PRA for the accidental introduction of Rhynchophorus ferrugineus (red palm weevil) into Ghana

Pest: Rhynchophorus ferrugineus (red palm weevil)
Country/area at risk: Ghana

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Scope of PRA
The red palm weevil (Rhynchophorus ferrugineus) is highly invasive and has recently expanded beyond its natural range from southern and southeast Asia westwards, over vast areas of the Middle East and the Mediterranean basin. It also has become established on the islands of Aruba and Curacao in the southern Caribbean. Although it may still take some time until its spread reaches Ghana by natural dispersal, it remains a possibility that the species will use other countries in Africa as stepping stones for further dispersal, possibly reaching Ghana. Apart from natural spread, currently, the only major and likely pathway of introduction of R. ferrugineus is through the import of palm trees with a stem diameter >5 cm. If the species were to be accidentally introduced to Ghana, the likelihood of establishment and rapid spread throughout the country is high. This is mainly based on the wide availability of host plants for its development, combined with a suitable climate throughout the year, and its ability to rapidly self-disperse as flying adult weevils. This would pose a significant threat to the production of oil palm, a commodity that is just starting to increase in importance in Ghana.
PRA Area
Whole country of Ghana
Reason for PRA
Demo or test PRA
Do previous PRAs exist for this pest?
Yes
Details of previous PRAs for the pest in the PRA area
This is the first PRA for red palm weevil risk to Ghana.
Details of other previous PRAs for the pest
A number of PRAs for this species are publicly available on the internet. A short PRA conducted by EPPO covers the Mediterranean region, another one China. One important document is a final project report on containment and eradication initiated by the EU. Defra (UK government) has also compiled a concise factsheet containing detailed information on detection and identification. Another more recent PRA for this species covers the Cayman Islands. The current PRA is largely based on the results provided in these studies and risk assessments. Links to individual documents mentioned here are given below: https://rnqp.eppo.int/recommendations/summarysheet_pest?pest=RHYCFE https://pra.eppo.int/pra/eee93e99-dedf-4b03-8d0e-71fec77a9dbd https://planthealthportal.defra.gov.uk/assets/factsheets/Rhynchophorus-ferrugineus-Defra-PP-Factsheet-Oct-2016-FINAL3.pdf https://www.researchgate.net/publication/301244029_Establishment_and_potential_risks_of_a_new_invasive_pest_red_palm_weevil_Rhynchophorus_ferrugineus_in_China

Pest Categorization

Identity

Preferred Scientific Name: Rhynchophorus ferrugineus (Olivier, 1790)
Preferred Common Name: red palm weevil
Other Scientific Names: Calandra ferruginea Fabricius, 1801; Curculio ferrugineus Olivier, 1790; Rhynchophorus signaticollis Chevrolat, 1882
International Common Names: (English) Asiatic palm weevil; coconut weevil; red stripe weevil; **(Spanish)** picudo asiático de la palma; **(French)** charançon asiatique du palmier

Phylum: Arthropoda; **Class**: Insecta; **Order**: Coleoptera; **Family**: Curculionidae

Other taxonomic remarks: The taxonomy and classification of red palm weevils have undergone a number of changes in understanding and circumscription. The vast majority of publications presumably do refer to *R. ferrugineus* rather than the closely related *R. vulneratus*, as the former is by far the most widely invasive . Generally, two species of red palm weevil, *R. ferrugineus* and *R. vulneratus* are recognised, although for some time they were also treated as synonyms. Interestingly, the 'red palm weevil' species that appeared in the USA was *R. vulneratus* rather than *R. ferrugineus*, though the latter is the invading species in all of the other global introductions (Rugman-Jones *et al*., 2013).

The genus *Rhynchophorus* contains ten species, of which seven, including *R. ferrugineus* and *R. vulneratus*, 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) suggested that *R. ferrugineus* is the typical *Rhynchophorus* species occurring worldwide. It is interesting to note that although the species has been continuously described under the author's name Olivier, some papers, especially those from the subcontinent, also indicate the author as Fabricius (Abraham *et al*., 1989; Ramachandran, 1991; CABI, 2020).

Presence or absence in the PRA area

So far there have been no records of this species from Ghana or its neighbouring countries.

Regulatory status of the pest

Regulatory status of the pest elsewhere

The EPPO Global Database gives the following regulatory status:
Africa
East Africa A1 list
Egypt A2 list
Morocco Quarantine pest
Southern Africa A1 list
Tunisia Quarantine pest
America
Brazil A1 list
Mexico Quarantine pest
USA Federal import quarantine order (APHIS USDA, 2010)
Asia
Bahrain A2 list
Israel Quarantine pest
Jordan A2 list
Europe

Georgia A1 list
Turkey A2 list

RPPO/trade bloc
CAHFSA A1 list
COSAVE A short PRA for Paraguay from 2007 is available on the COSAVE website
EAEU A1 list
EPPO A2 list
EU PZ Quarantine pest (Annex III); RNQP (Annex IV)
OIRSA A1 list

