adults were sexed after emergence from cocoons and kept

separately in small jars prior to the beginning of the observations. Sexing of adults was done according to the presence of a series of black hairs on the dorsal, frontal part of snouts of males and their absence in the females (Fig. 1).

During this study, photographs were used to establish and study specific behavioral activities. Canon AE1 Program camera, provided with Vivitar Automatic Extension Tubes, was used for documenting specific behavioral activities. In most experiments, mating activities were observed for 1 hr in glass jars (15 cm height and 10 cm diameter), other observations were recorded in plastic rectangular arenas (25 x 15 x 5 cm) (Fig. 2). Based on preliminary observations, the 1h observation period was adequate for observing and recording all mating activities of the RPW since most of these activities occurred during the first 15 min after the introduction of the weevils in the test arena, A stopwatch was used for recording the time for all behavioral activities. The observation arena provided an adequate space for weevil movement. The adults were provided with one cotton wick saturated with a sugar solution. All observations were made at room temperature 21±1°C, RH 65±5%, and 2-6 pm.

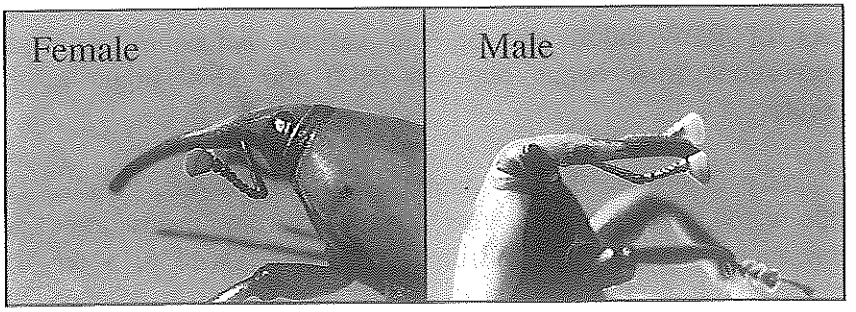

Fig. 1. Female (left) and male (right) RPW showing a series of black hairs on the dorsal, frontal part of the snout of the male and their absence in the female.

Fig. 2. Jars and plastic rectangular containers used for observation of mating behavior of adults RPW.

Behavioral Characteristics of Adults

The sequence and duration of mating behavior activities including the periods of pre-mounting, mounting, and copulation was observed and recorded using ten pairs of 1, 7, 21, and 45-d-old unmated (virgin) males and females. These mating behavioral activities were observed for possible age differences. Each pair from each age group was observed for 1 hr. The Least Significance Difference (LSD test, $P = 0.05$; SAS, 1990) was used to assess the effect of RPW adult age on the various behavioral activities. Observations were begun between 0900 and 1100 hours in the laboratory.

To determine if copulation was successful (i.e., females lay fertile eggs), the females were separated from males after the termination of copulation. Each female was placed in a jar and provided with one cotton wick saturated with sugar solution for feeding and egg laying. The cotton wick was replaced weekly and the number of eggs recorded. The viability of the eggs was determined by counting the number of hatched larvae. LSD test was used for data analysis (SAS, 1990).

Effect of Mating Status on Subsequent Mating Behavior

The effect of mating status of one aging group (21-day-old adults) on duration of pre-copulation (pre-mounting and mounting) and copulation was determined using four groups of paired adults: (1)

unmated (virgin) males and females, (2) unmated males and mated females, (3) mated males and unmated females, and (4) mated males and females. Eight pairs from each combination group were observed for 1 h each. LSD test ($P = 0.05$) was used to assess the effect of mating status on subsequent mating behavior.

Sex Recognition

Behavioral activities and sex recognition of males RPW were recorded using four groups of ten males each. Each group was kept separately in plastic containers for observation. Observations lasted for 1 hr.

Mating Behavior with Carcasses

Individual unmated males (1, 7, 21, or 45-d-old; n = 12) were introduced, separately, into plastic containers together with 4 h or 3 d carcasses consisted of either females or males that died a natural death. The sequence of mating behavioral activities was observed.

