Rhynchophorus ferrugineus

Scientific Name
Rhynchophorus ferrugineus (Olivier)*

Figure 1. *R. ferrugineus* adult (Image courtesy of Amy Roda, USDA-APHIS).

*There is an array of color variations across the native and introduced range of *Rhynchophorus ferrugineus,* and the taxonomy has changed multiple times in the past. Recent molecular research suggests that *Rhynchophorus ferrugineus* may actually be a species complex composed of two or more cryptic species (Rugman-Jones et al., 2013). The suggested second species, *Rhynchophorus vulneratus*, is currently synonymized under *Rhynchophorus ferrugineus.*

From the molecular analysis, the species detected in Laguna Beach, California more closely resembles *Rhynchophorus vulneratus* (Rugman-Jones et al., 2013). PPQ will continue to refer to this detection as *Rhynchophorus ferrugineus* until additional information is available.

Figure 2. *R. ferrugineus* adult, red stripe color morph (Image courtesy of Center for Invasive Species Research).

Synonyms:
Calandra ferruginea Fabricius
Curculio ferrugineus Olivier
Rhynchophorus signaticollis Chevrolat
Rhynchophorus vulneratus (Panzer)

Common Names
Red palm weevil, Asiatic palm weevil, coconut weevil, red stripe weevil

Type of Pest
Weevil

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

Reason for Inclusion
CAPS Target: AHP Prioritized Pest List for FY 2011

Pest Description
Eggs:
"Whitish-yellow, smooth, very shiny, cylindrical with rounded ends, slightly

narrower at the anterior end, averaging
0.98 by 2.96 mm" (EPPO, 2007).

<u>Larvae:</u>
"Piriforme, apodous, colour, creamy white to ivory, cephalic capsule brown russet-red to brilliant brown-black. Body slightly curved. Last instar is 36 to 47 mm in length by 15 to 19 mm in width" (EPPO, 2007).

<u>Adult male:</u>
Length: "19 to 42 mm, width 8 to 16 mm. Body elongate-oval, general colour ferruginous to black, legs lighter coloured than body; elytra dark red to black, shiny or dull, slightly pubescent; black spots on pronotum extremely variable" (EPPO, 2007).

Head: "dull to shiny; smooth to finely punctured; interocular space slightly more than one-half width of rostrum at base" (EPPO, 2007).

Figure 3. *R. ferrugineus* larva, pupa, and adult (Image courtesy of Center for Invasive Species Research).

Antennae: "arising laterally from scrobe at base of rostrum; scrobe deep, broad and widely opened ventrally; scape elongate, longer than funicle and club combined or equal to one-half length of rostrum; funicle with 6 segments; antennal club large usually ferruginous or reddish-brown; broadly triangular with several setae dorsally and ventrally; inner side of spongy area with 8 to 15 setae" (EPPO, 2007).

Pronotum: "with sides gradually curved to apex and abruptly constricted anteriolaterally; slightly pubescent to shiny; posterior margin nearly rounded; colour mostly ferruginous and varying to dark brown and black; underside of pronotum mostly ferrugineus or dark brown, may vary to almost black, very minutely punctured. Scutellum varying from reddish brown to black; somewhat pointed posteriorly, one-quarter to one fith elytral" (EPPO, 2007).

Elytra: "smooth or slightly velvety pubescent, nearly rectangular, with punctuation along the outer edges with 5 deep striae and traces of 4 laterally; length of each elytron two and one-third times its own width" (EPPO, 2007).

Abdomen: “usually ferruginous, but may vary from ferruginous to almost black; first abdominal sternite as long as third and fourth combined but much shorter than second” (EPPO, 2007).

Adult female:
“Length 26 to 40 mm, width 10 to 16 mm. Very similar to male in body size, colour, markings on pronotum, except rostral setae absent; snout longer, slender and more cylindrical, setae on front femur absent and on front tibia much shorter” (EPPO, 2007).

The Center for Invasive Species Research produced a video, detailing the “Overview of the Red Palm Weevil” available on the website: http://cisr.ucr.edu/red_palm_weevil.html.
The video also provides information on the two color morphs of *R. ferrugineus.*

Biology and Ecology:
Females bore into palm tissue with their rostrum to lay eggs (Murphy and Briscoe, 1999). This usually occurs near a tree wound. Several eggs may be laid near each other before the female cements the hole closed. Females lay an average of 250 eggs; eggs hatch in approximately three days (Murphy and Briscoe, 1999). They will also lay eggs in wounds caused by the beetle *Oryctes rhinoceros* (EPPO, 2008).