Distribution summary

Distribution from the Crop Protection Compendium (22/03/2021)

Africa: Djibouti, Egypt, Libya, Mauritania, Morocco, Tunisia
Asia: Bahrain, Bangladesh, Cambodia, China (Fujian, Guangdong, Guangxi, Hainan, Jiangsu, Tibet, Yunnan, Zhejiang), Georgia, Hong Kong, India (Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Daman and Diu, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Meghalaya, Odisha, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal), Iran, Iraq, Israel, Japan (Honshu, Kyushu, Ryukyu Islands), Jordan, Kuwait, Lebanon, Malaysia (Peninsular Malaysia), Myanmar, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand, Turkey, United Arab Emirates, Vietnam, Yemen (Socotra)
Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France (Corsica), Greece (Crete), Italy (Sardinia, Sicily), Malta, Montenegro, Portugal (Madeira), Russia (Southern Russia), Spain (Balearic Islands)
North America: Aruba, Curacao (Curaçao), Netherlands Antilles

According to Booth *et al*. (1990) *R. ferrugineus* occurs from Pakistan eastwards to Taiwan and the Philippines. It is now also found in Saudi Arabia and the United Arab Emirates. A specimen of *R. ferrugineus* was captured in a trap in Palestine. Flach (1983) reported that *R. ferrugineus* occurs together with *R. vulneratus* in the Philippines, but it is the exclusive species in India and Sri Lanka. Hartley (1977) reported the occurrence of *Rhynchophorus* in African oil palms but did not indicate the species. A record of *R. ferrugineus* in Queensland, Australia (CABI/EPPO, 2010; EPPO, 2014) published in previous versions of the Invasive Species Compendium (ISC) is invalid. Records of *R. ferrugineus* from Indonesia, Sabah and Sarawak (Malaysia), Singapore and Papua New Guinea published in previous versions of the ISC are now thought likely to be of *R. vulneratus* or *R. bilineatus* (CABI/EPPO, 2016). There is no evidence that records from Samoa, Solomon Islands and Vanuatu (EPPO, 2014) published in previous versions of the ISC are of *R. ferrugineus* (CABI/EPPO, 2016) (CABI , 2020).

The species has become widespread in many southern European and North African countries. Records from America are so far restricted to Aruba (present, localized) and Curaçao (present) (CABI, 2020). It was reported in the United States at Laguna Beach, California late in 2010, but this was a misidentification of the closely related species *R. vulneratus*, and this species did not become established (Hoddle *et al.*, 2017).

Association with host plants

Hosts: *Agave americana* (century plant), *Areca catechu* (betelnut palm), *Arenga pinnata* (sugar palm), *Borassus flabellifer* (toddy palm), Brahe*a armata, Brahea edulis, Butia capitate, Calamus merrillii, Caryota cumingii, Caryota maxima, Caryota urens* (fishtail palm), *Chamaerops humilis* (dwarf fan palm), *Cocos nucifera* (coconut), *Corypha umbraculifera, Corypha utan* (gebang palm), *Elaeis guineensis* (African oil palm), *Howea forsteriana* (paradise palm), *Jubaea chilensis, Livistona*

chinensis (Chinese fan palm), *Livistona decora, Metroxylon sagu* (sago palm), *Phoenix canariensis* (Canary Island date palm), *Phoenix dactylifera* (date-palm), *Phoenix sylvestris* (east Indian wine palm), *Roystonea regia* (cuban royal palm), *Sabal* (palmetto-palm), *Sabal palmetto* (Cabbage palmetto), *Saccharum officinarum* (sugarcane), *Trachycarpus fortunei* (chinese windmill palm), *Washingtonia filifera* (desert fanpalm), *Washingtonia robusta* (Mexican Washington-palm) (CABI, 2020).

Host specificity: There are some records from outside the Palm family (Arecaceae): *Agave americana* and *Saccharum officinarum* (sugarcane). Some non-palm ornamentals have also been reported to be attacked by the weevil (Menon & Pandalai, 1960). However, these don't seem to be main hosts of this species and it remains unclear if the weevil can fully develop inside them. *R*. *ferrugineus* is essentially a pest of palms (CABI, 2020).

Habitat: Generally, the species is highly associated with the occurrence of its host plants, where it attacks the flowering stage, fruiting stage, and vegetative growing stage (CABI, 2020).

Potential for establishment

Survival: *R. ferrugineus* is likely to survive all year round in all parts of Ghana where palms grow, both in ornamental plantings and in any natural habitats.

Reproduction (self-sustaining population): The life cycle of *R. ferrugineus* ranges from 45 to 139 days, depending on the climate, which allows for several generations in a year (APHIS USDA, 2010)). Recently, *R. ferrugineus* has spread over a wide geographical area in a very short time period, indicating a high ability to reproduce under a relatively wide range of climatic conditions. The species has become an economically important pest in oil palm plantations in Malaysia and on rattan on Fiji under climatic conditions comparable with the PRA area (Braza 1988, Harith-Fadzilah *et al.* 2020).