Unusual Behavioral Activities of RPW

Preliminary observations of adults, in addition to observations made during the various experiments conducted in this study, indicated the presence of strange behavioral activities prior, during, and after mating. Several of these activities were recorded.

RESULTS AND DISCUSSION

Behavioral Activities of Adults

Pre-Mounting and Mounting. There were distinguishing behavioral characteristics of each sex of RPW. Males were the only initiators of mating. Males tended to move faster and more frequently than females and apparently males responded readily to the form of motion of females. During the pre-mounting period (starting from the placement of adults in the observation arena and including the preliminary contact of both males and females prior to mounting; Fig. 3A-B), the male slowly approached the female and touched her last abdominal segment using his snout (Fig. 3A). The male then touched the middle section of the female's elytra several times with his snout

and antennae (Fig. 3B). Male then touched the thorax of the female and grasped her abdomen with his prothoracic legs; antennae of both sexes projected forward (Fig. 3C). The mean pre-mounting period (i.e., the time adults were placed together until the initial mounting of the male on the female began) was significantly ($P < 0.05$) longer for 1 and 7 d-old weevils than for 21 and 45-d-old weevils (Table 1) and ranged from 5.5 to 18.5 min.

There was no courtship behavior prior to mounting. In most instances, males mounted from the back of the females, but could mount from any angle or direction (Fig. 3C-E) until they reach the precise position for copulation (Fig. 3F). The mounting procedure started with the males slowly climbing onto the female's dorsum. Receptive females usually remained stationary and mounting occurred quickly. Non-receptive females (rarely occurred; approximately 2%) attempted to escape by walking away. In this instance, the male attempted to change his holding position, mostly moving clockwise until he held the female using all three pairs of legs. Based on visual observations, there was no interruption of mounting caused by the departure of females. The mean mounting duration, from initial to full mounting (Fig. 3C, E, F), was not significantly different between age groups (Table 1) and ranged from 35.5 to 43.3 sec.

Copulation. Sequence of copulation activity (defined as the time period from beginning of abdominal flexing of the male until it dismounts from the female) occurred rapidly where both unmated males and females seemed to be mutually attracted to each other by a visual stimulus. Further study is needed to prove this point. In order to completely insert the genitalia after full mounting, the male-sternum had to be on the female-dorsum (Fig. 4A). The male extended and bent his genitalia downward toward the female's genital opening. In this position, the male raised his prothoracic legs and placed them on the thorax of the female. When the male started to insert the genitalia into the female, he grasped the female underneath using the three pairs of legs. The male finally lowered his rostrum to the female's thorax. The female stood motionless during the copulation period.

Table 1. Duration of pre-mounting, mounting, and copulation of adults RPW as affected by age.

	Pre-mounting, min		Mounting, sec		Copulation, min	
Weevil age, d	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range
1	14.3 ± 2.3 a	10.2 – 18.5	35.5 ± 3.4 a	31.1 - 45.2	3.8 ± 0.9 c	2.9 – 4.8
7	13.1 ± 2.9 a	9.5 – 17.6	40.1 ± 5.4 a	32.1 – 47.1	4.9 ± 1.4 b	4.1 – 7.1
21	10.2 ± 1.3 b	8.1 – 14.1	43.3 ± 6.3 a	39.1 – 48.2	9.8 ± 1.2 a	7.1 – 10.1
45	8.1 ± 1.4 c	5.5 – 11.2	36.3 ± 3.1 a	34.2 – 40.2	8.1 ± 1.1 a	34.2 – 40.2

Means (± SE) followed by the same letter are not significantly different at the p = 0.05 level (LSD test, SAS Institute, 1990). Data were transformed to square root of X before analysis (n = 10)

During the dismounting stage, the male retracted his genitalia and moved backward slightly; occasionally, the male moved backward. In both cases, the prothoracic legs of the male were withdrawn first from between the female's pronotum and elytra and the male finally withdraw his meta- and mesothoracic legs before moving backward or forward. After copulation, both weevils resumed normal activity by walking within the observation arena and/or attaching themselves to the cotton wick.

