Rhynchophorus palmarum

Figures 1 & 2. Adult *R. palmarum* (Image courtesy of Jennifer C. Giron Duque, University of Puerto Rico, Bugwood.org).

Scientific Name
Rhynchophorus palmarum (Linnaeus)

Synonyms:
Calandra palmarum,
Cordyle barbirostris Thunberg*,*
Cordyle palmarum,
Curculio palmarum,
Rhynchophorus cycadis Erichson*,*
R. depressus Chevrolat*,*
R. languinosus Chevrolat

Common Names
South American palm weevil, giant palm weevil, palm-marrow weevil, American palm weevil

Type of Pest
Weevil

Taxonomic Position
Class: Insecta, **Order**: Coleoptera, **Family**: Curculionidae

Reason for Inclusion
Additional Pest of Concern List

Pest Description
Eggs: "The egg is pearly white in color, elongate-ovoid in form, and is 2.40 ± 0.07 mm [0.09 in] long and 0.87 ± 0.02 mm [0.03 in] wide when freshly laid. Toward the end of embryonic development, when the mandibles of the first-instar larva are visible, the egg swells slightly, increasing to about 0.91 mm [0.04 in] wide. The external surface is extensively pitted, and bears 7 grooves which extend around the circumference" (Hagley, 1965).

Larvae: "The larva is typically eruciform and [caterpillar-like and legless], and is 2.40 ± 0.001 mm [0.09 in] long and 0.94 ± 0.014 mm [0.04 in] wide in the first instar. The head is rich orange brown and bears a pair of stout mandibles. The abdomen is creamy white and semitransparent, each segment bearing distinct tufts of lateral setae. The later instars vary considerably in size. The mature larva is 51 ± 5.6 mm [5 in] long and 25 ± 3.8 mm [0.98 in] wide, with a [head] width of 8.06 ± 0.43 mm [0.3 in]. At this stage the cuticle becomes considerably darker, the head becoming dark brown and the abdomen assuming a reddish brown coloration. At maturity, the larva enters a prepupal stage" (Hagley, 1965).

Pupae: The tough, fibrous cocoon is made from the vascular bundles of the palm after the softer tissues have been eaten away (Hagley, 1965). "It is 72 ± 6.6 mm [2.8 in] long and 30 ± 2.2 mm [1.2 in] wide" (Hagley, 1965). The pupa is naked within the cocoon of palm material, and has a soft thin, cuticle (Hagley, 1965).

Adults: "The adult is deep black [in color]. The entire [body] surface is deeply pitted and is covered with short [hairs]. The insect has a sheen at emergence. The insect then assumes a dull black color for most of its adult life. The males are readily distinguished from the females by the presence of a "comb" of hairs on the proboscis starting 1-2.5 mm (0.04 - 0.10 in) [from its tip] and extending for a distance of about 5 mm (0.2 in). Both sexes are large and powerful, measuring 33 ± 1.2 mm [1.30 in] long and 15 ± 1.5 mm [0.59 in] wide" Hagley (1965).

Figure 3. Prepupa of *R. palmarum* that was taken from its pupal cocoon (Image courtesy of Center for Invasive Species Research, University of California, Riverside).

Figure 4. *R. palmarum* adult emerging from a pupal cocoon (Image courtesy of Center for Invasive Species Research, University of California, Riverside).

Biology and Ecology

The life-cycle of *R. palmarum* in the coconut palm is about 80 days (Griffith, 1987) or 120 to 180 days, including 30 to 60 days as adult (Sánchez et al., 1993). The females are attracted to fresh trunk wounds and lay their eggs inside the plant tissue in a hole made with their rostrum. Eggs are laid near or on the internodal area of the palm trunk next to the crown.

Eggs can be frequently found around the internodal stem region as well as in the base of young petioles, in the fiber running along the petioles around the stems, and the endosperm of damaged, mature nuts (Hagley, 1965).

After hatching, larvae bore into the stem where they tunnel vertically between the vascular bundles (Hagley, 1965). The larvae of *R. palmarum* feed on live vegetative and rotting tissue and extensively tunnel while developing. Adults are active between 7 to 11 AM and 5 to 7 PM (Hagley, 1965). They fly only during the day but avoid flying during the hottest hours of the day (noon and early afternoon).