Potential for economic, social and environmental impact

The impact of *R. ferrugineus* is a worldwide problem and the economic impact of *R. ferrugineus* to palms around the world is devastating. The impact on the economy in invaded countries in particular is regarded as very high. Not only does it result in a need to replace ornamental palm trees, but the impact on production of dates and coconuts is regarded as very high. In addition, the species impacts cultural values, for example in Saudi Arabia where date palms are of high cultural value (Palm Protect, 2016). In Ghana, the accidental introduction of the *R. ferrugineus* has the potential to halt the development of plant oil production through growing oil palm (Ofosu-Budu & Sarpong, 2013).

Summary of categorization of Rhynchophorus ferrugineus (red palm weevil)

Does the pest have the potential to qualify as a quarantine pest? Yes

Risk Assessment

Probability of entry

Pathway: Plants for planting

Spread of R. ferrugineus on a global scale is primarily through the international movement of palm trees from nurseries for planting. This can be both ornamental and commercially used palm species.

1. What is the probability of the pest being associated with the

pathway at origin? **Rating:** Medium
Confidence: Medium

It is not clear to what degree palm trees (both ornamental and commercially used species) are imported into Ghana and whether this includes imports from countries with existing infestations of *R. ferrugineus*.

The species has been introduced to a number of countries in a short space of time, and it spread particularly rapidly throughout the Mediterranean. The weevil is also present in almost all the major coconut-growing countries in the tropics. However, information is not available on its quarantine status in the countries in which it is absent (CABI 2020).

Shipments of infested plants for planting of ornamental palm trees seem to be the main pathway (except plants in vitro) (EPPO, 2020c). The early stages of an *R. ferrugineus* infestation are difficult to detect because the larvae feed within the plant; the plant does not show signs of damage during early infestation attack (EPPO, 2008).

The weevil can be spread over long distances in infested plants for planting that are hosts of the pest (date palms, coconut palms, areca palms and many other palm species). However, the pest cannot complete its life cycle in palms with trunks/stipes less than 5 cm wide; these are very common in trade, and they are not considered to be an important pathway. On palms with trunks above this diameter (>5 cm) the life cycle can be completed; these are usually shipped as bare-rooted plants with limited growing medium attached or potted plants in various sizes for ornamental purposes (EPPO, 2020a).

2. What is the probability of the pest surviving during transport?

Rating: High
Confidence: Medium

According to a recent PRA for China, the survival rate of the pest in transportation is regarded as high. Here it is estimated to be more than 40% during transportation, but no references about timing and/or distance are provided (Rui-Ting & Aziz, 2011).

3. What is the probability of the pest surviving or evading existing pest management procedures? **Rating:** High
Confidence: High

It is difficult to identify the early stages of infection (Rui-Ting & Aziz, 2011). While *R. ferrugineus* is a relatively large insect, usually >25 mm (~1 in) long, as it is a stem borer, its larval stages are concealed and difficult to detect. The female lays eggs in wounds or in the soft tissue of the plant and after hatching, the larvae burrow into the stem, creating large galleries that eventually weaken and destabilize the tree. The damage caused by the larvae is only visible long after infestation, and by the time the first symptoms of the attack appear, they are so serious that they generally result in the death of the tree (APHIS USDA, 2010).

4. What is the probability of transfer to a suitable host or, in the case of potential weeds, habitat? **Rating:** High
Confidence: High

Self-dispersal within the environment is through adult flight, and the pest can find its host plants in widely dispersed areas. Studies suggested that they can detect breeding sites (cut tissue, wounds etc.) at distances of at least 900 m (EPPO, 1997). Marked beetles were found five days after release

up to 7 km away from the place where they were released (EU, 2011). The complete life cycle from egg to adult emergence, takes an average of 82 days in India and adults live 2-3 months, with up to three generations a year (EPPO, 1997; EPPO, 2020a).

In the case of Ghana, the probability of transfer to a suitable host is high for adult beetles hatching from untreated imported palm trees. Suitable climatic conditions allow adult beetles to be active all year round, and the self-dispersal capacity of *R. ferrugineus* is high enough to reach any part of the country through the dispersal flight of just a few successive generations.

Probability of entry summary: Plants for planting

Rating: Medium
Confidence: Low

Plant importation is generally seen as the main pathway aiding the spread of *R. ferrugineus*. However, there is considerable uncertainty amongst experts about the relative importance of plants for planting as a pathway compared to local spread (EPPO, 2020a).

There have also been further minor pathways discussed in the past:

Esteban-Duran *et al*. (1998) suggested that *R. ferrugineus* is among the pests that could potentially be introduced to Spain and other countries of the European Union through imported vegetables (CABI, 2020).