The mean copulation period varied significantly ($P < 0.05$) with weevil age (Table 1); the length of copulation increased with increasing weevil's age, and ranged from 3.8 to 9.8 min. Duration of copulation in other curculionid insects varied significantly. The period ranged from 15 to 30 min for boll weevils *Anthonomus grandis grandis* Boheman (Mayer and Brazzel, 1963), from 30 to 72 min in granary weevil *Sitophilus*

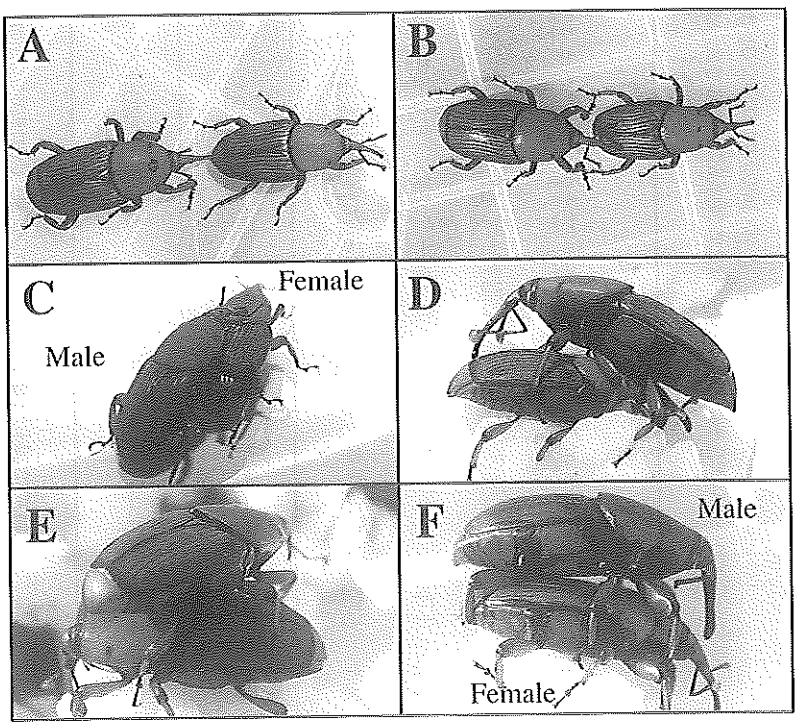

Fig. 3. Sequence of adults RPW behavioral activities during pre-mounting and mounting stages. (A) Male slowly approached the female from behind, in most instances, with the snout of the male is

touching the last abdominal segment of the female; antennae of the female projected forward. (B) Male is touching the middle section of the female's elytra several times with the snout and antennae; antennae of both sexes projected forward. (C) Male is touching the thorax of the female and grasping her abdomen with its prothoracic legs; antennae of both sexes projected forward. (D) Male approaches the female from front. Note the grasping of the male to the body of the female using mainly his prothoracic and mesothoracic legs; the metathoracic legs of the male still on ground. (E) Male is changing his mounting position when contacting the female from the front until it gets a firm "Holding Position". (F) Full mounting of the male in which the male is grasping the body of the female with its three pairs of legs.

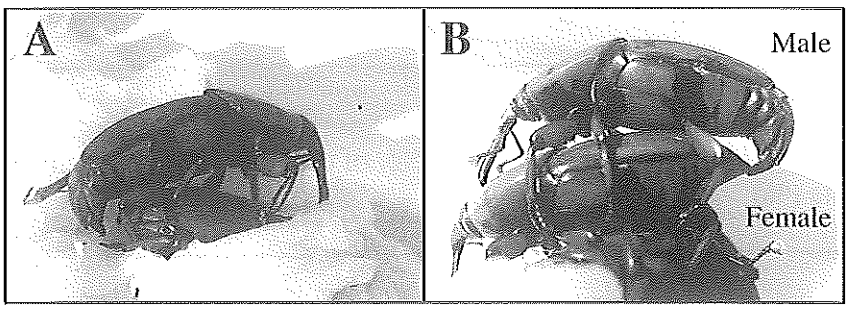

Fig. 4. Copulation of adults. (A) the male is initiating extension of its genitalia toward the female in which the male placed its prothoracic legs on the female's thorax, and (B) Male obtained a firm "Genital Hold" on the female underneath that remained motionless during the copulation period.