Adults fly at a speed of 6 m/s (19.7 ft/s) and may travel up to 1.6 kilometers (1 mi) in 24 hours (Griffith, 1987; Hagley, 1965). Their preferred habitat is at the base of the leaf axil (Griffith, 1987), and the weevils may be found hidden there during the day (Hagley, 1965). Adults may also be found at the base of the stem, on the fiber surrounding the bases of younger petioles, between the roots of the palm above the soil surface, burrowed in soil at depths of 15 to 23 mm (6 to 9 inches), and hidden in leaf litter or crop trash (Hagley, 1965).

In Central America, the maximum adult population occurs during the dry season, and the altitudinal range is from sea level up to 1200 m [0.75 mi] (Sánchez et al., 1993). Females may oviposit 120-150 eggs in 30 days (Wattanapongsiri, 1966; Weissling and Giblin-Davis, 1994).

Hagley (1965) observed that palms between 3 to 5 years were the most attractive to weevils as hosts. However, older palms can also be attacked depending upon conditions (especially older African oil palms) (R. M. Giblin-Davis, personal communication).

Symptoms/Signs

Infested palms show a progressive yellowing of the foliage. The emerging leaves are destroyed, and flowers are necrotic. The leaves dry out in ascending order in the crown, and the apical leaf bends and eventually drops. Galleries and damage to leaf-stems made by the larvae are easily detected in heavily infested plants. In coconut, larval tunnel openings and frass can be found at the bases of the leaf

Figure 5. Palm frond damage caused by *R. palmarum* (Image courtesy of Center for Invasive Species Research, University of California, Riverside).

Figure 6. Damaged palm frond caused by *R. palmarum* (Image courtesy of Center for Invasive Species Research, University of California, Riverside).

axils (Hagley, 1965). Tissue of affected plants produces a strong, characteristic foul odor. Pupae and old larvae are frequently found in the crown area in the petiole bases where they are often well concealed and hard to locate (M. S. Hoddle, personal communication).

Figure 7. Canary Island palm killed by *R. palmarum* (Image courtesy of Center for Invasive Species Research, University of California, Riverside).

The internodal stem region is soft and can have both feeding and oviposition punctures (Hagley, 1965). Punctures may also be present on the edges of the petiolar bases as well as on the undamaged surfaces of immature nuts (Hagley, 1965).
The most extensive damage is caused by the older instars which are capable of excavating tunnels 30 to 40 cm (11.8 to 15.8 in) in length and 2 to 3 cm (0.8 to 1.2 in) in diameter within 24 to 36 hours (Hagley, 1965). Multiple larvae can completely destroy the internal tissues of a 3 to 5 year old palm in about 5 to 6 weeks (Hagley, 1965).

If the nematode *B. cocophilus* is present, a crosswise cut of the palm trunk at 0.3 to 2 m (1 to 6.6 ft) above the soil line shows the tell-tale red-ring symptom, which is a circular brick-red area in tall cultivars and usually browner in dwarf and hybrid cultivars (Griffith, 1987).

Figure 8. Red ring disease on coconut palm with *R. palmarum* galleries, Ecuador (Image courtesy of Robin Giblin-Davis, University of Florida).

Figure 9. Red ring disease on coconut palm, Trinidad (Image courtesy of Robin Giblin-Davis, University of Florida).

The discolored band is 3 to 6 cm wide (1.2 to 2.4 in) and about 3 to 4 cm (1.2 to 1.6 in) from the periphery. Occasionally, in trees older than 20 years, the whole central tissue is red instead of the typical 5 cm (2 in) band.

Pest Importance

In Central and South America this species is considered a primary pest of palm (Alpizar et al., 2002). Wattanapongsiri (1966) states that *R. palmarum* has been reported as a serious pest in banana, papaya, cacao, sugar cane, coconut and other palms within Mexico and Central America. Adults have also been recorded occasionally feeding on avocado and citrus and may be minor pests of these crops under some circumstances (M. S. Hoddle, personal communication).

EPPO (2005) states that Costa Rica, Colombia, Venezuela, and Brazil report the largest damage in palm plantation crops. It has also been reported as a pest on ornamental palms (EPPO, 2005).