The importation of palm frond greenery as cut flowers is an unlikely pathway for the movement and entry of red palm weevil. Eggs may be deposited in the proximal end of the frond where young larvae feed before moving into the main part of the palm (Faleiro 2006; Salama *et al*. 2009). However, young *R. ferrugineus* in cut fronds are unlikely to be able to complete development before the frond dries to an unsuitable level, and are also unlikely to move to find a suitable host due to their limited mobility (Bertone, *et al*. 2010).

There do not seem to be any proven cases where the species has been able to invade as a stowaway not associated with palm trees. However, there have been five interceptions of unidentified *Rhynchophorus* spp. from baggage and cargo at US ports (PestID, 2009). Two were from Mexico, one from North Africa, one from Congo, and one from Ecuador. These very few interceptions indicate that the weevils in this genus may move in a limited manner as a hitchhiker (Bertone, *et al*. 2010).

Transport of seeds seems to be low risk, and countries like the USA and Australia continue to allow the import of seeds (APHIS USDA, 2010).

Is this a major or minor pathway? Major

Does this pathway require management measures? Yes

Probability of entry summary

	Summary rating	Summary confidence level	Major/minor pathway?	Pathway requires management measures

Probability of entry: Pathways				
Plants for planting	Medium	Low	Major	Yes

Currently, the only major and likely pathway of introduction of *R. ferrugineus* is through the import of palm trees with a stem diameter >5 cm. The likelihood that this will happen in the near future in Ghana is difficult to predict as no data on current levels of the importation of palm tree into the country were found.

Probability of establishment

1. What is the probability that suitable hosts or, in the case of potential weeds, habitats are available in the PRA area?

Rating: High
Confidence: High

Any ornamental palm trees, naturalised stands of introduced palms, economically grown palms such as oil palm or coconut, or stands of native and/or endemic palms are at risk of being infected by the red palm weevil. With regards to native palm tree species, there is a high risk that these could become new hosts of *R. ferrugineus*, even if they are currently not known to be hosts of this species.

If rapid response measures are applied to palms where infection has been detected at an early stage, it is possible that the spread of the weevil could be contained. Even then, smaller naturalised tree stands may provide a reservoir for continued spread throughout the country.

2. If transmitted by vectors, what is the probability that suitable vectors are available in the PRA area?

Rating: N/A
Confidence: N/A

Not applicable

3. What is the probability that climatic conditions and other abiotic factors will allow the pest to establish in the PRA area?

Rating: High
Confidence: High

Survival: *R. ferrugineus* is likely to survive all year round in all parts of Ghana where palms grow, both in commercial or ornamental plantings, and in any natural habitats.

Reproduction (self-sustaining population): The life cycle of *R. ferrugineus* ranges from 45-139 days, depending on the climate, which allows for several generations in a year (APHIS USDA, 2010). Recently, *R. ferrugineus* has spread over a wide geographical area in a very short time period, indicating a high ability to reproduce under a relatively wide range of climatic conditions.

4. What is the probability that existing control measures for other pests in the PRA area are unable to prevent establishment?

Rating: High
Confidence: High

The control of *R. ferrugineus* requires a very specific approach. It is therefore unlikely that other pest control measures already established in Ghana could also control this species.

5. What is the probability that existing natural enemies in the PRA

area are unable to prevent establishment?

Rating: High
Confidence: High

Different strains of entomopathogenic fungi from *R. ferrugineus* from around the Mediterranean basin have been identified. Laboratory, semi-field, and field assays for one of these strains of *Beauveria bassiana* have demonstrated the potential that entomopathogenic microorganisms have for controlling these palm pests. Overall, a number of different biological control agents have been found for *R. ferrugineus*, but so far no highly efficient approach has been fully developed (CABI, 2020). It is unlikely, that any non-coevolved natural enemies already present in Ghana will be able to exert a high degree of control.

6. What is the probability that other biological characteristics of the pest will enable establishment?

Rating: Medium
Confidence: Medium

There is no detailed information on specific biological characteristics of this species which may aid establishment. However, the successful invasions of many countries through possibly only a relatively low number of infected young trees, demonstrate that the species is generally a very successful invader.

7. What is the probability of establishment under foreseeable climate change conditions?

Rating: High
Confidence: Low

It is difficult to predict the effects of forseeable climate change on the probability of establishment. There are however, no high-altitude areas in Ghana, currently out of reach for this species, that could become more accessible with climate change.

Probability of establishment summary

Rating: High
Confidence: High

Widespread presence of suitable hosts in combination with year-round suitable climatic conditions in most if not all parts of the country, make establishment after an accidental introduction highly likely.

Probability of spread

1. What is the expected rate of natural spread in the PRA area?

Rating: High
Confidence: High

Adult red palm weevils have a high dispersal capability. Assessments during a European research project showed that flight was very variable between individuals and age was strongly correlated to frequency of flight, which occurred from 2-97 days of age, with 96% of flights being undertaken by 13-19 day old adults. Weevils aged up to 2 months could cover a distance of 10 km within a single flight, and 20% of weevils were still able to perform long flights after 2 months of age. Overall, 41% of flying individuals were able to cover a mean distance of 5 to 10 km per flight. One individual flew 48 km in a single flight and one covered a distance of 250 km during its life. Mated males performed more flights

and flew longer distances than virgin ones, which together with a longer life than females, make them an overlooked risk as they can signal palms to other weevils by the pheromone they emit (Palm Protect, 2016).

