Rhynchophorus ferrugineus

Scientific Name
Rhynchophorus ferrugineus (Olivier)

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

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

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

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).

Larvae:
"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).

Adult male:
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).

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).

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

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).

<u>Adult female:</u>
“Length 26-40 mm, width 10-16 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. 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 1-1.5 generations per year.

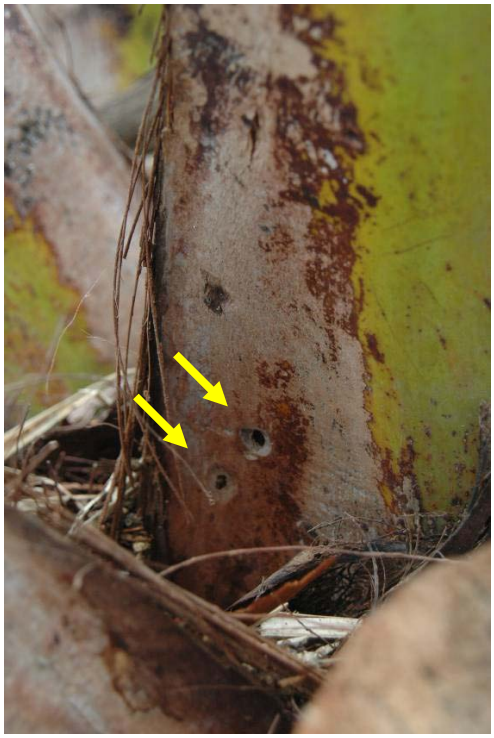

Figure 4. *R. ferrugineus* larval feeding holes at base of frond (Image courtesy of Amy Roda, USDA-APHIS).

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. 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, 2010). 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).

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

R. ferrugineus adults are active mostly during the day and can fly long distances (>900 meters) in search of hosts or breeding sites (USDA-APHIS, 2010). Abbas et al. (2006) found that marked and released weevils could migrate up to 7 km in 3-5 days. Adults are usually attracted to damaged or dying palms although undamaged palms can also be attacked (Murphy and Briscoe, 1999).

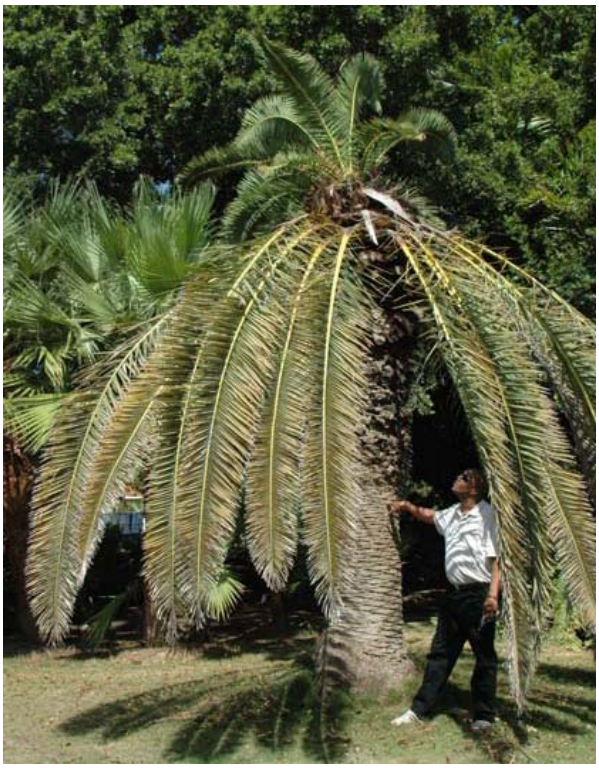

Figure 6. Deformed, offset growth of the top canopy of a palm infested with *R. ferrugineus* (Image courtesy of Amy Roda, USDA-APHIS).

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, 2010). Additionally, distorted or "clipped" fronds may be seen. 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 4.). 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. 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).

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

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 4-6 months when weevil populations are high (Conti et al., 2008).

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.

Figure 8. *R. ferrugineus* larval damage to fronds (Image courtesy of Amy Roda, USDA-APHIS).

Pest Importance

R. ferrugineus is a serious pest of palms (USDA-APHIS, 2010). 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 10-25% 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).

Figure 9. *R. ferrugineus* larval damage to fronds (Image courtesy of Amy Roda, USDA-APHIS).

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.

Known Distribution

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

Potential Distribution within the United States

Rhynchophorus ferrugineus was recently found in the Laguna Beach area of Orange County, California (CDFA, 2010). This pest poses the biggest threat to areas where host material is present. States with the highest host density for this pest include Florida and some parts of Louisiana and California (USDA-CPHST, 2010).

