

Oryctes rhinoceros

Scientific Name

Oryctes rhinoceros (Linnaeus, 1758)

Synonyms:

Oryctes stentor Castelnau, 1840
Scarabaeus rhinoceros Linnaeus

Common Name

Coconut rhinoceros beetle (CRB),
coconut beetle, rhinoceros beetle,
palm rhinoceros beetle, Asiatic
rhinoceros beetle

Type of Pest

Beetle

Taxonomic Position

Class: Insecta, **Order:** Coleoptera,
Family: Scarabaeidae

Reason for Inclusion in Manual

Suggestion from CAPS Community

Pest Description

Descriptions of all life cycles can be found in Gressitt (1953).

Eggs: Eggs are whitish brown and 3 to 4 mm (approx. $\frac{1}{8}$ to $\frac{3}{16}$ in) (Giblin-Davis, 2001). Eggs are initially soft and oblong but swell into a rubbery circle four to five days after being laid (Hinckley, 1973).

Larvae: Newly hatched larvae are 7.5 mm long (approx. $\frac{5}{16}$ in) (Lever, 1979). "The large (60 to 105 mm long [approx. $2\frac{3}{8}$ to $4\frac{1}{8}$ in]) white mature larva is C-shaped, with a brown head capsule and legs. The posterior part of the abdomen is a bluish-grey colour" (Giblin-Davis, 2001). Larval instars are



Figure 1. *Oryctes rhinoceros* female (Mark Schmaedick, American Samoa Community College).



Figure 2. *Oryctes rhinoceros* male (Aubrey Moore, University of Guam).



Figure 3. Larva of *Oryctes rhinoceros* (Mark Schmaedick, American Samoa Community College).

differentiated by the size of their head capsules (Gressitt, 1953).

Pupae: “The color is somewhat yellowish brown and the body has a somewhat rubbery appearance. Most of the external adult structures can be detected...the pupa ranges from 39.4 to 51.5 mm. [approx. $1 \frac{9}{16}$ to 2 in] long, 19-23.6 [approx. $\frac{3}{4}$ to $1\frac{15}{16}$ in] wide, and 16 to 19.4 [approx. $\frac{5}{8}$ to $\frac{3}{4}$ in] deep...the surface is rather smooth and shiny, with minute punctures or bristles in part. The ventral surfaces and legs bear distinct reddish bristles. The sclerotization of the exoskeleton is highly developed, and the beetle is extremely strong. The sides of the mandibles and parts of the legs and ventral surfaces of the body are clothed with bright reddish brown hairs” (Gressitt, 1953).

Adults: Adults range from 30 to 57 mm (approx. $1 \frac{3}{16}$ to $2 \frac{1}{4}$ in) (Giblin-Davis, 2001) and are black “with a fine reddish pubescence on the ventral surface.” Adults “bear on the head a median horn curved backward; the horn is much longer in the male than in the female” (Lever, 1979).

Male: “The male has a large horn on its head and a smooth and shiny abdomen” (Vargo, 1995).

Female: “The female has a smaller horn [than the male] but is distinguished by long, erect, reddish hairs that are visible at the tip of the abdomen” (Vargo, 1995).

There can be considerable variation in body size and the length of the cephalic horn in both males and females. This is correlated with the larval environment (Gressitt, 1953).

Biology and Ecology

The life cycle can range from 4 to 9 months. More than one generation can occur per year (Giblin-Davis, 2001); when conditions are favorable there may be more than 3 generations per year. All stages of the pest may be found at the same time (Gressitt, 1953).

Adults mate several times in dead or dying plant material (Catley, 1969), including decaying palm trunks (Zelazny and Alfiler, 1987). The females make a serpentine burrow in which they lay their eggs. According to Hinckley (1973), females can oviposit in “almost any log or heap soft enough for burrowing, yet firm enough to provide compacted frass”. Females lay between 3 and 4 clutches of eggs with about 30 eggs per clutch (Hinckley, 1973), laying between 70 and 140 eggs total



Figure 4. Breeding site of *Oryctes rhinoceros* under a coconut log (Mark Schmaedick, American Samoa Community College).