This species can infest healthy, undamaged palms (Hagley, 1965). Larvae often destroy the apical growth area of the tree by feeding on the growing tissue in the palm crown. Infested palms can eventually die (EPPO, 2005); 30 larvae are able to kill an adult coconut palm (Fenwick, 1967; Griffith, 1968; from EPPO, 2005). Economic damage is dependent on both the species of palm and the number of larvae present (EPPO, 2005).

In addition to directly damaging plant tissue, *R*. *palmarum* is the vector of the nematode *Bursaphelenchus cocophilus* (Griffith, 1987; Brammer and Crow, 2002). *Bursaphelenchus cocophilus* is the causal agent of the red-ring disease, which causes serious economic losses in palm plantations in South and Central America. Only female adults vector the nematode *Bursaphelenchus cocophilus*. Adult female weevils, which are internally infested with *B. cocophilus,* disperse to a healthy coconut palm and deposit the juvenile stage of the nematode during oviposition. Nematodes enter the wounds, feed, and reproduce in the palm tissues, causing the death of the infected trees. The weevil larvae are parasitized by juveniles of *B. cocophilus,* which persist in the insect through metamorphosis (EPPO, 2005).

Figure 10. Coconut palm with red ring disease, Trinidad (Image courtesy of Robin Giblin-Davis, University of Florida).

The infective stage of the nematode can be found internally in the tracheal sacs or in the hemocoel among the gut tract loops. From these locations, the infective stage moves to the ovipositor of adult female weevils (Griffith, 1987). The adult weevils emerge from their cocoons in the rotted palm and disperse to apparently healthy or stressed and dying palms, completing the life-cycle. This pathogen can cause death of the plant 3-4 months after symptoms are evident (EPPO, 2005).

Figure 11. Coconut palm petioles with red ring disease, Ecuador (Image courtesy of Robin Giblin-Davis, University of Florida).

Known Hosts

R. palmarum has been reported on 35 plant species in 12 different families (EPPO, 2007a). The insect is economically important to palms and sugarcane (EPPO, 2007a).

Primary hosts: *Cocos nucifera* (coconut), *Elaeis guineensis* (African oil palm), *Euterpe edulis* (assai palm), *Metroxylon sagu* (sago palm), *Phoenix canariensis* (Canary Island date palm), *Phoenix dactylifera* (date palm), and *Saccharum officinarum* (sugarcane) (EPPO, 2007a; Thomas, 2010).

Secondary hosts: *Ananas comosus* (pineapple), *Annona reticulata* (custard apple), *Artocarpus altilis* (Fosberg breadfruit), *Carica papaya* (papaya), *Citrus* spp. (citrus), *Mangifera indica* (mango), *Musa* spp. (banana), *Persea americana* (avocado), *Psidium guajava* (guava), *Theobroma cacao* (cocoa) (EPPO, 2007a;).

Adults can feed on a multitude of plant species including:
Acrocomia aculeata (gru gru palm)[1], *Ananas sativa* (pineapple)[4], *Anona reticulata* (sugar apple)[4], *Anona muricata* (soursop)[4], *Bactris major* (black Roseau palm)[1], *Bambusa* sp. (bamboo)[2], *Beta vulgaris* (beet)[3], *Brassica rapa* (turnip)[3], *Carica papaya* (paw paw)[5], *Chrysalidocarpus lutescens* (bamboo palm)[1], *Citrullus vulgaris* (watermelon)[4], *Citrus aurantium* (orange)[4], *Colocasia* sp. (dasheen)[3], *Cucumis sativus* (cucumber)[4], *Cucurbita pepo* (pumpkin)[4], *Daucus carota*

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[1] Succulent stem
[2] Young shoot
[3] Tuber
[4] Ripened fruit
[5] Green and ripened fruit

(carrot)[3], *Desmoncus major* (picmoc palm)[1], *Dioscorca* sp. (yam)[3], *Euterpe broadwayana* (manac palm)[1], *Mangifera indica* (mango)[4], *Manicaria saccifera* (timite palm)[1], *Maximiliana caribaea* (cocorite palm)[1], *Musa sapientum* (banana)[4], *Oreodoxa oleracea* (cabbage palm)[1], *Persea gratissima* (avocado pear)[4], *Psidium guyava* (guava)[4], *Sabal* sp. (carat palm)[1], *Saccharum officinarum* (sugarcane)[1], *Solanum lycopersicum* (tomato)[4]*Solanum melongena* (egg plant)[4], *Spondias cytherea* (golden apple)[4], and *Xanthosoma* sp. (tannia)[3] (Hagley, 1965).