After hatching, larvae begin feeding on the surrounding palm tissue, tunneling into the interior of the palm (Figure 4). Tunnels are filled with frass and plant sap. Larvae bore into the soft tissue of the host plant. On mature palms, this can occur at the tree crown, upper portion of the trunk, or base of the petioles (Murphy and Briscoe, 1999). Larval development averages around two months (Murphy and Briscoe, 1999); however, development is very temperature-dependent. In Spain, there are 1 to 1.5 generations per year. Once fully grown, the larvae pupate in an oval-shaped cocoon within the tree or at the base of the palm frond, taking an average of three weeks to mature to adult (Murphy and Briscoe, 1999).

The adult weevil emerges from the pupal case but stays within the cocoon for several more days before completely emerging (Figure 5). It is believed that adults are completing sexual maturity during this time. The preoviposition for adult weevils after cocoon emergence is approximately one week. Oviposition can last between 8 to 10 weeks. Adult weevils mate multiple times and live for 2 to 3 months (USDA-APHIS-PPQ, 2010b). The complete life cycle from egg to adult emergence averages 82 days in the West Coast of India (Menon and Pandalai, 1960). *R. ferrugineus* can complete several generations a year (Murphy and Briscoe, 1999).

R. ferrugineus adults are active mostly during the day and can fly long distances (>900 meters (0.6 miles)) in search of hosts or breeding sites (USDA-APHIS,

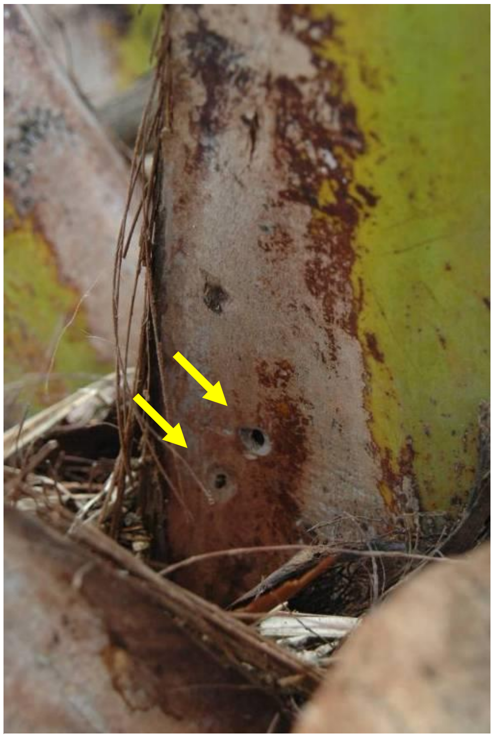

Figure 4. *R. ferrugineus* larval feeding holes at base of frond (Image courtesy of Amy Roda, USDA-APHIS).

Figure 5. Adult *R. ferrugineus* emergence holes (Image courtesy of Amy Roda, USDA-APHIS).

2010b). Abbas et al. (2006) found that marked and released weevils could migrate up to 7 km (4.3 miles) in 3 to 5 days. Adults are usually attracted to damaged or dying palms although undamaged palms can also be attacked (Murphy and Briscoe, 1999).

Damage

Infested palms are hard to detect since the larvae feed on the internal tissues of the palm. Under careful observation, surveyors may be able to detect infested plants with holes in the crown or trunk, with or without oozing brown liquid and chewed up fibers (USDA-APHIS, 2010b). Additionally, distorted or “clipped” fronds may be seen (Figures 6, 7). At high infestation levels, symptoms resembling drought stress, like wilting or yellowing, may be observed (EPPO, 2007).

Green leaves may droop because of loss of support by bored axils and a collapsed canopy (Conti et al., 2008). A very typical sign of infestation is the distorted growing point at the top of the palm (Figure 8). The growth at the top of the canopy can become deformed and offset. This distortion is a very common symptom and is more easily seen than other symptoms of infestation. Frass and cocoons may also be visible, particularly at the base of damaged fronds after they are removed from the tree. The interior of the palm may be destroyed without there being distinctive signs of deterioration externally.

Figure 6. Extreme *R. ferrugineus* larval damage to palm frond (Image courtesy of Amy Roda, USDA-APHIS).

Figure 7. *R. ferrugineus* larval damage to fronds (Image courtesy of Amy Roda, USDA-APHIS).