Wind drift is possible, but probably less important than active dispersal flights.

2. If transmitted by vectors, what is the expected rate of spread by vectors in the PRA area?

Rating: N/A
Confidence: N/A

Not applicable.

3. What is the expected rate of spread with commodities or conveyances in the PRA area?

Rating: Low
Confidence: Medium

Direct transport by humans: unlikely; only active transport of palm trees

Transport via vehicles (e.g. boat, cars, including tyres): unlikely

Transport via animals (e.g. berries digested by birds, seeds stuck to wool, etc.): unlikely

4. What is the probability of the pest spreading to an area of higher economic importance than the area of introduction?

Rating: High
Confidence: High

It is likely that within only few years, any significant stands of palm tree in Ghana, whether commercially grown plantations, ornamental plantings or natural stands, could be infected due to the strong dispersal capacity of the species, no matter where the port of entry would be.

Dispersing adults can find their host plants in widely separated areas. Studies suggested that they can detect breeding sites (cut tissue, wounds, etc.) at distances of at least 900 m (EPPO, 1997). Marked beetles were found five days after release up to 7 km away from the place where they were released (EU, 2011). The complete life cycle from egg to adult emergence, takes an average of 82 days in India and adults live 2-3 months, with up to three generations a year possible (EPPO, 1997; EPPO, 2020a).

5. If a commodity pathway has been identified as one of the pathways of entry, what is the probability that the intended use of the commodity increases the rate of spread?

Rating: High
Confidence: Medium

The probability that the use of the commodity, in this case young palm trees for planting, increases the spread is high. It is likely that any imported palm trees will be transported closer to already existing plantations or other stands of palm trees. Even if planting takes place in areas with no previous planting of palm trees this will still aid spread throughout the country.

6. What is the potential rate of spread under foreseeable climate change conditions?

Rating: Low
Confidence: Low

It is difficult to predict the effects of forseeable climate change on the rate of spread. As climatic conditions are already favourable for the spread of the species in all parts of the country, it is possible that spread won't change much even with significantly changed climatic conditions.

Probability of spread summary

Rating: High
Confidence: High

Favourable climatic conditions in combination with a strong proven dispersal capacity of the *R. ferrugineus* result in a high likelihood of rapid spread once established in the country.

Potential economic, environmental and social consequences

1. What is the level of economic loss to agriculture, forestry or horticulture associated with this pest in its existing geographic range?

Rating: High
Confidence: High

The following summary is from the Crop Protection Compendium datasheet (CABI, 2020).

Infestations of red palm weevil have a tremendous impact, not only on the economic produce of the palm (dates) but also on society. In the Gulf region, date palm is closely associated with the culture, religion and the life of the people. Approximately 30% of the world's date production comes from the Gulf region of the Middle-East. Recent statistics shows that *R. ferrugineus* infestation may cause severe economic losses ranging between 1 and 5%, accounting for 5.18 to 25.92 million USD, respectively, with indirect losses increasing this figure several fold. The estimated cost saving of the curative treatment of palms in the early stage of attack is US $20.73 to 103.66 million for 1 and 5% infestation levels, respectively (El-Sabea et al., 2009). Menon and Pandalai (1960) suggested that *R. ferrugineus* is a serious pest of coconut palms in India and Sri Lanka. Ganapathy et al. (1992) observed *R. ferrugineus* damage in 34% of coconut groves in Cochin, India. Dhileepan (1991) reported that the weevil is a major pest of oil palms in Kerala. Flach (1983) suggested that *R. ferrugineus* and *R. vulneratus* are major pests of the sago palm in Sarawak. A relatively recent record of *R. ferrugineus* in India as a pest on oil palm (Misra, 1998) poses serious implications to some countries in South-East Asia (e.g. Malaysia, Indonesia) where oil palm is a major economic crop. In most European countries, the target of red palm weevil infestation is mainly the ornamental palms ruining the aesthetic beauty of parks and roads. Overall, red palm weevil damage to any type of palm accounts for losses of millions of dollars because the pest feeds on the trunk.

In addition: It is thought that the effects of this pest and the measures required to eradicate and control them are having significant, and potentially devastating, impacts on the palm tree populations and landscape in the Mediterranean basin. The numerous nurseries throughout the Mediterranean basin that supply exotic palms are of great economic value. In Spain alone, over 50,000 palm trees have been destroyed in the fight against the red palm weevil between 1996-2010 and > 90% of these occurred between 2005 and 2010. However, the eradication and control of *R. ferrugineus*, especially over large areas, is hampered by the huge costs required and budget limitations, which are compounded by the difficulties in the eradication on private properties, resulting in re-infestation of 'cleaned' areas (Palm Protect 2016).