Pathogens Vectored

This species vectors *Bursaphelenchus cocophilus* (formerly *Rhadinaphelenchus cocophilus*) which can infect several species of tropical palms including: Canary Island date, Cuban royal, date, and most commonly oil and coconut palms (Brammer and Crow, 2005). This pathogen can kill young host trees (Brammer and Crow, 2005).

Known Distribution

Argentina, Barbados, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba*, Dominica, Dominican Republic*, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Honduras, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico*, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela (EPPO, 2005; EPPO, 2006; EPPO, 2007b).

*Distribution has not been confirmed (R. M. Giblin-Davis, personal communication). Surveys using pheromone traps are needed to confirm the presence of *R. palmarum* in these areas (R. M. Giblin-Davis, personal communication).

Potential Distribution within the United States

In 2011, this species was detected in the border areas of Calexico and San Ysidro, California; and Mexicali, Tecate, and Tijuana, Mexico (USDA-APHIS-PPQ, 2011). All detections have been within 2.5 miles of the United States and Mexico border (USDA-APHIS-PPQ, 2011). The extent of the infestation is currently being assessed (USDA-APHIS-PPQ, 2011). *Rhynchophorus palmarum* detections in California have been determined to be negative for *Bursaphelenchus cocophius*, which can cause red-ring disease in coconut and oil palms (USDA-APHIS-PPQ, 2011).

In May 2012, two detections of *R. palmarum* were found in Alamo, Texas (USDA-APHIS-PPQ, 2012). Both detections were within 5 miles of the U.S.-Mexico

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[1] Succulent stem
[2] Young shoot
[3] Tuber
[4] Ripened fruit
[5] Green and ripened fruit

border. Red ring disease has not been found in Texas (USDA-APHIS-PPQ, 2012).

This species could potentially affect several areas in the United States (mainly southern states) where primary hosts of *Rhynchophorus palmarum* are present (listed in **Hosts** section). These states include Alabama, Arizona, California, Florida, Georgia, Hawaii, Louisiana, Massachusetts, Mississippi, North Carolina, South Carolina, and Texas (R. M. Giblin-Davis, personal communication; USDA-NRCS, 2011). Some primary hosts are also present in Puerto Rico and the Virgin Islands (USDA-NRCS, 2011).

Pathway

This species may move through infected plants, like nursery stock. This species may also move short distances through adult flight (EPPO, 2005). Both males and females are considered strong fliers and can fly over half a mile in one flight (Hagley, 1965).

This species has been intercepted 10 times with 5 additional interceptions being identified at the genus level only (AQAS, 2011, queried 8-24-2011). These interceptions occurred from January 1986 to October 2009. Interceptions occurred in airports (6), at land borders (2), and maritime ports (7). Most interceptions occurred on fruit as well as other plant parts. Six interceptions occurred on *Musa* sp. (banana) and one occurred on *Cocos nucifera* (coconut). Material originated from Ecuador (6), Mexico (3), Guatemala (2), and Congo, El Salvador, Peru, and an unidentified African country (1 each) (AQAS, 2011; queried 8-24-2011).

Survey

CAPS-Approved Method*:

There are two CAPS-approved methods for *R. palmarum.* Visual surveys may be used to detect larval populations before adults emerge. A trap and lure combination may be used to detect adult populations.

Visual inspection

Visual inspection may be used if palms with highly suspect damage and signs of infestation are observed. If permission can be obtained by the property owner, remove palm fronds by cutting the frond at the base with a pole cutter. Once the frond has been removed, inspect the base of the frond for tunneling, larvae, pupae, or adults. Splitting the base of the frond with a hatchet can greatly assist with inspections for tunnels, larvae, and pupae (M. S. Hoddle, personal communication).