granarius (L.) (Wojcik, 1969), 4.8 h for the maize weevil *Sitophilus zeamais* Motschulsky (Walegenback and Burkhholder, 1987), and 9 h for the pecan weevil *Curculio caryae* (Horn) (Hatfield et al. 1982). In other coleopterans, mating duration varied from a few seconds, as in the drugstore beetles, *Stegobium paniceum* (L.) (Ward, 1981) to 20 h in *Lytta nuttalli* Say (Gerber & Church 1973).

The effect of age of mated females on the production of eggs 30 d after one full copulation with males of similar age, and the rate of egg hatching (Table 2). The mean total number of eggs laid by the females decreased significantly ($P < 0.05$) with increasing weevil age,

and ranged from 65.5 eggs from 1-d-old female to 43.5 eggs from 45-d-old female. The rate of egg hatching also decreased significantly ($P < 0.05$) with increasing weevil age, and ranged from 75.6% from 1-d-old weevils to 47.4% from 45-d-old weevil.

Females separated from males for periods as long as 30 d still produced fertile eggs. This may indicate that sperm from one mating can produce fertile eggs for the reproductive life of the female. The high capability of females RPW for sperm storage would assure the continuation of production of offspring under low densities and where the chances of encountering a mate would be greatly reduced.

Table 2. The effect of age of mated females RPW on production of eggs 30 days after one full copulation from males of similar age, and the rate of egg hatching.

Age of mated female, d	No. of eggs laid	No. of eggs hatched	Hatching rate (%)
1	65.5 ± 9.2 a	49.5 ± 8.3	75.8 a
7	68.0 ± 8.9 a	41.0 ± 7.2	60.3 b
21	51.5 ± 6.4 b	25.3 ± 4.5	49.1 c
45	43.0 ± 7.1 c	20.4 ± 3.4	47.4 c

Means (± SE) followed by the same letter are not significantly different at the $P = 0.05$ level (LSD test, SAS, 1995). Data were transformed to square root of X before analysis (n = 10)

The short copulatory period (2.9 – 4.8 min) reported in this study was adequate for insemination of the female during copulation. Females RPW may not need to frequently mate with other males. Insemination of the female by several males may be necessary in the field for maintaining genetic variability in the population (Gordon and Bandal, 1967).

The touching of the male to the dorsum of the female by his snout, antennae, and prothoracic legs may have been an external manifestation of sexual excitement or courtship in the male and this may calm the female and induce her to readily accept his attempt to copulate. In addition, visual attraction of males to females was also observed in other curculionid species such as *H. postica* (LeCato and Pienkowski 1970), *S. zeamais* (Walgenback and Burkholder 1987), *C. caryae* (Horn) (Collins et al. 1996), and in other beetles such as ladybird beetle, *Harmonia axyridis* Pallas (Obata, 1987).

Vision has been interpreted in many instances as playing an important role in mating behavior, however, RPW mated as frequently in the dark as in the light (WK, unpublished data). This may also be true in confined area where adults RPW were seen under the fiber sheath of infested palm trees where both sexes are present.

Several mating positions of adults RPW were observed. The most copulating position was the "Male-Sternum to Female-Dorsum" position (Fig. 4B). Occasionally, some adults were seen in an inverted position where the adults were lying on their sides in an abdomen to abdomen position (Fig. 5). This position was also observed between males. Another position rarely observed in which the male was on his back holding the female and where legs were projected upward.

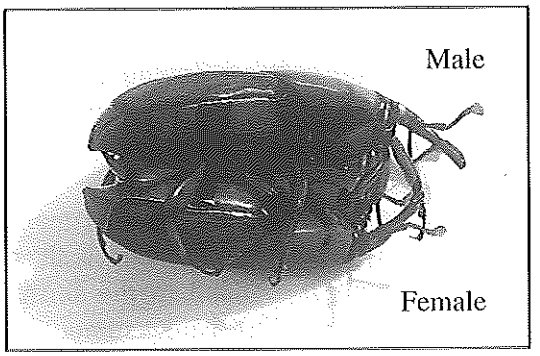

Fig. 5. Male-Female Side-Side Abdomen-Abdomen copulating position.