2. What is the level of potential economic loss to agriculture, forestry or horticulture in the PRA area?

Rating: High

Confidence: Medium

Agriculture: The impact from a widespread establishment of *R. ferrugineus* in Ghana could potentially be very high. This is particularly the case when Ghana succeed to increase production of **oil palm**. Ghana is a significant producer of this crop and currently has a total of 305 758 ha of oil palm, more than 80 percent of which is cultivated by private small-scale farmers. It is estimated that 243 852 tonnes of palm oil is produced annually (Ofosu-Budu & Sarpong 2013).

Oil palm production in Ghana is mostly restricted to area with high rainfall in the southwest of the country.

Coconut production and export in Ghana have increased significantly over the last few years. As of 2018, the coconut production hovered around 224 million fruits, equal to approximately 380k tons. Around 80% of the coconuts are produced by small-holder farmers (Hommel 2019).

Another commercially important palm tree species in Ghana is *Raphia vinifera*, the West African piassava palm, bamboo palm or West African bass fibre. A multipurpose tree that is very important for the local population, supplying food, fibres and building materials. The fibres are exported to many other countries.

Many more palm species in Ghana provide important NTFPs from wild stands including rattan and products for drinks production (Ouattara *et al.* 2015).

3. What is the level of negative impact on native biodiversity associated with this pest in its existing geographic range?

Rating: Medium
Confidence: Medium

Little information is available about the environmental impact of *R. ferrugineus* within its introduced range and in particular on populations of native and endemic palm species. There is, however, great concern that the palms, *Phoenix canariensis* and *P. theophrasti* native to the Canary Islands and Crete respectively, as well as palm groves such as those of Elche in Spain, a UNESCO World heritage site, will eventually succumb to infestations of these pests (Palm Protect 2016).

4. What is the level of potential negative impact on native biodiversity in the PRA area?

Rating: High
Confidence: Low

West Africa is home to 13 genera and 39 species of palm trees, with 18 species being recorded from Ghana alone (Stauffer et al. 2017).

The introduction of *R. ferrugineus* would pose a significant risk for the survival of at least some of the palm species native to Ghana. There is also the possibility that the loss, in particular of old trees, could impact on native and endemic plants and animals relying on as a part of their habitat, for example, epiphytic plants, deadwood beetles, nesting native bees; food source for pollinators.

5. What is the level of negative impact on ecosystem patterns and processes associated with this pest in its existing geographic range?

Rating: N/A
Confidence: N/A

Currently, no assessments are available.

6. What is the level of potential negative impact on ecosystem patterns and processes in the PRA area?

Rating: High
Confidence: Low

Increased use of insecticides to control the red palm weevil may impact negatively on populations of native insects, including pollinating bees and wasps, as well as on soil biodiversity and water quality.

A possible breakdown of native palm tree stands may impact on nutrient cycling and structural modifications of habitats may change the availibilty of habitats for many native and endemic species.

7. What is the level of negative social impact associated with this pest in its existing geographic range?

Rating: High
Confidence: High

The impact of *R. ferrugineus* on cultural values, specifically in Saudi Arabia where data palms are of high cultural value, is high (Palm Protect, 2016). In most European countries, the target of red palm weevil infestation is mainly the ornamental palms, ruining the aesthetic beauty of parks and roads (Palm Protect 2016).

8. What is the level of potential negative social impact in the PRA area?

Rating: Medium
Confidence: Low

Employment rates: In areas with commercial production of palm (oil palm, coconut) farmers and workers along the market chain may lose their livelihoods when yields reduce significantly. There may be the risk that commercial importers of palm trees have to lose their business in order to prevent the introduction of the red palm weevil.

Tourism: The aesthetics of dying palm trees and an overall loss of palm trees may impact negatively on tourism in some coastal areas. It is recognised that palms provide significant cultural services, e.g. in the form of palms in urban environments, lining streets and town squares, in public parks and private gardens, but placing an economic value on such services is very challenging for economists (Palm Protect, 2016).

Recreational potential: Similar to tourism, usage of recreational areas in urban areas by residents may potentially change (loss of shaded recreational places).

Other: Costs for eradication and containment measures; costs for replanting palm trees; old specimen trees themselves have a high monetary value, in particular if they impact on the value of the property they are standing on, or are part of the view from other properties.

There is a low risk of increased exposure to harmful chemicals if the use of pesticides to control *R. ferrugineus* increases.

9. What is the level of potential negative impact in the PRA area (for all sectors) under foreseeable climate change conditions?

Rating: Medium
Confidence: Low

It is difficult to predict the effects of forseeable climate change on the impact of the species. As climatic conditions are already favourable for a rapid development of the species in many parts of the country, it is possible that this won't change much even with significantly changed climatic conditions. However, impact may increase when palm trees start to struggle with the impact of climate change

themselves making them more susceptible to pests and diseases.