The trunk of the host becomes weakened when attacked and can become a hazard due to the possibility of collapsing onto the surrounding area (EPPO, 2007).

Larvae may be found in the bole, frond, or crown of palms five years or younger. As palms age, larvae are generally found in the crown and at the base of fronds (EPPO, 2008). Infested trees can die within 4 to 6 months when weevil populations are high (Conti et al., 2008).

Figure 8. Deformed, offset growth of the top canopy of a palm infested with *R. ferrugineus* (Image courtesy of Amy Roda, USDA-APHIS).

Damage caused by larval feeding can resemble symptoms caused by *Fusarium* fungi (*e.g.*, wilting, drooping fronds) or rodents (*e.g.*, holes at the base of fronds). It can be difficult to make the distinction as to the cause of the damage until life stages of *R. ferrugineus* can be found.

Pest Importance

R. ferrugineus is a serious pest of palms (USDA-APHIS-PPQ, 2010b). It has been reported as a pest on coconut in India and Sri Lanka (Menon and Pandalai, 1960; in EPPO, 2008), sago palm in Malaysia (Flach, 1983; in EPPO, 2008), and date palm in the Middle East (EPPO, 2008). High crop losses can occur with severe infestations. In infested farms in Arabia, yields were estimated to have fallen from 10 to 0.7 tons per hectare, while yield losses in Tamil Nadu, India have been recorded as high as 10 to 25% for palm plantations (Murphy and Briscoe, 1999).

In the Caribbean and Europe, another major economic impact of the pest is the damage to and death of palms in the landscape. Palms are an important aesthetic component for hotels, residential properties, and the urban landscape. The palm nursery industry is also negatively impacted by *R. ferrugineus*.

Larvae can often destroy the apical growth area in the crown of palms through feeding and can eventually cause host death (EPPO, 2008).

Known Hosts

Acreca catechu (betel nut palm), *Agave americana* (Maguey), *Arenga pinnata* (sugar palm), *A. saccharifera* (sugar palm), *Borassus flabellifer* (plamyru/toddy palm), *Brahea armata* (blue fan palm), *Butia capitata* (jelly palm), *Calamus merrillii* (palasan), *Caryota cumingii, C. maxima* (pugahan), *Chamaerops humilis* (dwarf fan palm), *Cocos nucifera* (coconut), *Corypha utan* (gebang palm), *C. umbraculifera* (talipot palm), *Elaeis guineensis* (oil palm), *Livistona australis* (Australian fan palm), *L. chinensis* (Chinese fan palm), *L. decipiens* (ribbon fan palm), *L. saribus* (serdang palm), *L. subglobosa* (Chinese fan palm), *Metroxylon sagu* (sago palm), *Oncosperma horrida* (thorny palm), *O. tigillaria* (nibung palm), *Phoenix canariensis* (Canary Island date palm), *P. dactylifera* (date palm), *P. sylvestris* (date palm), *P. theophrasti* (Cretan date palm), *Roystonea regia* (royal palm), *Sabal blackburniana* (=*umbraculifera*), *Trachycarpus fortunei, Washingtonia* sp. (Murphy and Briscoe, 1999; Malumphy, 2007; Melifronidou-Pantelidou, 2009).

R. ferrugineus has been shown to successfully reproduce on diets consisting of *Curcurbita* spp. (squash), *Malus* spp. (apple), *Musa* spp. (banana), and *Saccharum officinarum* (sugarcane) (Salama et al., 2009).

Pathogens Vectored

This pest is not currently known to vector any pathogens or other associated organisms. However, *Rhynchophorus palmarum* vectors the nematode *Bursaphelenchus cocophilus* that causes red ring disease of palms, and 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.

Known Distribution

Africa: Algeria, Egypt, Madagascar, Morocco, and Tunisia*, **Asia:** Bahrain, Bangladesh, Cambodia, China, Cyprus, Georgia, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kuwait, Laos, Malaysia, Myanmar, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Syria, Taiwan, Thailand, Turkey, United Arab Emirates, Vietnam, and Yemen. **Caribbean:** Aruba, Curaçao, and Sint Maarten (listed as Netherland Antilles), **Europe:** France, Greece, Italy, Malta, Portugal, and Spain, **Oceania:** Australia, Papua New Guinea, Samoa, and Solomon Islands (Murphy and Briscoe, 1999; Bozbuga and Hazir, 2008; EPPO, 2008; Borchert, 2009; Pelikh, 2009, EPPO, 2011)

*Currently considered under eradication (EPPO, 2011).