Effect of Mating Status on Subsequent Mating Behavior

The effect of mating status of 21-d-old adults on the duration of pre-copulation and copulation (Table 3). The duration of pre-copulation was significantly affected by the mating status of males or females. Mated males with mated or unmated females (i.e., group 3 and 4) started copulation sooner than unmated males (group 1 and 2). Unmated males began copulating with mated females sooner than unmated females. The pre-copulation period ranged from 12.1 min in group 1 (unmated males and females) to 7.9 min in group 4 (mated males and females).

The duration of copulation was significantly ($P < 0.05$) affected by mating status, and also followed similar trend to the duration of pre-copulation. Previously mated weevils (as in group in this study) copulated sooner and faster than unmated weevils. The copulation period ranged from 10.1 min for unmated weevils to 5.5 min for mated adults.

Sex Recognition

In an experiment where four groups of ten males RPW were present in the test arena, the male often attempted to mount other males and then insert their genitalia. In most cases, males that were mounted by other males did no show any aggressiveness or rejection behavior. Few exceptions to this phenomena were observed in which some males struggled violently with aggressive males. In one instance, two males in which each was trying to mount the dorsal side of the other (Fig. 6A). When the first male was successful after several trials in mounting the second male, it attempted to insert its genitalia (Fig. 6B) but failed and dismounted after few seconds. The second male then attempted to gain the dorsal side of the first male and was also successful; it also extended his genitalia but with no success in copulation. Males apparently responded to the form of motion of another weevil, regardless of sex. The mating stimulus in RPW seems to be at least in part visual and nondiscriminatory as to sex.

Table 3. Effect of mating status of 21-days-old adults RPW on duration of pre-copulation (pre-mounting and mounting) and copulation.

			Pre-copulation, min		Copulation, min	
Group	Male	Female	Mean ± SE	Range	Mean ± SE	Range
1	Unmated	Unmated	12.1 ± 2.3 a	9.1 – 14.6	10.1 ± 2.3 a	8.4 – 12.1
2	Unmated	Mated	10.2 ± 2.1 b	7.1 – 10.3	8.1 ± 2.1 b	7.1 – 9.2
3	Mated	Unmated	8.2 ± 1.2 c	6.5 – 8.9	6.2 ± 1.2 c	4.6 – 6.4
4	Mated	Mated	7.9 ± 1.9 c	7.0 – 9.2	5.5 ± 1.5 c	4.3 – 6.7

Means (± SE) followed by the same letter are not significantly different at the p = 0.05 level (LSD test, SAS Institute, 1995). Data were transformed to square root of X before analysis (n = 8). Unmated = virgin or unexperienced; Mated = non-virgin or experienced (previously mated).

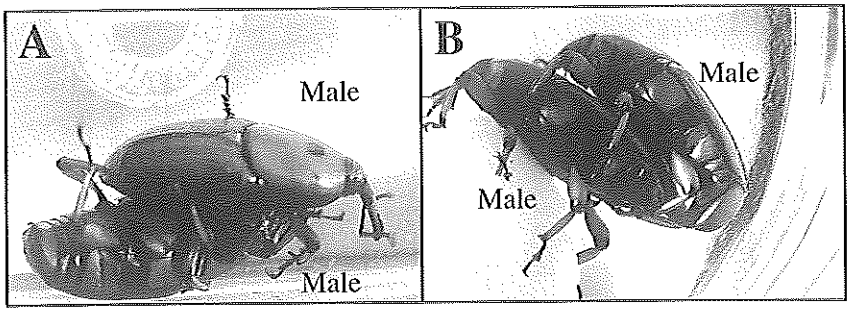

Fig. 6. Male RPW attempted to copulate with another male, (A) male struggled violently with an aggressive male, and (B) successful attempt by one male in mounting and attempting to insert his genitalia. The male dismounted after few seconds without real copulation.