Another visual inspection method entails cutting a “window” in the crown of a highly suspect tree. Based on the size of the tree, multiple fronds are cut from one side of the crown from near the tip to the start of the trunk to reveal any tunneling occurring in the crown. This method will affect the appearance of the palm and access to the canopy may be difficult. Therefore, only highly suspect trees should be used and permission must be obtained from the property owner. Due to the long life cycle of the weevil, this type of inspection may detect the larval and pupal stages of the pest before adult weevils would be able to be detected in traps.

Trapping

1.1Trap and Lure

The trap for *R. palmarum* is a home-made bucket trap (instructions found in USDA-APHIS, 2010) or a commercial palm weevil trap. For home-made traps, the bucket may range in size from one to five gallons. There are three attractants needed to trap for *R. palmarum*: two lures and a food bait that is prepared on site. The two lures are 1) an aggregation pheromone and 2) ethyl acetate. Food baits can include sugarcane, apples, or palm or date parts (chopped into 3 to 4 cm (1 $^{1}/_{4}$ to 1 $^{3}/_{4}$ inch) pieces); or a10 percent molasses and water solution containing 1 teaspoon of baker's yeast (USDA-APHIS, 2010). All three attractants (the two lures and food bait) are required to report negative data for *R. palmarum*. The pheromone and ethyl acetate lures should be replaced every six weeks (42 days).

IPHIS Survey Supply Ordering System Product Names:

1) *Rhynchophorus palmarum* Aggregation Lure
2) Palm Weevil Lure, Ethyl Acetate
3) Palm Weevil Bucket Trap

Note: at the present time, it appears that placing pheromones for both *R. palmarum* and *R. ferrugineus,* Red Palm Weevil, in the same trap is an acceptable practice. Therefore, if both pests are targets, the trap should be baited with the pheromone lures for *R. palmarum* and *R. ferrugineus,* ethyl acetate, the food bait, and propylene glycol as a killing agent.

1.2 Trap Construction

Traps may either be purchased or constructed on site. Traps should have the following features:

Figure 12. Homemade *R. ferrugineus* trap covered with burlap (Image courtesy of Amy Roda, USDA-APHIS).

Figure 13. Homemade *R. ferrugineus* trap with entrance holes (Image courtesy of Amy Roda, USDA-APHIS).

- Rough texture on the outside of the bucket to allow weevils to crawl up the outer surface (attach burlap, ground cloth, or some other material, to the outside of the container) (Figure 12).Holes large enough (approximately 3 cm (1 $^{1}/_{5}$ inches)) to permit weevil entry in the side of the bucket, cut near the rim (Figure 13).
- Sufficient space at the bottom for a liquid mixture that is used to trap and kill the weevils that enter the trap.
- A tight-fitting trap lid to prevent contamination of the trap contents.
- Trap lid with a loop for hanging the trap in trees.

1.3 Food Bait Preparation

Figure 14. Lid of homemade bucket trap with hanging lure (Image courtesy of Amy Roda, USDA-APHIS).

Completely cover the food bait with a liquid solution. The liquid is critical as the weevils are attracted to the humidity and it prevents the weevils from crawling out of the trap. A 50 to 50 solution of propylene glycol (low-toxicity anti-freeze such as RV & Marine Antifreeze) and water helps minimize evaporation and the chance of the trap drying and the beetles escaping. Enough water and propylene glycol should be added to completely cover the bait and in a quantity that will remain until the next servicing date. Surrounding environmental conditions will dictate how quickly the trap will dry; and the quantity of liquid or frequency of servicing may need to be adjusted.

Molasses is widely available, easy to use, and was found to be effective in surveys in the Caribbean. Date parts, date palm waste, and sugarcane have been found to be very effective in areas where the weevil is established. When available, date parts, date palm waste, or sugarcane should be used as the preferred food baits.

Note: The food bait should be placed in the bottom of the bucket and covered with liquid. Food baits should not be placed in separate containers or bottles. Weevils could crawl onto these containers and fly out of the trap.

Use a wire to attach the two lures to the trap lid, allowing the lure to suspend about one-half inch above the liquid (Figure 14).