(Giblin-Davis, 2001). After oviposition, they cover them with the chewed material (Hinckley, 1973). Males usually arrive after the females lay their eggs and stay longer in the breeding site to prepare the wood for the larvae (Zelazny and Alfiler, 1991; Alfiler, 1999). Zelazny and Alfiler (1987) described four phases of the adult life of *O. rhinoceros* in the Philippines: immature phase, first feeding, breeding phase, and late life feeding. The last two phases occurred simultaneously. In late life feeding, the beetles will occasionally make additional visits to palms (reviewed in Alfiler, 1999).

Eggs are laid in manure, rotten wood, decaying vegetation found in coconut plantations, or other organic matter (Giblin-Davis, 2001; Schmaedick, 2005). Trees damaged by typhoons can serve as breeding sites (Moore, 2007). Bedford (1976) states that dead standing palms are the most favored breeding sites. Eggs hatch in about 12 days (Giblin-Davis, 2001).

Larvae can be found in decaying or dead standing palms (Giblin-Davis, 2001) and eat rotting organic matter (Muniappan, 2002). They may be found feeding in the trunks of living palms, but this is only when the tree is already seriously injured by the adult or other means (Gressitt, 1953). In Guam, a significant number of *O. rhinoceros* have been found to complete their entire life cycle in the crowns of coconut palms with larvae feeding on decaying detritus caught between the petioles (Moore, 2012). Crowns are only damaged by adults as they bore into folded, emerging fronds to feed on sap.

In lab conditions, larvae preferred temperatures around 27 to 29°C (81° to 84°F) and had a strong negative phototaxis response, possibly an adaptation against desiccation and predation (Bedford, 1980). They avoid areas where temperatures are above 37°C (100°F) (Hinckley, 1973). Larvae seem to prefer areas with high moisture content, with more larvae being found in material when moisture content was 80 to 100% (Kamarudin et al., 2005). Earlier work found a moisture content over 77% was needed for satisfactory larval development (reviewed in Kamarudin et al., 2005). They develop fully in 72 to 130 days (Giblin-Davis, 2001) going through three instars (Gressitt, 1953; Hinckley, 1973). Once mature, larvae go through a nonfeeding pre-pupal stage lasting 8 to 13 days before pupation occurs (Schmaedick, 2005).

Pupation usually occurs in the soil but can also occur in the larval habitats as well (Giblin-Davis, 2001). Larvae construct oval pupal cells measuring 55 x 35 x 33 mm (approx. $2 \frac{3}{16} \times 1 \frac{3}{8} \times 1 \frac{5}{16}$ in) enclosing it with sawdust and frass (Gressitt, 1953) and sometimes construct cocoons of soil or plant tissue when pupating in softer material (Vargo, 1995). Pupation lasts about 20 days. Adults will remain in the cocoons after pupation is complete for about 11 to 20 days (Giblin-Davis, 2001). This is to allow the exoskeleton time to darken and harden (Hinckley, 1973).

After emergence, adults remain mostly around the breeding sites (Giblin-Davis, 2001). Adults can fly to the crowns of host plants to feed, flying between dusk and dawn (Catley, 1969). The depth of burrows made by adults can range from 2 to 50 cm (approx. $\frac{3}{4}$ to $19\frac{11}{16}$ in), averaging around 21 cm (approx. $8\frac{1}{4}$ in). Adults stay to feed in the burrows several days (Hinckley, 1973). Under favorable conditions, adults are likely to fly short distances whereas longer flights occur when conditions are adverse (Catley, 1969). Hinckley (1973) found that after feeding, adults could travel distances between 2 and 4 km (1.24 to 2.48 mi). Flight is inhibited by rain and moonlight (Vargo, 1995). Adults live for about 3 months (Schmaedick, 2005).

Damage

Damage is caused by the adult stage, specifically young adults that bore into the crowns of healthy palms. Adults can penetrate 10 to 50 cm (approx. $3\frac{15}{16}$ to $19\frac{11}{16}$ in) down close to the center of the spear cluster (Giblin-Davis, 2001). Adults bite through the tightly packed unopened leaves in the central bud. The leaf midribs are most often injured (Lever, 1979).

