European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

Data sheets on quarantine pests
Fiches informatives sur les organismes de quarantaine

Rhynchophorus ferrugineus

Identity

Name: *Rhynchophorus ferrugineus* (Olivier, 1790)
Synonyms: *Calandra ferruginea* Fabricius, 1801, *Curculio ferrugineus* Olivier, 1790, *Rhynchophorus signaticollis* Chevrolat, 1882
Taxonomic position: *Insecta*: *Coleoptera*:, *Curculionidae*:, *Rhynchophorinae*
Notes on taxonomy and nomenclature: the genus *Rhynchophorus* contains ten species, of which seven are known to attack palms (Booth *et al*., 1990). A key to related genera and the revision of this species was provided by Wattanapongsiri (1966). Reginald (1973) considers *R. ferrugineus* as the typical *Rhynchophorus* species. In Papua New Guinea, *R. ferrugineus* has been described as subsp. *papuanus* (Mercer, 1994).
Common names: Asiatic palm weevil, coconut weevil, red palm weevil, red stripe weevil (English), picudo asiático de la palma (Spanish), charançon asiatique du palmier (French), Indomalaiischer Palmen-Rüssler (German)
EPPO code: RHYCFE
Phytosanitary categorization: EPPO A2 action list no. 332

Hosts

R. ferrugineus is essentially a pest of palms (*Arecaceae*), being recorded on *Areca catechu, Arenga pinnata*, *Borassus flabellifer*, *Calamus merillii*, *Caryota maxima, Caryota cumingii, Cocos nucifera, Corypha gebanga, Corypha elata, Elaeis guineensis, Livistona decipiens, Metroxylon sagu, Oreodoxa regia, Phoenix canariensis, Phoenix dactylifera, Phoenix sylvestris, Sabal umbraculifera, Trachycarpus fortunei, Washingtonia* sp., etc. It can also attack *Agave Americana* and sugarcane (*Saccharum officinarum*).

Geographical distribution

EPPO region: Israel (since 1999, under eradication), Jordan (since 1999, under eradication), Spain (limited distribution in south, in Andalucía since 1996, in Comunidad Valenciana since 2004)
Asia: Bangladesh, Bahrein, Cambodia, China (Guangdong), India (widespread), Indonesia (widespread), Iran, Iraq, Israel (since 1999), Japan (since 2000, Kyushu only), Jordan (since 1999), Kuwait, Laos, Myanmar, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, United Arab Emirates, Vietnam
Africa: Egypt(since 1992, only in Ismaelyia and Sharkyia governorates)
Oceania: Papua New Guinea, Solomon Islands, Western Samoa
EU: Spain
See CABI/EPPO (2003).

Biology

Adults of *R. ferrugineus* are active during day and night, although flight and crawling of is generally restricted to daytime. Leefmans (1920) reported that adults are capable of long flights and can find their host plants in widely separated areas; his studies suggested that they can detect breeding sites at distances of at least 900 m. Mating takes place at any time of the day, and males and females mate many times during their lifetime. The pre-oviposition period can range from 1-7 days. Oviposition is generally confined to the softer portions of the palm and continues for approximately 45 days. During this period, the weevil lays an average of 204 eggs. Eggs are in wounds along the trunk or in petioles, and also in wounds caused by the beetle *Oryctes rhinoceros*. There is a short post-oviposition period of 10 days before the weevil dies. On hatching, the apodal larvae begin feeding towards the interior of the palm. In palms up to 5 years old, the larvae may be found in the bole, stem or crown. As palms advance in age, the grubs are generally confined to the portions of the stem close to the growing point. In palms more than 15 years old, the larvae are generally found in the stem about 2-3 feet below the crown, in the crown and bases of leaf petioles. The larval period is 36-78 days (average 55 days) (Nirula *et al*., 1953). Jaya *et al*. (2000) recorded seven larval instars when *R. ferrugineus* was reared on sugarcane. However, larval growth did not conform to Dyar's rule. When about to pupate, larvae construct an oval-shaped cocoon of fibre (Menon & Pandalai, 1960). The complete life cycle of the weevil, from egg to adult emergence, takes an average 82 days in India (Menon & Pandalai, 1960).

After emergence from the pupal case, the adult weevil remains inside the cocoon for 4-17 days (average 8 days) (Menon & Pandalai, 1960). According to Hutson (1933), the weevil becomes sexually mature during this period of inactivity. Adults live 2-3 months, irrespective of sex. In captivity, the maximum life span of the adult was 76 days for the female and 113 days for the male. It has been suggested that a single pair of weevils can theoretically give rise to more than 53 million progeny in four generations in the absence of controlling factors (Menon & Pandalai, 1960; Leefmans, 1920). In Egypt, El Ezaby (1997a) reported that the weevil has three generations per year, the shortest generation (first) of 100.5 days and the longest (third) of 127.8 days. The study also showed that the upper temperature threshold of the egg was 40°C.