While males often mounted other males, females were rarely seen mounted on one another. It has been suggested (LeCato and Pienkowski 1970) that female mounting was not considered sexual activity but rather a result of aggregation of many females under closely confined conditions.

Mating Behavior with Carcasses

Observations indicated that the behavior of the male RPW prior to copulation with the carcass of another weevil (Fig. 7) included: (1) examination and manipulation of the dead body with the male's snout, antennae, and forelegs (Fig. 7A, B), (2) mounting (Fig. 7C), and (3) very short copulatory attempt (bending the tip of his abdomen downwards and attempting to insert the genitalia). In all instances, older males (45-day-old) did not initiate mating with dead partners, but young males (1-day-old) had a strong mating drive and attempted to mate with dead bodies of females or males. Position of the dead female played a role in the male's attempt to mount and copulate. The young male (1 or 7-day-old) initiated a normal copulatory position where he extended his genitalia and attempted to insert it into the female, but her retracted the genitalia after few seconds. The male spent about 2 to 3 min manipulating the female lying on its back (the male used the snout to touch the snout and thorax of the dead female), while the female standing on its legs was not manipulated by

the male into a mating position. Older males seem to recognize dead females after touching them with their snouts, antennae, and forelegs. Dehydration of the females after their death may have destroyed any localized chemical cues. Obata (1987) suggested that the chemical factor in this case seems to be the key stimulus necessary for a copulatory attempt.

The mean number of mounting and copulatory attempts by males with dead bodies of females or males is shown in Table 4. Males aged 1, 7, or 21 d mounted dead females slightly more than dead males regardless of the time period after their natural death. Males aged 45 d did not mount any dead female or male. Young males (1 and 7-d-old) also attempted to mate with the bodies of 4 h and 3 d beetles of either sex. The percentage of copulatory attempts was slightly higher for females than males. Only 8.3% of males of 21-d-old attempted to copulate with both sexes 4 h after their death, but no attempt was made on adults 3 d after their death. Males of 21 and 45 d of age did not show any copulatory attempt with females regardless of the time period after the death of the partner. Successful copulation (complete insertion of the genitalia into the female genital opening) was observed by 1-d-old unmated male with two females 4 h after their death, and by unmated male 7-d-old with one female 4 h after her death.The above-observed copulation lasted for 25-30 seconds.