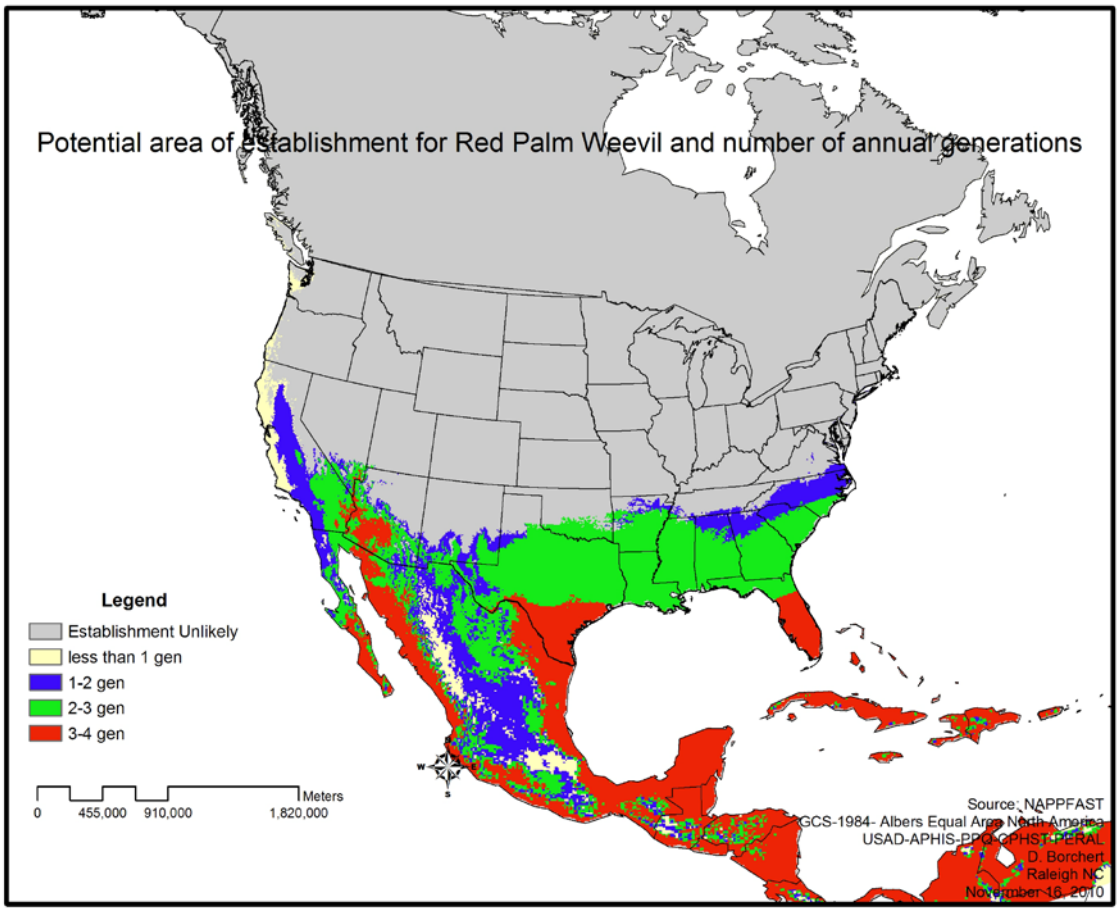

Figure 10. Potential area of establishment for Red Palm Weevil and number of annual generations. Map courtesy of USDA-APHIS-PPQ-CPHST. Check www.nappfast.org for the most recent map updates.

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 9-11).

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).

Trap with lure:

The trap for *R. ferrugineus* is a home-made 5-gallon bucket trap (instructions found in USDA-APHIS, 2010) or a commercial trap. The lure used is a combination of 1) an aggregation pheromone (mixture of 4-methyl-5-nonanol and 4-methyl-5-nonanone), 2) ethyl acetate, and 3) a food bait, that could include sugarcane, apples, palm stems (chopped into 3 to 4 cm pieces) or 10 percent molasses containing 1 teaspoon of baker's yeast (USDA-APHIS, 2010). All three lure components are required to report negative data for *R. ferrugineus*.

Prepare a 50 to 50 solution of propylene glycol and water (anti-freeze/coolant) and place it in the bottom of the inside of the bucket. Enough water and propylene glycol should be added to cover 75 percent of the food bait. The

solution will extend the life of the food baits and keep the weevils retained in the trap.

Collect insect specimens from the trap and replace food baits every 7-9 days. The pheromone and ethyl acetate lures should be replaced based on the lure manufacturer's recommendations. The release rates and longevity of the lures are also based on temperature (i.e., the release rate increases at higher temperatures).

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

Specific guidelines for surveying for *R. ferrugineus*, including detailed trapping instructions, can be found in the New Pest Response Guidelines for Red Palm Weevil (USDA-APHIS, 2010) at: http://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/nprg-redpalmweevil.pdf

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.

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. Use the screening aids developed by EPPO (2007) and R.M. Giblin-Davis and for assistance in identification of *R. ferrugineus*.

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/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.