Potential consequences summary

Rating: High
Confidence: High

The potential impact of an accidental introduction of *R. ferrugineus* is likely to be very high. This is not only with regards to the economic production of palm oil and coconut but also concerning non-timber forest products (NTFPs) from wild palm stands. In addition, there is a potentially very high risk for significant population decline of native pam tree species and knock on effects with regards to important ecosystem services.

Risk assessment summary

	Summary rating	Summary confidence level	Major/minor pathway?	Pathway requires management measures
Probability of entry:Pathways				
Plants for planting	Medium	Low	Major	Yes
Probability of establishment	High	High		
Probability of spread	High	High		
Potential economic, environmental and social consequences	High	High		

Does the pest require phytosanitary measures? Yes

Currently, the pathway of importing young palm trees for planting in Ghana, in particular from geographical regions which are already invaded by *R. ferrugineus*, is still of low significance. However, should this change, or should *R. ferrugineus* manage to enter the country despite a currently low risk of accidental introduction, Ghana is at high risk that *R. ferrugineus* become quickly established and will exert significant negative impacts to the economy and environment of the country.

Risk Management

Pathway of entry

Management option	Notes
Plants for planting	Import of palm tree is currently the only pathway open for *R. ferrugineus* to enter Ghana as the nearest records of the species are too far away to allow invasion by natural spread. Howwever, long term this may change as there are already records from Mauritania and a natural colonisation along the West African coast over time seems plausible. **Pre-border:** Shipment of in vitro plants and palm seeds are apparently safe

	(EPPO PRA, 2020; USDA factsheet, Giblin-Davis *et al*. 2013). Equally, the import of plants with stem diameters <5 cm and the import of fruits are deemed to be safe (Giblin-Davis *et al*. 2013). An assay studied the feasibility of a quarantine treatment for Canary Islands date palms. Palms were naturally infested and placed in a sealed container. Infested palms were exposed to aluminium phosphide for 48 h. The infested and treated palms were inspected for the presence of all stages of *R. ferrugineus*. Treatment completely eliminated all live stages of *R. ferrugineus* (i.e. 100% efficacy) and no phytotoxic effects of aluminium phosphide were observed for up to 1 year after exposure to aluminium phosphide. This treatment, which could be easily applied in sealed containers used to prepare and ship palms overseas, could therefore be recommended to significantly reduce the enormous risks that palm imports currently bring worldwide (Palm Protect, 2016). The introduction of *R. ferrugineus* to many countries through the trade of adult palms indicates that the best method for preventing introduction of this pest is to prohibit importation of all host species (with the exception of seeds and possibly in vitro reared seedlings and young plants with a small stem diameter below 5 cm). This measure has, for example, been put in place for the USA, in order to prevent the entry of *R. ferrugineus*, but also of closely related species such as *R. palmarum*, the South American palm weevil (APHIS USDA, 2010). **At the border:** Palm Protect developed detection techniques for use at trade points and open areas. For detection of individual palms in quarantine/at trade point, two protocols were successfully demonstrated based on olfaction and acoustics. Dogs were trained to detect infestations of both the red palm weevils, and the accuracy of detection was high but depended on the palm host. Acoustic monitoring was able to detect *R. ferrugineus* larvae inside young palms shortly after infestation, and long before any visual symptoms appear (Palm Protect, 2016). Equally the treatment with aluminium phosphide described under 'pre-border' treatment could be applied at the border itself.

After entry

Management option	Notes
Surveillance, containment and eradication	**Eradication:** In many areas, particularly larger countries (as in the Mediterranean), eradication of *R. ferrugineus* is deemed unlikely and containment is seen as more realistic (Palm Protect 2016). It is still not clear under which circumstances eradication using the methods currently applied in Europe for containment of *R. ferrugineus* might be possible. Localised eradication of a small starter population, restricted to only few infected plants, may be possible. Eradication has been cited for California, USA, but this has been shown to be in relation to a closely related species, before it could become properly established (CABI 2020). However, a successful eradication programme of the red palm weevil was undertaken in the Canary Islands to protect the native *P. canariensis* after this insect was detected in resorts of Fuerteventura and Gran Canaria in 2005. This included a ban on the importation of any palms from outside the islands, and a programme of work including monitoring for the pest; inspection of palm trees and nurseries; accreditations for transplants and movement of palm trees; elimination of infected trees; plant health treatments and mass trapping; and an awareness campaign including a website, talks, seminars, courses, newsletters and leaflets. In 2007, an outbreak was reported on Tenerife, but since 2008 no additional weevils have been detected (Palm Protect 2016). **Containment to prevent further spread**: No fully effective methods are currently available once the pest becomes established and any efforts to