After entering the palm, the beetle feeds on juice produced by host tissue (Giblin-Davis, 2001). It then bores outwards emerging from the base of a central frond (Barber et al., 1971). Adult feeding damages the inflorescences and fronds which may decrease or delay fruit production. Mature fronds will often have patches of missing foliage if attacked while in the developing stage (Giblin-Davis, 2001). Damage can appear as V-shaped cuts in the fronds or holes in the midrib (Schmaedick, 2005). Plants killed by *O. rhinoceros* provide additional breeding sites for future generations (Moore, 2007).

There is a positive correlation between abundance of larval food and damage by adults to palms. Outbreaks can be



Figure 5. Palm damage caused by *O. rhinoceros* adults (Ben Quichocho, USDA-APHIS, Guam).



Figure 6. Feeding damage caused by *Oryctes rhinoceros* (Ernie Nelson, Greenscapes Inc, Guam).

caused by natural catastrophes (typhoons, diseases) or human destruction (replanting, milling, composting, military devastation) (Hinckley, 1973).

In older healthy palms, beetle damage can be tolerated. But in palms from 1 to 3 years old, damage by *O. rhinoceros* can result in severe malformation or death (Giblin-Davis, 2001). Death of the palm occurs when the beetle bores down to the meristematic tissue which can destroy the growing point. This is more likely to occur in young palms with small crowns (Catley, 1969). Attacks are typically concentrated on the margins of palm groves and on taller palms (reviewed in Bedford, 1980).

Adults chew the plant tissue to extract the juices and leave a fibrous frass which is pushed out of the burrow entrance. This extruded material is a sign that adults are still present in the host (Catley, 1969; Giblin-Davis, 2001). They will infrequently bore into partly grown nuts (causing nut drop) and into date palm inflorescences (reviewed in Gressitt, 1953). Gressitt (1953) states that *O. rhinoceros* prefers tall, mature palms, but when lacking will attack young palms.

In sugarcane, adults will bore upwards in the stem from the entrance near ground level (reviewed in Gressitt, 1953).

Pest Importance

In its native range, it is controlled by various factors, but when introduced to new areas without natural controls (like predators or diseases) it becomes a threat to coconuts and other palms (Gressitt, 1953).

Oryctes rhinoceros is considered one of the most damaging insects to coconut and African oil palm in southern and South East Asia as well as the western Pacific Islands (Giblin-Davis, 2001). It can attack other palm species as well (Schmaedick, 2005). Economic losses to copra (dried coconut kernel) producers in Asia and the Pacific Islands can be high and are affected by reduced yields, the cost of control measures, plantation establishment costs (re-planting to replace dead or severely damaged trees), and quarantine procedures to limit the spread (Catley, 1969).

The introduction of *O. rhinoceros* into Palau led to the widespread devastation of coconuts on some of the islands, with overall tree mortality around 50% within 10 years (Gressitt, 1953; Moore, 2007). Estimates in India suggest that *O. rhinoceros* is responsible for at least 10% loss in coconut yield. In Diego Garcia (part of the British Indian Ocean Territory), one-third of coconut seedlings planted are killed by this pest (reviewed in Catley, 1969). Estimated annual costs of *O. rhinoceros* in South Pacific Territories exceed \$1.1 million (Catley, 1969).

Deep burrows in young palms can often be lethal due to either direct injury to the growing tip or through secondary infections by bacteria or fungi (Hinckley, 1973). The palm may also suffer severe loss of leaf tissue which can decrease nut set (Vargo, 2000). Damage caused by *O. rhinoceros* can lead to secondary infestations by

pathogens and other weevils. Secondary damage caused by *Rhynchophorus* spp. are considered more severe than the initial *O. rhinoceros* attacks (Catley, 1969).

Known Hosts

Gressitt (1953) states that the preferred larval habitat is *Cocos nucifera* (coconut) wood, followed by *Artocarpus* spp. (breadfruit), *Calophyllum inophyllum* (Alexandrian laurel), *Mangifera* spp. (mango), and *Pandanus* spp. (pandanus palms). The larvae of *O. rhinoceros* feed on rotting organic matter (Muniappan, 2002).

Adults feed on several species of palm as well as coconut. Hosts of adults include:

Major hosts

Cocos nucifera (coconut), *Elaeis* spp., and *Elaeis guineensis* (African oil palm) (Giblin-Davis, 2001).