For laboratory rearing of adults, freshly shredded sugarcane tissue served both as food and oviposition medium (Rananavare *et al*., 1975). Rahalkar *et al.* (1978) reported that an artificial diet containing sugarcane bagasse, coconut cake, yeast, sucrose, essential minerals and vitamins, agar, water and food preservatives maintained 12 generations of the weevil.

Detection and identification

Symptoms

The pest affects stems and growing points. It is very difficult to detect *R. ferrugineus* in the early stages of infestation. Generally, it is detected only after the palm has been severely damaged. Careful observation may reveal the following signs which are indicative of the presence of the pest (Coconut Research Institute, 1987): holes in the crown or trunk from which chewed-up fibres are ejected (this may be accompanied by the oozing of brown viscous liquid); crunching noise produced by the feeding grubs can be heard when the ear is placed to the trunk of the palm; withered bud/crown.

Morphology

Eggs

Creamy white, oblong, shiny; average size 2.62 x 1.12 mm (Menon & Pandalai, 1960). Eggs hatch in 3 days and increase in size before hatching (Reginald, 1973). The brown mouth parts of the larvae can be seen through the shell before eclosion.

Larvae

Up to 35 mm long; brown head, white body composed of 13 segments; mouthparts well developed and strongly chitinized; average length of fully grown larvae 50 mm, and width (in middle) 20 mm.

Pupae

Pupal case 50-95 x 25-40 mm; prepupal stage of 3 days and pupal period of 12-20 days; pupae cream coloured, then brown, with shiny surface, greatly furrowed and reticulated; average size 35 mm x 15 mm.

Adults

Reddish brown, about 35 x 10 mm, with long curved rostrum; dark spots on upper side of thorax; head and rostrum comprising about one-third of total length. In male, dorsal apical half of rostrum covered by a patch of short brownish hairs; in female, rostrum bare, more slender, curved and a little longer than in male (Menon & Pandalai, 1960). See Booth *et al*. (1990) for a full description.

Detection methods

The Davis Red Weevil Detector is an electronic instrument capable of amplifying the noise made by *R. ferrugineus* larvae (Coconut Research Institute, 1971). This detector is essentially a low frequency amplifier. Conventional light traps do not attract *R. ferrugineus* (Sadakathulla & Ramachandran, 1992). In Sri Lanka, Ekanayake (in Reginald, 1973) found traps baited with split fresh coconut petioles to be effective in reducing the number of palms attacked by weevils and consequently recommended it in estate practice. The Coconut Research Institute (1987) suggested regular surveys of all young palms up to 10-12 years of age as an inspection measure to detect weevil-infested palms.

Recently, aggregation pheromones have been used to mass-trap or detect adult weevils. Faleiro & Chellapan (1999) reported the use of ferrugineol-based pheromone lures for trapping *R. ferrugineus*. They also suggested that it was essential to use these together with food bait (sugarcane) to obtain higher catches of the weevil. Abraham *et al*. (1999) also found that weevil trapping is only effective if the pheromone is used along with the food bait. A specially designed pheromone trap was described by Maheswari & Rao (2000). Rajapakse *et al*. (1998) found that the 5L open plastic bucket baited with ferrugineol (4-methyl-5-nonanol)-pentanol, hung on coconut palm stems at 1.5 m caught significantly more adult weevils than ferrugineol-pentanol baited funnel and metal traps. Ferrugineol remained effective as a bait for 12 weeks under field conditions. Hallett *et al*. (1999) found that trap catches were maximized by placing the traps at ground level or a height of 2 m and that vane traps were superior to bucket traps. Muralidharan *et al*. (1999) found a significant number of weevils were attracted to bucket traps baited with sugarcane, followed by traps baited with coconut exocarp; date fronds were the least preferred bait. Nakash *et al*. (2000) suggested the use of dogs to detect weevils infesting date palms in Israel. Bokhari & Abuzuhira (1992) developed a test for weevil-infested date palms in Saudi Arabia. In such palms, the rate of transpiration increased and diffusive resistance and water potential were reduced. All three factors could be monitored to detect infestation by *R. ferrugineus*.

Pathways for movement
The pest can be spread over long distances in infested plants for planting of host palms. Short-distance spread is possible by adult flight.