Potential Distribution within the United States

In 2010, *Rhynchophorus ferrugineus* was detected in the Laguna Beach area of Orange County, California (USDA-APHIS-PPQ, 2010a). This pest poses the biggest threat to areas where host material is present. Regions with the highest host density for this pest include California, Florida, some parts of Louisiana, and Puerto Rico (USDA-APHIS-PPQ-CPHST, 2011) (Figures 9 and 10).

Note: The data source used to generate the following NAPPFAST maps reports nursery data at the state level. In addition, some hosts in urban areas may be under-reported for risk. Local, first-hand knowledge of host presence (in nurseries and urban environments) should be considered in addition to the overall risk map.

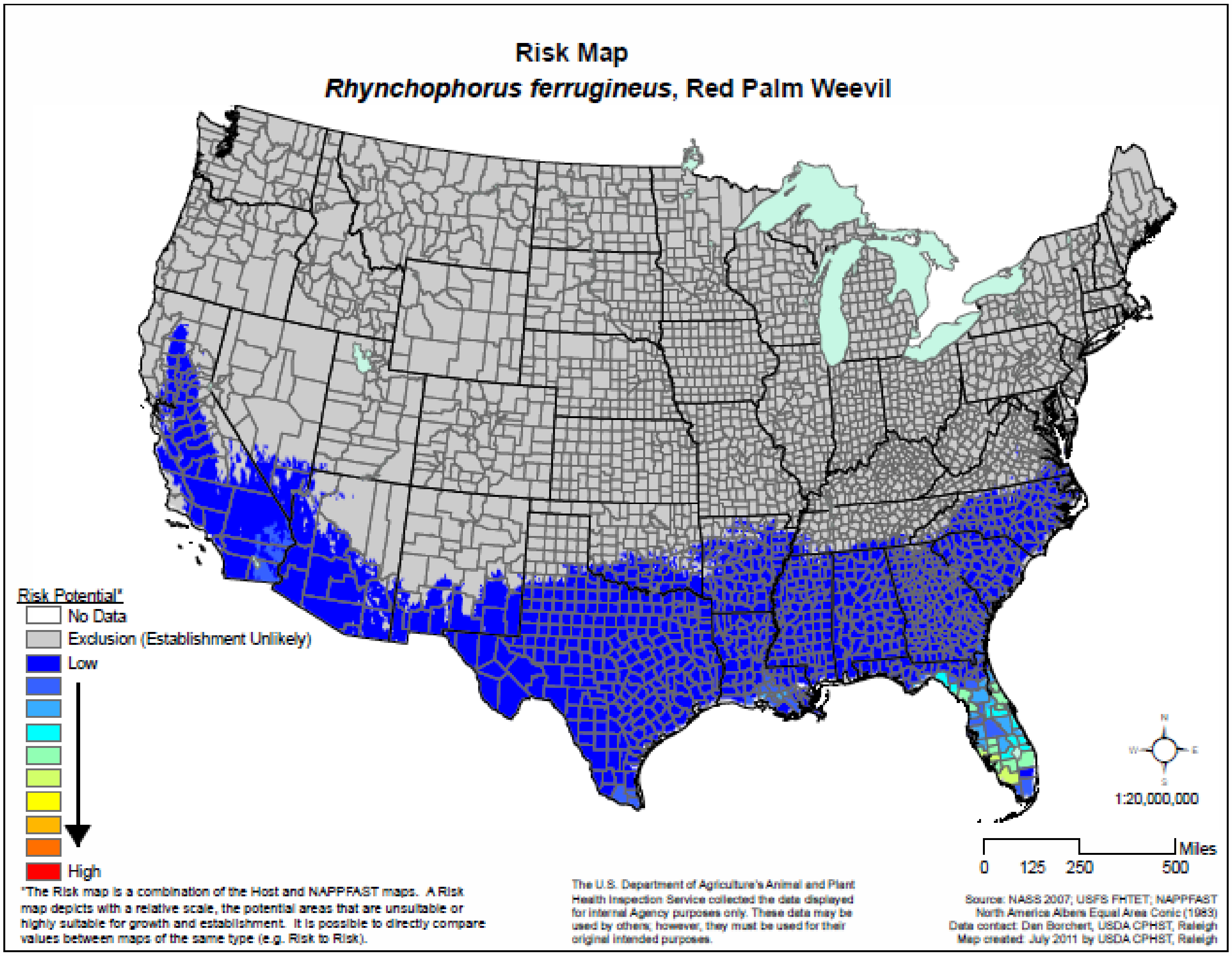

Figure 9. Risk map for Red Palm Weevil within the continental United States. Values from low to high indicate increased risk based on climate and host availability. Map courtesy of USDAAPHIS-PPQ-CPHST. Check www.nappfast.org Map courtesy of USDA-APHIS-PPQ-CPHST. Check www.nappfast.org for the most recent map updates.