References

Abbas, M. S. T., S. B. Hanounik, A. S. Shahdad, and S. A. Al-Bagham. 2006. Aggregation pheromone traps, a major component of IPM strategy for the red palm weevil, *Rhynchophorus ferrugineus* in date palms (Coleoptera: Curculionidae). Journal of Pest Science 79: 69-73.

Abraham, V. A., S. S. Nair, and C. P. Radhakrishnan Nair. 1999. A comparative study on the efficacy of pheromone lures in trapping red palm weevil *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Curculionidae) in coconut gardens. Indian Coconut Journal Cochin 30: 1-2.

Al-Ajlan, A. M. 2008. Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae). *in* J. L. Capinera, (ed.). Encyclopedia of Entomology.

Bokhari, U. G. and R. Abuzuhira. 1992. Diagnostic tests for red palm weevil, *Rhynchophorus ferrugineus* infested datepalm trees. Arab Gulf Journal of Scientific Research. 10(3): 93-104.

Borchert, D. M. 2009. New Pest Advisory Group Report on *Rhynchophorus ferrugineus* (Olivier): red palm weevil. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Plant Epidemiology and Risk Analysis Laboratory.

Bozbuga, R. and A. Hazir. 2008. Pests of the palm (*Palmae* sp.) and date palm (*Phoenix dactylifera*) determined in Turkey and evaluation of red palm weevil (*Rhynchophorus ferrugineus* Olivier) (Coleoptera: Curculionidae). EPPO Bulletin 38: 127-130.

CABI. 2010. *Rhynchophorus ferrugineus.* Crop Protection Compendium. Accessed 13 August 2010 from: http://www.cabi.org/cpc/

CDFA. 2010. Red Palm Weevil (RPW). California Department of Food and Agriculture. Accessed October 29, 2010 from http://www.cdfa.ca.gov/phpps/rpw/

Conti, F., F. Sesto, E. Raciti, V. Tamburino, and S. Longo. 2008. Ecological factors affecting the spread of *Rhynchophorus ferrugineus* (red palm weevil) in Eastern Sicily. Palms 52(3):127-132.

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

EPPO. 2008. Data sheet on quarantine pests *Rhynchophorus ferrugineus*. European and Mediterranean Plant Protection Organization Bulletin 38: 55-59.

Malumphy, C. and H. Moran. 2007. Plant Pest Notice: Red Palm Weevil, *Rhynchophorus ferrugineus* (No. 50). Department for Environment, Food and Rural Affairs, Central Science Laboratory.

Melifronidou-Pantelidou, A. 2009. Eradication campaign for *Rhynchophorus ferrugineus* in Cyprus. EPPO Bulletin 39: 155-160.

Menon, K. P. V. and K. M. Pandalai. 1960. Pests. In: The Coconut Palm: a Monograph, pp. 261–265, Indian Central Coconut Committee, Ernakulam (IN).

Muralidharan, C. M., U. R. Vaghasia, and N. N. Sodagar. 1999. Population, food preference and trapping using aggregation pheromone (ferrugineol) on *Rhynchophorus ferrugineus*. Indian Journal of Agricultural Sciences 69, 602–604.

Murphy, S. T., and B. R. Briscoe. 1999. The red palm weevil as an alien invasive: biology and the prospects for biological control as a component of IPM. Biocontrol News and Information, 20(1):34n-46n.

Nakash J., Y. Osem and M. Kehat. 2000. A suggestion to use dogs for detecting *Rhynchophorus ferrugineus* infestation in date palms in Israel. Phytoparasitica 28: 153-155.

Pelikh, K. 2009. First report of RPW in Republic of Georgia. Red Palm Weevil Website. <http://www.redpalmweevil.com/newlook/RPWReport/Georgia.html>.

Sadakathulla, S. and T. K. Ramachandran. 1992. Avoid light trap in coconut gardens. Indian Coconut Journal Cochin 23, 5.

Salama, H. S., R. N. Zaki, and A. S. Abdel-Razek. 2009. Ecological and biological studies on the red palm weevil *Rhynchophorus ferrugineus* (Olivier) Archives of Phytopathology and Plant Protection 42(4): 392-399.

Thomas, M. C. 2010. Pest alert, giant palm weevils of the genus *Rhynchophorus* (Coleoptera: Curculionidae) and their threat to Florida Palms. Florida Department of Agriculture and Consumer Services, Division of Plant Industry. DACS-P-01682.

USDA-APHIS. 2010. New Pest Response Guidelines. Red Palm Weevil. USDA-APHIS-PPQ-Emergency and Domestic Programs-Emergency Planning, Riverdale, Maryland. http://www.aphis.usda.gov/import_export/plants/manuals/

USDA-CPHST. 2010. Host map *Rhynchophorus ferrugineus*, red plam weevil. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, NCSU APHIS Plant Pest Forecasting System. Website <http://www.nappfast.org/caps_pests/CAPS_Top_50.htm>.

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