Pest significance
Economic impact
Menon & Pandalai (1960) reported that *R. ferrugineus* is a serious pest of coconut (*C. nucifera*) in India and Sri Lanka. Ganapathy *et al*. (1992) observed *R. ferrugineus* damage in 34% of coconut groves in Kerala (IN), while Dhileepan (1991) reported that the weevil is a major pest of oil palm (*E. guineensis*) in the same state, and it is reported on this host more generally in India (Misra, 1998). Flach (1983) reported that *R. ferrugineus* and *R. vulneratus* are major pests of sago palm (*M. sagu*) in Malaysia (Sarawak). *R. ferrugineus* also causes serious damage on date palm (*P. dactylifera*) in the Middle East.

In the EPPO region, *R. ferrugineus* has already given rise to isolated outbreaks in date-producing countries (Israel, Jordan), while the outbreak in southern Spain is threatening the largest palm plantation in Europe, at Elche in Comunidad Valenciana, which is rated as a World Heritage Site by UNESCO.

Control
<u>Chemical control</u>
As damage by *R. ferrugineus* is difficult to detect during the early stages of infestation, emphasis is generally placed on preventive aspects. However, this is not always possible. The common and practical curative measure is through the use of insecticides. Preventive and curative measures include: trunk injection with systemic insecticides such as monocrotophos carried out during the early stages of infestations (Rao *et al*., 1973; Anon., 1976), or with carbosulfan and pirimiphos ethyl (El Ezaby, 1997); treatment of wounds with repellents and filling leaf axils with insecticide dusts such as lindane or ??chlordane mixed with sand (Mathen & Kurian, 1966; Abraham, 1971); drenching of the crown of infested trees with insecticides (Kurian & Mathen, 1971). Barranco *et al*. (1998) recorded the percentage mortality of *R. ferrugineus* larvae treated with different rates of fipronil and azadirachtin (neem). Laboratory trials conducted by Cabello *et al*. (1997) showed that imidacloprid was more effective against all stages of *R. ferrugineus* larvae than oxamyl.

<u>Biological control</u>
Reginald (1973) suggested that natural enemies do not play an important part in controlling *R. ferrugineus*. There were some attempts in the laboratory and field using the predacious *Chelisoches morio* in India (Abraham & Kurian, 1973). However, this did not provide a measurable impact on the weevil. Using pathogens may be rewarding. Gopinadhan *et al*. (1990) reported that a cytoplasmic polyhedrosis virus infected all stages of the weevil in Kerala (IN); infected late-larval stages resulted in malformed adults and drastic suppression of the host population. Although various mites have been reported in India as parasites of *R. ferrugineus* (Nirula *et al*., 1953; Peter, 1989), their impact on the population needs to be ascertained.

<u>IPM programmes</u>
Integrated pest management for *R. ferrugineus* has been developed and tested in coconut palms in India (Kurian *et al*., 1976; Sathiamma *et al*., 1982, Abraham *et al*., 1989). Included in the IPM programme were: cultural measures such as plant and field sanitation; physical methods (preventing entry of weevils through cut ends of petioles and wounds; use of

attractants and other chemicals (including filling of leaf axils with lindane and sand as a preventive measure). Abraham *et al*. (1989) found the IPM approach very effective in reducing the number of infested palms in Kerala (IN). They suggested that its major components should be: surveillance, trapping the weevil using pheromones lures, detecting infestation by examination of palms, eliminating hidden breeding sites, clearing abandoned gardens, maintaining crop and field sanitation, using preventive chemical treatments, curative chemical control, implementing phytosanitary measures, training and education. In the Al Qatif region of Saudi Arabia, Vidyasagar *et al*. (2000a) successfully developed an IPM programme which, in addition to mass pheromone trapping, included a survey of all cultivated gardens, systematic checking of all palms for infestation, periodic soaking of palms, and mass removal of neglected farms. Reviews of control strategies and IPM for *R. ferrguineus* have also been presented by various other authors (Ramachandran, 1998; Nair et al., 1998; Murphy and Brisco, 1999).

<u>Cultural and sanitary methods</u>

These include prompt destruction of infested plant material (Kurian & Mathen, 1971) and prophylactic treatment of cut wounds (Pillai, 1987). Abraham (1971) suggested cutting leaves at or beyond the region where leaflets emerge at the base to prevent entry by the weevil into the stem. Azam & Razvi (2001) found that deep cutting to remove growing points of off-shoots (unwanted growths from the trunk) completely, then treating the cut surface with an insecticide such as formothion or dimethoate and covering it with mud reduced the level of infestation to less than 4% compared to 20% for an untreated control (cut at the trunk surface).