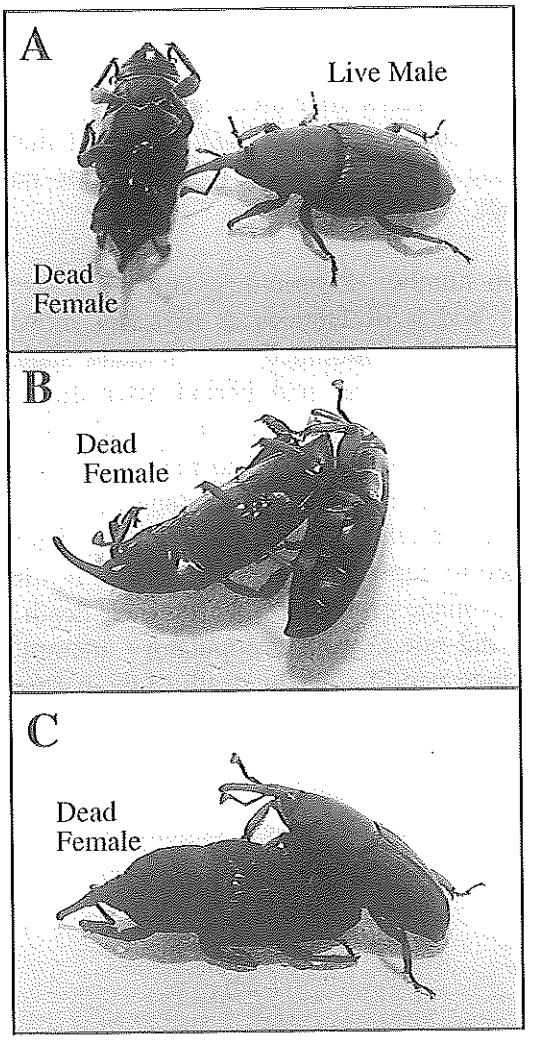

Fig. 7. Mounting and copulatory attempts by 1-d-old male RPW with a dead body of a female or male 4 h after their death. (A) Male examined the dead body of a female with its snout and antennae, (B) Successful attempt by the male to flip the dead body for mounting using all three pairs of legs, and (C) Male initiated the mounting stage and extended its pro- and metathoracic legs on the abdomen of the female; the mesothoracic legs still on the ground. The male extended his genitalia but no real copulation occurred.

Table 4. Behavioral response of males RPW with dead body of females and males.

Age of unmated male, d	n	Dead partner	4 h after death of the partner		3 d after death of the partner	
			No. of mounting	No. of copulatory attempt (%)	No. of mounting	No. of copulatory attempt (%)
1	12	Female	8	5 (41.7)	4	2 (16.7)
		Male	5	4 (33.3)	2	1 (8.3)
7	12	Female	4	3 (25.0)	2	1 (8.3)
		Male	3	3 (25.0)	1	-
21	12	Female	4	1 (8.3)	1	-
		Male	2	1 (8.3)	-	-
45	12	Female	-	-	-	-
		Male	-	-	-	-

Unusual Behavioral Activities of RPW

Several aspects of mating behavior of RPW were not understood. One of which often observed was the strong aggregation of adults (Fig. 8A), regardless of sex and age, the attachment of each other, and mounting on each other using their three pairs of legs. The aggregation of adults may play an important role in sexual selection in RPW. Attachment and mounting of adults may stimulate virgin adults (especially the females) to be receptive to copulation.

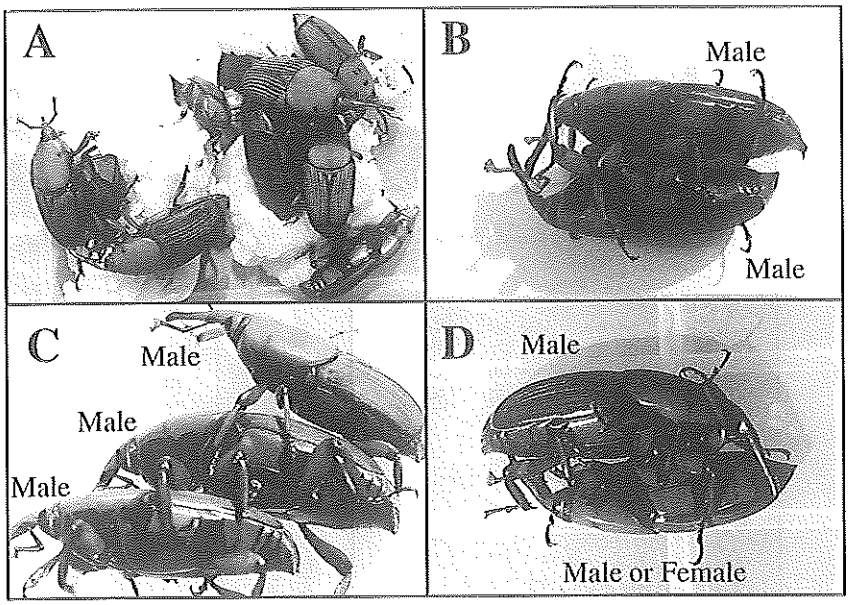

Fig. 8. Various strange behavioral activities of adults RPW. (A) Tight aggregation of adults, regardless of age and sex, (B) Mounting of the male on another male in a side-side copulating position, (C) Three males in "Multiple Male Mounting" position, and (D) Male facing the wrong direction of other weevil regardless of its sex.

The landing of the male sideway on another male, also called "Male-Male Side-Side" position, is another strange behavioral aspect.This occurred mostly between males but rarely (3%) between females (Fig. 8B). The "Multiple Male Mounting"(Fig. 8C) in which each male was trying to insert his genitalia into the other male is also another behavioral characteristic of the adults. Some males were seen

in the "Wrong-Side" position, where adults faced the wrong direction of other weevil regardless of its sex and without attempting to extend their genitalia (Fig. 8D). In this situation, both adults touched each other using their snouts and antennae. The latter behavior was also observed in elaterid beetles (Lilly 1959) and large milkweed bugs (Gordon and Bandal 1967).