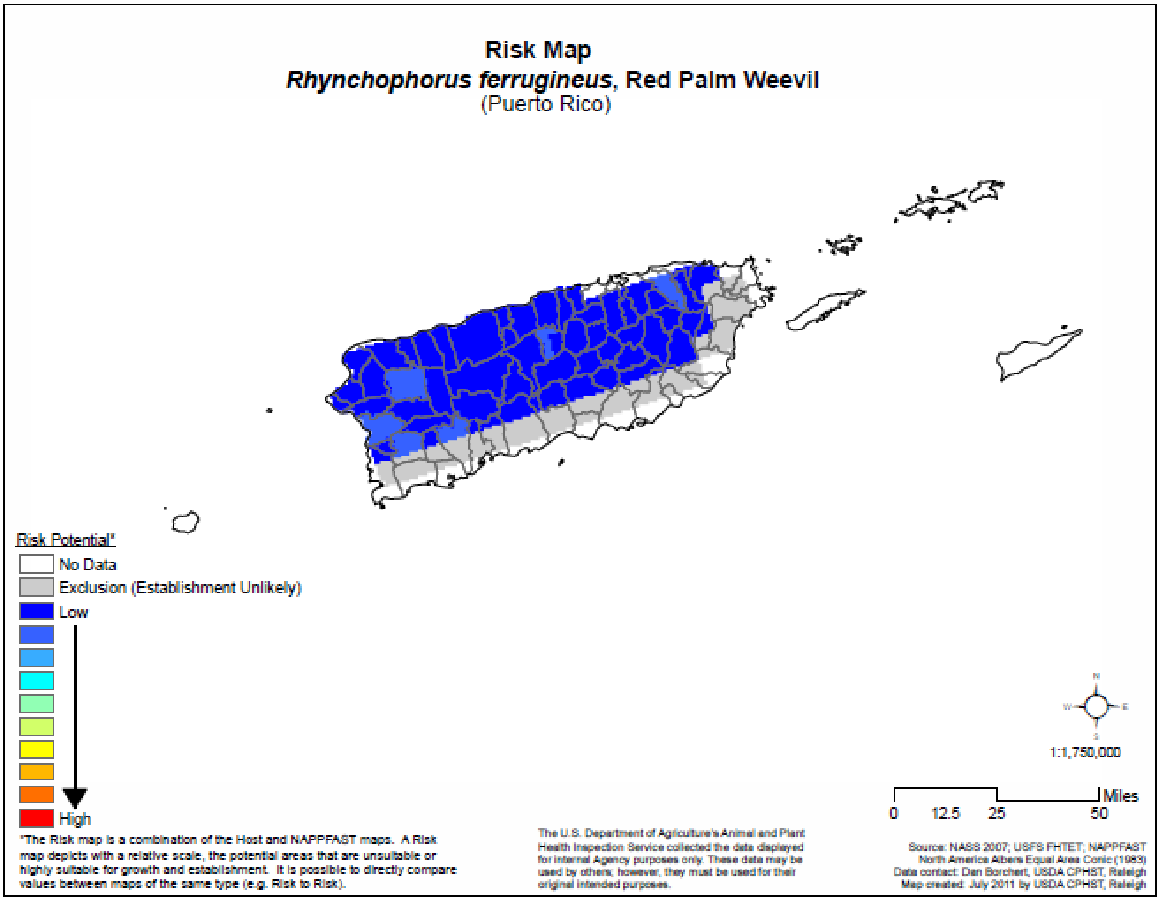

Figure 10. Risk map for Red Palm Weevil for Puerto Rico. Values from low to high indicate increased risk based on climate and host availability. Map courtesy of USDA-APHIS-PPQ-CPHST. Check www.nappfast.org Map courtesy of USDA-APHIS-PPQ-CPHST. Check www.nappfast.org for the most recent map updates.