1.4 Trap Placement

For surveys in the urban environment, traps should be suspended from trees or poles. Traps should be hung approximately 2 meters (6.6 feet) above the ground. This will reduce the possibility of disturbance by people, pets, and wild animals. Hang the traps from **non-host** trees or telephone poles, within 30 meters (100 feet) of a host tree. Canary palms are especially attractive to *R. ferrugineus.*

Note: it is important to hang the traps from non-host trees. Native palm weevils can be attracted to the food bait and can attack the trees if traps are hung in host trees.

Note: if traps will be placed in a unique environment (i.e., non-urban, palm nursery or production areas, etc.), please contact Amy Roda for instruction on trap placement.

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1.5 Trap Servicing

Collect insect specimens from the trap and replace food baits every seven to nine days. The pheromone and ethyl acetate lures should be replaced every six weeks (42 days). The release rates and longevity of the lures are also based on temperature (i.e., the release rate increases at higher temperatures). Lures may need to be changed more frequently in hot, dry regions such as Texas and California. It is also of crucial importance to keep enough water and propylene glycol in the traps to completely cover the food bait.

Rhynchophorus palmarum vectors the nematode *Bursaphelenchus cocophilus* that causes red ring disease of palms. Other Rhynchoprinae beetles, including *Dynamis borassi* and *Metamasius hemiterus,* are also reported to vector the red ring nematode. To date the geographic areas of the nematode-carrying weevils have not overlapped with the U.S. native palmetto weevil *R. cruentatus* or with the invasive red palm weevil, *R. ferrugineus*. These beetles are not known to vector the nematode but the possibility exists as other species of Rhynchorpinae serve as hosts.

In order to detect the red ring nematode, follow these procedures **if** suspect palm weevils are found in traps (any of the species listed above). The following information has been excerpted from the **Protocol for Preparing and Forwarding Suspect South American Palm Weevil from Survey Traps for Confirmation and to Maximize Red Ring Nematode Detection**:

1. When suspect palm weevils are recovered from palm weevil bucket traps, carefully remove the weevil and place it in a screw-top vial containing water. Do not rinse the surface of the weevil or put the weevil in alcohol. If the weevil is still alive, freeze it for several hours to kill it before immersing in water.

2. If possible, wrap Parafilm® around the vial screw cap to prevent leakage. Label the vial with a local collection number using a Sharpie® permanent pen.

3. From the liquid in the trap with a weevil, extract approximately 50 cc's from the:
   a. top surface of the liquid in the trap if it is mostly propylene glycol;
   b. bottom of the trap if it's mostly water.

Place the liquid sample in a separate container that will not leak. A pipette or glass (not plastic) turkey baster can be used for this. Be sure to rinse it thoroughly between samples if reused to prevent cross-contamination. Write the same collection number on this container.

4. Until the specimen and other container of water can be shipped for identification, place the vial in cool conditions such as an ice-chest with cool packs, but do not freeze the specimen.

Follow the rest of the sample submission instructions in the **Protocol for Preparing and Forwarding Suspect South American Palm Weevil from Survey Traps for Confirmation and to Maximize Red Ring Nematode Detection**.

Literature-Based Methods:

Trapping: *Rhynchophorus palmarum* is detected by using pheromone baited traps (Oehlschlager et al., 1993). The main aggregation pheromone for *R. palmarum* is (4S,2E)-6-methyl-2-hepten-4-ol, called rhynchophorol. A minor component is (4S,5S)-4-methyl-5-nonanol, called ferrugineol (Giblin-Davis et al., 1995). Fermenting plant tissue (palm or sugarcane) is synergistic when added to the lure (Giblin-Davis et al., 1995). A trap consists of a 4-liter (1 gallon) plastic container with windows (15 x 10 cm or 5.9 x 3.9 in) for insect entry. Each trap contains a slow release (3 mg/day) pheromone (Rhyncholure) suspended from the lid, and 4 to 5 pieces of halved 10 to 12 cm (3.9 to 4.7 in) long sugarcane stalk. These pieces are pre-immersed in 1% a.i. Sevin 80®, (1-naphthyl-methylcarbamate) or 1% a.i. Furadan®, (2-3-dihydro-2,2-dimethyl-7-benzofuranil methylcarbamate). Pheromone is renewed every 3 to 4 months, and sugarcane pieces every 2 to 3 weeks. Weevils can be removed and counted every two weeks (Alpizar, et al. 2002; Oehlschlager et al., 2002; Oehlschlager et al., 1993). Traps can be attached to palm trunks at chest height. Trap density may vary according to stand age, 1 trap/9.5 ha (0.04 mi^2), and 1/6.6 ha (0.025 mi^2), for stands less than 5 years old, and stands 6 to 24 years old, respectively (Oehlschlager et al., 2002).