Another strange or unusual mating behavior was the manipulation of a male to two dead females (Fig. 9A) and the successful attempt by the male to flip both bodies and mounted on the top of them for about 1 min. The male extended his genitalia for few seconds and then retracted it.

Young males seem to have strong sexual drive and were seen examining, mounting, and attempting to copulate with a female's abdomen where the head and the thorax of the female were separated (Figure 9C, D). This strong sexual drive of males RPW was also seen in other insects such as male hen fleas, *Ceratophyllus gallinae* (Schrank), attempting to copulate with dead females (Humpheries 1967) and the attempt of male crab-hole mosquitoes, *Deinocerites cancer* L., with cast pupal skins (Provost and Haeger 1967).

This study revealed that males RPW were the only initiators of mating behavior and there was no courtship behavior prior to mounting. The short copulatory period was adequate for insemination. The results of this laboratory study described mating activities and may not represent what may actually occur in the field. Weevils are considerably closer in jars or plastic containers than in the field so there is more opportunity for weevils to aggregate and mate.

The observations and data presented in this study may stimulate interest in many unknown aspects of mating behavior of RPW. The results also expand our knowledge of RPW biology and may provide a background for testing RPW pheromones in the laboratory.

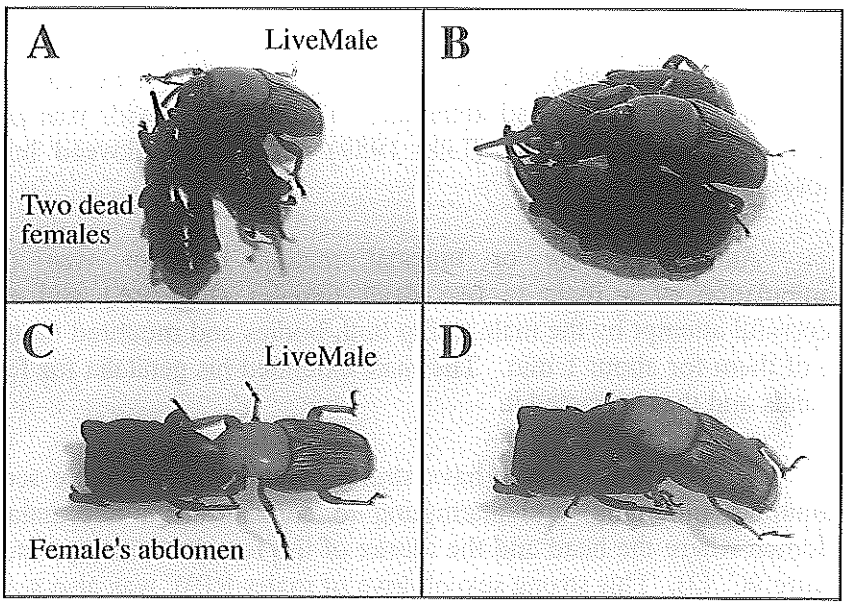

Fig. 9. Unusual behavioral activities of males RPW with dead females. (A) Manipulation of the male RPW to two dead females, (B) successful attempt by the male to flip both bodies and mounts on top for about 1 min. The male extended his genitalia for few seconds and then retracted it, (C) Male examined the female's abdomen (head and thorax of the dead female were separated), and (D) Male attempted to mount the female's abdomen.

Further studies should be conducted to understand the RPW-date palm tree interaction and the factors affecting their behavior. These include the study of the effect of environmental and physiological factors on mating frequency of RPW, weevil activities in the presence or absence of host odor or frequency of RPW, weevil activities in the presence or absence of host odor or food, and time of day in which mating occurs. Knowledge on the function of aggregation pheromones in the mating behavior of RPW is also important for the development of pheromone application in controlling the RPW.

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