	achieve containment will require buffer zones of at least 10 km around infested areas (European Union 2011). **Mechanical/chemical control:** An injection device specifically for palm trees that quickly and efficiently delivers insecticide into the palm's trunk, with minimal damage to palm tissues, has been developed. Stipe injection resulted in a better distribution and higher persistence of pesticide compared with frond injection and crown spraying, suggesting that stipe injection could be a good alternative for the control of *ferrugineus*. A relatively wide range of further containment and control approaches have been looked into with varying success (CABI 2020). **Biological control:** Control methods include mass trapping and attract and infect procedures, using a Picusan® trap and entomopathogenic fungi. In field trials, the attract and infect device was found to be more effective at protecting palms than trapping alone. Between 40 and 80% of the adults captured with infective traps were infected with fungi, and traps remained effective for over 75 days. Moreover, infected adults were able to move distances over 300 m from the trap, helping to spread fungi to other weevils. Only 42% of the sentinel palms in the centre of infective trap plots were infested by weevils, compared to 100% infestation in mass trapping plots (Palm Protect 2016; Dembilio et al. 2012). Different strains of entomopathogenic fungi from *R. ferrugineus* from around the Mediterranean basin have been identified. Laboratory, semi-field, and field assays for one of these strains of *Beauveria bassiana* has demonstrated the potential that entomopathogenic microorganisms have for controlling these palm pests. Overall, a number of different biological control agents have been found for *R. ferrugineus*, but so far no highly efficient approach has been fully developed (CABI 2020). Although very difficult and costly, eradication programmmes can still be successful. They will however require a coherent nationwide approach and strictly imposed regulations and efficiently applied control mesures (see also Ferry 2019).
Restriction on end use or distribution	According to import legislation in Ghana the import of palm trees currently requires a permit but is not prohibited as such (GRA, 2020). A simple import ban on palm tree with a stem diameter larger than 5 cm will effectively shut down the only pathway of entry for the *R. ferrugineus*. In contrast, a more complicated regulation system relying on phytosanitary certificated for the import is unlikely to become fully reliable (see also Ferry 2019). It is also important to consider any illegal importation of palm tree and to adjust inspection regimes accordingly and to raise awareness about the dangers associated with this pest amongst the public. In case of accidental *R. ferrugineus* introduction into Ghana, domestic restrictions regarding the transport of palm trees would need to be introduced.

Other

Management option	Notes
Add the pest to the official	The National Plant Protection Organization (NPPO) of Ghana listed *R. ferrugineus* in its national pest list in October 2017.

list of regulated pests	This pest list contains both quarantine and regulated non-quarantine pests for different plant commodities in the country.
Initiate risk communication	Awareness levels about the dangers associated with *R. ferrugineus* are currently low. A recent (2017) 'Palm Oil Risk Assessment' conducted for Ghana does not mention whether trees for plantations are imported and risks associated with pests and diseases are not assessed (NEPCon, 2017). The content of this PRA should be shared with the NPPO in Ghana and decision makers should be alerted to put in place an import ban for palm trees with a stem diameter larger than 5 cm.
Appropriate measures have not been identified	A contingency plan should be developed and put in place in case an accidental introduction of *R. ferrugineus* is discovered, to allow the initiation of a rapid eradication programme.

Risk management summary

Prevention of entry, control and eradication of *R. ferrugineus* measures differ significantly from the approach required for most other pest species of agricultural crops. It is therefore unlikely that currently existing measures in place will be sufficient to deal with the threat associated with this serious pest.

Pest Risk Analysis Summary

A lot of research has recently become available on the biology of the red palm weevil (*Rhynchophorus ferrugineus*), including the prevention of its introduction, containment and control. Some of this work is still ongoing, and a range of suggested control measures still require further trials before they can become more widely available. However, the information already available (including from PRAs that already exist for this species) is sufficient to make informed assessments with high confidence levels for most parts of this PRA. The information below gives a summary assessment of the PRA on *R. ferrugineus*:

The species is highly invasive and has recently expanded beyond its natural range from southern and southeast Asia westwards, over vast areas of the Middle East and the Mediterranean basin.

Although it has been recorded from Mauritania, natural direct dispersal from this country is unlikely short term, but still plausible over time.

Currently, the only major and likely pathway of introduction of *R. ferrugineus* is through the import of palm trees with a stem diameter >5 cm.

If the species were to be accidentally introduced to Ghana, the likelihood of establishment and rapid spread throughout the country is high. This is mainly based on the wide availability of host plants for its development, combined with a suitable climate throughout the year, and its ability to rapidly self-disperse as flying adult weevils.

Establishment would likely lead to highly negative impacts on commercially used palm tree species in Ghana, both planted and wild stands. Many valuable old trees would be lost, and measures for containment and control of the pest, as well as for replacement of lost palm trees, would be costly.

There is a significant risk that native palm tree species would be threatened with severe declines through the impact of *R. ferrugineus*.

Currently, there are no adequate measures in place to prevent the arrival of *R. ferrugineus* in Ghana, nor to contain its spread or successfully eradicate a newly established population. Implementing any of the measures outlined in this PRA, with the exception of restricting the international trade of palm trees, would also be costly.

Next Steps

Peer review.

Contact Details

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