Survey

CAPS-Approved Method*:

There are two CAPS-approved methods for *R. ferrugineus.* 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 pulling the fronds to the ground or 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 (Figures 11-13).

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.

Figure 11. *R. ferrugineus* tunneling in frond. (Image courtesy of Amy Roda, USDA-APHIS).

Figure 12. Frond with pupal case. (Image courtesy of Amy Roda, USDA-APHIS).

Figure 13. Frond with new adults. (Image courtesy of Amy Roda, USDA-APHIS).

Trapping

1.1Trap and Lure

The trap for *R. ferrugineus* is a home-made bucket trap (instructions found in USDA-APHIS-PPQ, 2010b) 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. ferrugineus*: two lures and a food bait that is prepared on site. The two lures are 1) an aggregation pheromone (mixture of 4-methyl-5-nonanol and 4-methyl-5-nonanone) 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-PPQ, 2010b). All three attractants (the two lures and food bait) are required to report negative data for *R. ferrugineus*.

The pheromone and ethyl acetate lures should be replaced every six weeks (42 days).

IPHIS Survey Supply Ordering System Product Names:

1) *Rhynchophorus ferrugineus* 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. ferrugineus* and *R. palmarum*, the South American 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. ferrugineus* and *R. palmarum*, ethyl acetate, and the food bait.

1.2 Trap Construction

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

- 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 14).
- 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 15).
- 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.

Figure 14. Homemade *R. ferrugineus* trap covered with burlap (Image courtesy of Amy Roda, USDA-APHIS).

Figure 15. Homemade *R. ferrugineus* trap with entrance holes (Image courtesy of Amy Roda, USDA-APHIS).

1.3 Food Bait Preparation

Figure 16. 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 and date palm waste have been found to be very effective in areas where the weevil is established. When available, date parts or palm waste 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 16).

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:
A low frequency amplifier called the Davis Red Weevil Detector has been developed and is capable of amplifying the noise made by *R. ferrugineus* larvae (EPPO, 2008). In Saudi Arabia, Bokhari and Abuzuhira (1992) found that the rate of transpiration increased and diffusive resistance and water potential were reduced in infested date palms; monitoring any three factors, either alone or in combination, can be used to detect infestations.

The Coconut Research Institute suggests conducting regular surveys on all young palms up to 10-12 years to detect palms infested with *R. ferrugineus* (EPPO, 2008). Reginald (1973) recommends baiting traps with split fresh coconut petioles to help reduce the amount of palms attacked by weevils (from EPPO, 2008). Dead palms or palms beyond repair should be split open to check for *R. ferrugineus* and all debris burned to destroy the pest (Al Ajlan, 2008).

Detector dogs have been used in pilot studies to detect infested date palms in Israel (Nakash et al., 2000).

More recently, pheromones have been used for mass trapping and detection of adults (EPPO, 2008). Under field conditions, the pheromone ferrugineol remained active for 12 weeks as bait (EPPO, 2007). Abraham et al. (1999) found that trapping with the pheromone is only effective when used in conjunction with food baits. Traps baited with sugarcane followed by coconut exocarp were most attractive to weevils; date fronds were the least preferred (Muralidharan et al., 1999).

Not recommended
Conventional light traps are not effective at attracting *R. ferrugineus* (Sadakathulla and Ramachandran, 1992).

Identification

CAPS-Approved Method*:
Morphological. Identification should be verified by an identifier with expertise in the *Rhynchophorus* genus. 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**.

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

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Images
http://cisr.ucr.edu/red_palm_weevil.html

*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

R. ferrugineus is similar to *R. cruentatus*, a palm weevil species native to Florida and the southeastern United States and *R. palmarum*, a palm weevil native to Central and South America (Thomas, 2010). Thomas (2010) includes an identification key differentiating *R. ferrugineus* from both the native *R. cruentatus* and the exotic pest *R. palmarum*.

Damage caused by larval feeding can resemble symptoms caused by *Fusarium* fungi (*e.g.*, wilting, drooping fronds) or rodents (*e.g.*, holes at the base of fronds). It can be difficult to make the distinction as to the cause of the damage until life stages of *R. ferrugineus* can be found.

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Revisions

February 2013
1) Yemen added as a new country in Distribution section.

March 2014
1) Taxonomic note added about the possibility of *Rhynchophorus ferrugineus* being a species complex.