Minor hosts

Acanthophoenix rubra (barbel palm), *Agave sisalana* (sisal agave), *Agave americana* (American agave), *Aiphanes horrida* (= *A. caryotifolia*) (ruffle palm), *Ananas* spp. (pineapple), *Ananas comosus* (pineapple), *Areca* spp. (areca palm), *Areca catechu* (betel-nut palm), *Arecastrum plumosa*¹, *Arenga* spp. (arenga palm), *Arenga pinnata* (sugar palm), *Borassus* spp. (borassus palm), *Borassus flabellifer* (palmyra palm), *Caryota urens* (fish-tail palm), *Casuarina equisetifolia* (Australian pine), *Clinostigma samoense* (= *Cyphokentia samoensis*), *Colocasia* spp. (taro)², *Corypha* spp. (gebang palm), *Corypha umbraculifera* (talipot palm), *Corypha utan* (= *C. elata*) (buri palm), *Cyathea* spp. (tree fern), *Dictyosperma album* (red palm), *Dypsis pinnatifrons* (= *D. gracilis*), *Heterospathe elata* var. *palauensis*, *Hydriastele palauensis* (= *Gulubiopsis palauensis*), *Hyophorbe lagenicaulis* (= *Mascarena lagenicaulis*) (bottle palm), *Latania* spp., *Livistona* spp. (livistona), *Livistona chinensis* (Chinese fan palm), *Metroxylon* spp. (metroxylon), *Metroxylon amicarum* (= *Coelococcus carolinensis*) (Caroline ivory-nut palm), *Metroxylon sagu* (sago palm), *Musa* spp. (banana), *Normanbya* spp., *Nypa* spp., *Nypa fruticans* (nipa palm), *Oncosperma* spp., *Pandanus* spp. (pandanus palms), *Pandanus tectorius* (Tahitian screwpine), *Phoenix* spp. (date palm), *Phoenix dactylifera* (date palm), *Phoenix sylvestris* (wild date palm), *Pinanga* spp., *Pinanga insignis* (= *Pseudopinanga insignis*), *Pritchardia pacifica* (Fiji fan palm), *Raphia farinifera* (= *R. ruffia*) (raffia palm), *Raphia vinifera* (bamboo palm), *Roystonea regia* (royal palm), *Saccharum* spp. (sugarcane), *Stevensonia* spp., *Thrinax* spp. (thatch palm), *Verschaffeltia splendida* (Seychelles stilt palm), and *Wodyetia bifurcata* (foxtail palm) (Gressitt, 1953; Lever, 1979; Elfers, 1988; Giblin-Davis, 2001; Hail, 2010).

¹ This may refer to the species *Syagrus romanzoffiana* (queen palm) (Gressitt, 1953)

² Listed as a possible host in Gressitt (1953).

Pathogen or Associated Organisms Vectored

This species is not known to vector any pathogens or other associated organisms. However, adult burrows can provide access to secondary insects and pathogens that can kill the palm. Gressitt (1953) states that this species has been reported to spread

bud rot on coconut palms. Gressitt (1953) did not state whether *O. rhinoceros* vectored the pathogen or if the pathogen gained access to infect the plant through adult burrows. This disease is caused by *Phytophthora palmivora* (Srinivasulu et al., 2008).

Known Distribution

This species is found throughout Asia and the western Pacific (Giblin-Davis, 2001).

Africa: Mauritius, Mayotte, and Reunion; **Asia:** Bangladesh, Brunei, Burma, Cambodia, Chagos Archipelago, China, Cocos Islands, India, Indonesia, Japan, Laos, Malaysia, Maldives, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam; **Middle East:** Iran, Oman, Pakistan, and Yemen; **Oceania:** American Samoa, British Indian Ocean Territory, Federated States of Micronesia, Fiji, Guam, Niue, Palau, Papua New Guinea, Samoa, Tokelau, Tonga, and Wallis and Futuna (Lever, 1979; Bedford, 1980; reviewed in CABI, 1998; reviewed in Mohan, 2005; Schmaedick, 2005; Al-Habshi et al., 2006; Moore, 2007).

Status of Infestation in Guam (March 2013)

“In September 2007, an infestation of *Oryctes rhinoceros* was discovered along the beach of Tumon Bay in Guam. Since 2007, *O. rhinoceros* spread considerably from its original focus. Most of northern and central Guam is now infested. Through a combination of regulation, sanitation, and chemical and biological pesticides, the population has been suppressed. This supports the effort to prevent damage to palms in Guam and the movement of *O. rhinoceros* to other nearby island[s] and Hawaii” (T. McNary, personal communication, 2013).