The trap used by Aldana de la Torre et al. (2010) consists of a 20 liter (5 gallon) bucket that includes two vents on the top sides (8 cm by 12 cm (3.2 by 4.8 in)). The plastic removed from these vents are used to shade the holes to prevent water from getting in and insects from getting out. A mesh fabric is run from the outside base of the bucket to the cut holes to help facilitate pest entry into the trap as they might not fly directly into it. Low infestation areas should use 500 g (17.6 oz) of sugarcane and 1000 cc (33.8 fl oz) of a molasses-water solution (2:1 ratio). This mixture is allowed to ferment for at least three days before being placed in a container with holes in the top. This is then placed in the traps and changed every two weeks. The lure, rhynchophorol, is hung parallel to the window openings and is changed every three months. Traps are placed on the ground in vegetation strips, edges of abandoned lots, and boundaries of plantations (Aldana de la Torre et al., 2010).

This species is currently being monitored in California using traps baited with pheromone and fruit (Hoddle, 2011).

<u>Visual inspection:</u> The weevils are usually present at the apical region of the palm crowns. Pupae and old larvae are frequently found when inspecting the crown of infested plants. The palm weevil is attracted to wounds or cuts in the trunks of the palms. Its preferred habitat is at the base of the leaf axils. The presence of a foul odor surrounding the growing points and fruits is another indication of *R. palmarum.* Surveying should be done in the early morning or late afternoon, as adults only fly during the day and avoid the hottest hours.

Galleries and damage to leaf-stems made by the larvae are easily detected in heavily infested plants. Adults of *R. palmarum* are attracted to palms that have been physically damaged with tools, lightening, feeding damage by larvae of internally feeding beetle species (e.g., scarabs), or by rats (young palms), in addition to healthy trees (M. S. Hoddle, personal communication). Spear rots or basal rot also attracts the adults.

Identification

CAPS-Approved Method*:

Morphological. Identification should be verified by an identifier with expertise in the *Rhynchophorus* genus. A microscope with x50 magnification is needed (EPPO, 2007a). Follow the sample submission guidelines in the **Protocol for Preparing and Forwarding Suspect South American Palm Weevil from Survey Traps for Confirmation and to Maximize Red Ring Nematode Detection**.

EPPO. 2007. *Rhynchophorus ferrugineus* and *Rhynchophorus palmarum* (Diagnostics). European and Mediterranean Plant Protection Organization Bulletin 37: 571-579.

R.M. Giblin-Davis. Biology and management of palm weevils. University of Florida/IFAS. Fort Lauderdale Research and Education Center.

Images: http://cisr.ucr.edu/blog/invasive-species/palmaggedon-are-california%e2%80%99s-palms-about-to-face-the-perfect-storm/

Literature-Based Methods:

EPPO (2007a) gives a detailed description of the adult male with images as well as a description of the female and other life stages. A key to the different *Rhynchophorus* species is found in EPPO (2007a) and includes: *R. bilineatus*, *R. cruentatus*, *R. distinctus*, *R. ferrugineus*, *R. palmarum*, *R. phoenicis*, *R. quadrangulus*, and *R. ritcheri*. A description of all life stages can be found in Hagley (1965) and EPPO (2005). A Spanish description of the life stages can be found in Aldana de la Torre et al. (2010).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Pests

A key to differentiate *R. palmarum* from *R. ferrugineus* and the native *R. cruentatus* (found in the southeastern United States) can be found in Thomas (2010).

A key to differentiate *Rhynchophorus* and *Dynamis* larvae is found in EPPO (2007a).

Commonly Encountered Non-targets

This species may be confused with *R. ferrugineus* and *R. cruentatus* (found in the southeastern United States) (Thomas, 2010). These three species are referred to as “giant palm weevils”.

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Revisions

July 2016: NAPPFAST map removed.