<u>Pheromones and other behavioural chemicals</u>

Pheromones are increasingly being used as a management tool against *R. ferrugineus*. Detailed protocols for pheromone-based mass trapping of the weevil are provided by Hallett *et al*. (1999). Faleiro *et al*. (1999) evaluated pheromone lures for the weevil in date plantations in Saudi Arabia and found that high release lures (Ferrolure and Ferrolure+) obtained from Chem Tica Natural, Costa Rica, attracted twice as many weevils as low release formulations. These pheromone lures were equally effective in attracting the pest and were on a par with Agrisense lures from the UK. Vidyasagar *et al*. (2000b) measured the impact of using a pheromone-based mass trapping system as a component of IPM of the weevil in Saudi Arabia using aggregation pheromone, ferrugineol, 4-methyl-5-nonanol (Ferrolure) and/or 4-methyl-5-nonanol + 4-methyl-5-nonanone (9:1) (Ferrolure+). Adult weevil populations were reduced from 4.12 weevils per trap per week in 1994 to 2.02 weevils per trap per week in 1997 when this system was used and there was a significant reduction in the level of infestation of date palms by the weevil during this period. In terms of population dynamics, peak adult populations were trapped immediately after the winter season during April and May and a smaller peak was observed during October and November just before the onset of winter. There was a drop in captures of weevils at the onset of winter. El Garhy (1996) reported thresholds temperatures for weevil activity in the range of 12-14°C, with more adults captured in summer than in winter and twice as many females captured as males, irrespective of season. Faleiro *et al*. (1999) compared Ferrolure and Ferrolure+ and reported that the longevity of the lures was lower in summer than in winter. The longevity of both was greater under shade and when traps were exposed to sunlight; Ferrolure+ lasted longer than Ferrolure. Gunawardena *et al*. (1998) identified host attractants for the weevil from freshly cut coconut bark and found that a 1:1 mixture of gamma nonanoic lactone 1 and 4-hydroxy-3-methoxystyrene 2 were responsible. Perez *et al*. (1996) reported that there were no apparent differences between the pheromones of *R. ferrugineus* and *R. vulneratus*.

Sterile backcrosses /Sterile insect technique /Chemosterilization

Ramachandran (1991) reported that gamma radiation decreases production of viable eggs of *R. ferrugineus* with increasing radiation dose, although there is no apparent effect on the F2 generation. Rahalkar *et al*. (1973) reported that treatment of 1-2-day-old males of the weevil at a dose of 1.5 krad (15 Gy) resulted in 90% sterility with no adverse effect on survival. Treatment at higher doses increased sterility but reduced survival. A ratio of ten treated males to one normal was needed for appreciable suppression of progeny production. Using chemosterilants, Rahalkar *et al*. (1975) reported that treatment of male weevils with metepa or hempa did not result in a satisfactory level of sterility without adversely affecting their survival. However, metepa was more toxic than hempa.

Containment and possible eradication

In Israel (Hamburger *et al*., 2003), an outbreak on date palm which was detected in 1999 was rapidly delimited as a quarantine area. Within this contained area, the pest was suppressed by the following measures: mass trapping, chemical treatment of infested palms, destruction of heavily infested palms, preventive measures). After 4 years, catches were reduced from 324 in 2000 to 26 in 2002 and no new infested palm was found in 2002. It is possible that eradication can be achieved, and it is clear at least that the pest can be contained and suppressed.

Phytosanitary risk

R. ferrugineus is a polyphagous pest on palms, and could probably be a serious pest in any country where palms are widely cultivated. Esteban Duran *et al*. (1998) suggested that *R. ferrugineus* is among the pests that could potentially be introduced to other countries of the EPPO region through imported plants for planting. The date-producing countries of North Africa are particularly at risk. Israel and Jordan have already had outbreaks. All Mediterranean countries which grow palms as amenity trees in towns and on sea fronts also face a serious risk. Fitzgibbon *et al*. (1999) identified the weevil as having potential for introduction and establishment in northern Australia. *R. ferrugineus* has already extended its range to several new countries since the 1990s.

It is noteworthy that several other *Rhynchophorus* spp. attack palms in different parts of the world, in particular *Rhynchophorus bilineatus* and *Rhynchophorus vulneratus* in Southeast Asia, *Rhynchophorus phoenicis* in tropical Africa and *Rhynchophorus palmarum* in Central and South America. These species also present a certain risk to the EPPO region, but this risk has not yet been evaluated in detail. *R. ferrugineus* is the species which is most damaging in practice. There is, besides, no native *Rhynchophorus* sp. on palms in the EPPO region.

Phytosanitary measures

R. ferrugineus was added in 2005 to the EPPO A2 action list, and endangered EPPO member countries are thus recommended to regulate it as a quarantine pest. Outbreaks have already occurred in several EPPO countries (Israel, Jordan, Spain). It seems that, in the short term at least, domestic phytosanitary measures can contain these outbreaks if they are detected sufficiently early (see Containment and possible eradication above). However, it is clear that the best strategy for uninfested areas in the EPPO region is to exclude the pest altogether, by requiring all imported plants for planting of palms to originate in a pest-free area or pest-free place of production.

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