Pathway

This species may have moved throughout the Pacific on host material. The larvae are also known to survive floating logs transported on ocean currents (Lever, 1979). Logs are cast into the sea when there is not a pronounced dry season and logs cannot be burnt, as in Western Samoa (Catley, 1969). The spread of *O. rhinoceros* throughout the Pacific was helped through the shipping of wartime equipment (Lever, 1979).

It is believed that this species was introduced into Guam by a gravid female hitchhiking on cargo from Asia (Moore, 2007).

This species has been intercepted 5 times at U.S. ports of entry. Live adults were found in all instances. Two interceptions originated from Indonesia, 1 from China, 1 from Malaysia, and 1 from Sri Lanka. Only one interception occurred on host material (*Cocos nucifera*) suggesting that this species can move as a hitchhiker pest (AQAS, 2012, queried May 16, 2012).

Potential Distribution within the United States

There are currently no available host or risk maps available for this species. According to USDA-NRCS (2012), the main host *Cocos nucifera* (coconut) is found in Florida, Hawaii, North Carolina, and also Puerto Rico and the U.S. Virgin Islands. *Phoenix* spp. (date palms) are found in Arizona, California, Florida, Hawaii, Massachusetts, and

Maryland, while *Elaeis* spp. (oil palms) are found in Florida. *Saccharum* spp. (sugarcane) are grown throughout all of the southern half of the United States as well as Hawaii, Puerto Rico, and the U.S. Virgin Islands (USDA-NRCS, 2012). According to the 2007 Census of Agriculture, there are four states that grow sugarcane for harvest, Florida, Hawaii, Louisiana, and Texas (USDA-NASS, 2009). All of these are non-native, introduced species (USDA-NRCS, 2012).

Note: USDA-NRCS (2012) may not list all states where host plant material occurs.

Survey

CAPS-Approved Method*: There are two CAPS-approved methods for *O. rhinoceros*. Visual surveys may be used to detect larval or adult populations. 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. *Oryctes rhinoceros* adults bore through developing leaves and cause V-shaped cuts that are very visible and distinctive (A. Moore, 2013, personal communication). This type of damage is often the first sign of an *O. rhinoceros* infestation. A V-shaped cut made by a rhino beetle is always associated with a large (2.5 cm (1 inch)) bore hole in the crown of the attacked palm (A. Moore, 2013, personal communication). The bore hole is not always visible without removing outer petioles. In Guam, surveyors often fell coconut palms (which are not very valuable) and dissect the crown to confirm damage by *O. rhinoceros* (A. Moore, 2013, personal communication).

IMPORTANT: Permission **must** be obtained by the property owner before performing any destructive sampling of the palms. This should not be considered unless the palm is highly suspect (shows obvious damage or is dying).

Trapping

1.1 Trap and Lure

There are two trap options for *O. rhinoceros* 1) vanned bucket trap (home-made or commercial) or 2) bucket trap (home-made or commercial). There are two lures needed to trap for *O. rhinoceros*: 1) an aggregation pheromone (ethyl 4-methyloctanoate) and 2) ethyl acetate. Both lures are required to report negative data for *O. rhinoceros*. The addition of a food bait is optional for this target. Pieces of decaying coconut material may be used as a food bait.

The ethyl acetate lures should be replaced every six weeks (42 days). Replacement time for pheromone lures is still being determined.

IPHS Survey Supply Ordering System Lure Product Names:

- 1) *Oryctes rhinoceros* Aggregation Lure **and**
- 2) Palm Weevil Lure, Ethyl Acetate

IPHS Survey Supply Ordering System Trap Product Names:

- 1) Vaned Bucket Trap **or**
- 2) Palm Weevil Bucket Trap

Note: Do not include lures for other palm pests in the same trap when trapping for *O. rhinoceros*.

1.2 Trap Construction

There are two trap types that may be used; both traps are available commercially. Traps may either be purchased or constructed on site. Traps should have the following features:

A. Vaned Bucket Trap

(from A. Moore, 2013, personal communication)

- Five gallon bucket; interior diameter at the rim should be 28.5 cm (11.25 in) (Figure 8).
- Vanes panels made out of 6 mm (~ 1/4 in.) thick corrugated plastic.
- Dimensions of panels:
 - Length of panel is 61 cm (24 in),
 - Maximum width of panel is 30.5 cm (12 in),
 - Hole cut in the panels for hanging lure: 8 cm (about 3 in) in diameter.
- The distance from the top of the bucket to the top of the vanes is 30 cm (12 in).
- Bottom part of the vanes should taper to fit in a 5 gallon bucket (Figure 7).
- Allow a 5 cm (about 2 in) clearance between the bottom of the vanes and the bottom of the bucket.



Figure 7. One of the trap vanes (Aubrey Moore, University of Guam)



Figure 8. One of the trap vanes (Aubrey Moore, University of Guam)

B. Bucket Trap

- 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 9).
- 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 10).
- A tight-fitting trap lid to prevent contamination of the trap contents.
- Trap lid with a loop for hanging the trap in trees.



Figure 9. Homemade bucket trap covered with burlap (Image courtesy of Amy Roda, USDA-APHIS).



Figure 10. Homemade bucket trap with entrance holes (Image courtesy of Amy Roda, USDA-APHIS).



Figure 11. Lid of homemade bucket trap with hanging lure (Image courtesy of Amy Roda, USDA-APHIS).

1.3 Food Bait Preparation

Decaying coconut material may be used in addition to the two lures. Using the food bait has been shown to increase trap catches but it is optional. Place the decaying coconut material (about 7 L or three pieces of coconut wood measuring 6 cm thick x 30 cm diameter ($2\frac{3}{8} \times 11\frac{13}{16}$ in), cut up) in the bottom of the trap (Allou et al., 2006). Liquid

is not needed in the trap; *O rhinoceros* is not prone to escaping traps (A. Moore, 2013, personal communication).

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, telephone poles, or other vertical structure within 30 meters (100 feet) of a host tree.

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.

Survey Site Selection:

Areas with host plant material should be targeted. Nurseries as well as residential or public areas where host palms are used as ornamentals should be targeted for survey. Sugarcane and coconut plantations may also be surveyed for this species. *Oryctes rhinoceros* attacks palms of all ages (A. Moore, 2013, personal communication).

Time of year to survey:

This species is found year round in its current distribution. In Yemen, peaks in the population occur around March (Al-Habshi et al., 2006). In Guam, flight activity peaks are correlated with the full moon (Moore, 2012).

*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/>.

Key Diagnostics/Identification

CAPS-Approved Method*: Morphological.

Descriptions of the life stages can be found in Gressitt (1953). A key to *Oryctes* species can be found in Endrödi (1985).

*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

Oryctes rhinoceros larvae are similar to other larval species in the scarabeid family, including *Oryctes centaurus*, *Oryctoderus* sp., *Scapanes australis*, *Trichogomphus fairmairei*, and *Xylotrupes gideon*. A key to differentiate the larval stages of these species can be found in Bedford (1974).

Mohan (2005) states that this species is similar to *O. boas* (rhinoceros beetle) and *O. monoceros* (coconut beetle), both of which attack *C. nucifera* (coconut) (Gressitt, 1953). *Oryctes gnu* (= *O. trituberculatus*) is also similar but larger than *O. rhinoceros*. *Oryctes*

gnu has three tubercles on the thoracic ridge whereas *O. rhinoceros* has two (CABI, 2008). None of these species are known to occur in the continental United States.

Some species in the tribes Oryctini and Dynastini may be confused with *Oryctes rhinoceros*. In North America, only seven species in the Oryctini tribe occur: five species of *Strategus* and two species of *Xyloryctes* (R. Brown, 2013, personal communication). Some species in the Dynastini tribe, particularly females, could be confused with *Oryctes rhinoceros* (R. Brown, 2013, personal communication).

A genus level key to Dynastinae found in North America can be found in Ratcliffe (2002), while an interactive key to subfamilies and tribes of Scarabaeidae in the New World can be found in Villatoro and Jameson (2001). Neither includes *Oryctes* spp., but these keys may be useful in sorting out non-targets.

More information on *O. rhinoceros* and similar species in the genus can be found in Dechambre and Lachaume (2001). More information on similar Dynastidae species can be found in Lachaume (1999).

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