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Damage assessment of *Oryctes rhinoceros* Beetle (*Oryctes rhinoceros* Linn) and its host range in selected sites in the Philippines

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Abstract

The study was conducted to determine the extent of damage and host range of *O. rhinoceros* in different coconut areas in the Philippines. Using the five criteria based on Bedfort assessment, at least 50 coconut palms in one hectare were randomly selected and replicated three times from selected provinces in Luzon, Visayas and Mindanao. Results revealed that there were at least considered alternate host of *O. rhinoceros*; such as buri (*Corypha elata*), anahaw (*Saribus rotundifolius*), oil palm (*Elaeis guineensis*), nipa palm (*Nypa fruticans*), betel nut (*Areca catechu*), banana (*Musa* spp.), pineapple (*Ananas comosus*), papaya (*Carica papaya*), and Colocasia (*Colocasia* spp). Moreover, the most affected other host plant were African oil palm, particularly in Palawan and Davao del Sur sites where this is periodically planted as replacement for sugarcane, banana, coconut palm and forest areas.

The percentage of infested coconut palm based on the leaf damage caused by beetle was found ranging from 6.47 to 10.67%. Among the coconut fields surveyed, Goa, Camarines Sur site got the highest percentage of damage with 10.67% followed by San Francisco, Quezon (8.79%) Ragay, Camarines Sur, Baler and Dingalan, Aurora, Lopez, Quezon with 8.68%, 8.45%, 8.19%, and 7.53% respectively. In contrast, relatively low percentage of damage was recorded in Buenavista, Marinduque with 6.47%. In terms of leaf damage category, the highest was also observed in Goa, Camarines Sur with 2.01 followed by Baler Aurora and Padada, Davao del Sur with 1.89. The same category were observed in Dingalan, Aurora and Aborlan, Palawan with 1.87 while the lowest damage category was recorded from Valencia, Negros Oriental with 1.83. Attacks on coconut palms were not shown any danger on the plants.

Keywords: Beetle; Coconut; Host range; *Orytes rhinoceros*; Philippines

1 Introduction

The coconut tree (*Cocos nucifera* L.) also known as the coconut palm is grown in 92 countries of the tropics, where it is used as a source of food, oil production, and construction materials. About 25 percent of cultivated land of the country is planted to coconut trees, and it is estimated that between 25 percent and 33 percent of the population is partly dependent on coconuts for their livelihood (Magat, 2014). Worldwide, about 83% of the coconuts are produced in Asia where Indonesia is the largest producer with 3.8 million ha that produce about 18.3 million (35%) tons of nuts, followed by Philippines with an area of 3.5 million ha and production potential of 15.35 (30%) million tons of nuts. India on the other hand has an area of 2.1 million ha producing only about 11.9 (23%) million tons of nuts (FAOSTAT, 2014).

Out of 25% of cultivated land planted with coconut trees only about 68 out of 79 provinces are planted with coconut palms, Mindanao accounts for 59.8% of total nut production followed by Visayas (34%) and Luzon (20%), thus an estimated 33% of Filipinos are directly or indirectly dependent on coconuts for their livelihood. About 85% of coconut

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major production is exported in the form of copra meal/cake, coconut oil, desiccated coconut and oleochemicals (Dayrit, 2007). Other products include coconut water, vinegar, coir, coconut husk, beverage, sugar, alcohol, trunk used for construction, and handicrafts.

Despite the potential use of coconut, farmers are still suffering losses due to low prices, declining yields, and decreasing farm productivity. These problems are ascribed to aging palms, natural calamities such as drought, typhoons, and biotic stress that includes rodents, diseases and insect pests. Among the insect pests that upset coconut yield, coconut rhinoceros beetle (*O. rhinoceros*) is considered a major factor (Kumara et al., 2015) and remains one of the most destructive pests of coconut palm in the country and Southeast Asia. Adults of this pose major damage to coconut plants and other palm species. They feed on healthy leaves causing physical damage resulting in stunted growth and subsequently lead to secondary infections from bacteria or fungi (Bedfort, 1980).

In the absence of biological and/or chemical control methods, *O. rhinoceros* became increased its population size to the point that it became difficult to control. In spite of the danger that *O. rhinoceros* is likely to present for the future of coconut palm culture in the region might be neglected.

Relatively, this study aims to document the extent of damage and determine the host ranges of *O. rhinoceros* as destructive pest of coconut palm trees in the Philippines. The result of the study will generate new information and valuable data on the extent of damage and host plants imperative for an effective area-based pest management program as well as an invaluable contribution towards the field of entomology.

2 Material and methods

2.1 Study Sites

The study was conducted from coconut plantations in five provinces (Aurora, Quezon, Camarines Sur, Marinduque, and Palawan) in Luzon, one (Negros Oriental) in Visayas, and one (Davao del Sur) in Mindanao. Prior to the conduct the study, written permission was obtained from the respective local Philippine Coconut Authority and other authorities regarding the status of *O. rhinoceros* infestations in the area. Two (2) municipalities with coconut rhinoceros beetle infestations were chosen as experimental sites where collections of data on the extent of damage and presence of host plants of the insect. From every site identified, at least 50 coconut palms were assessed for infestations and this was replicated three times. The host ranges of the beetle, like other palm plant and non-palm species, were also determined by observing their presence and the damage caused by the beetle.

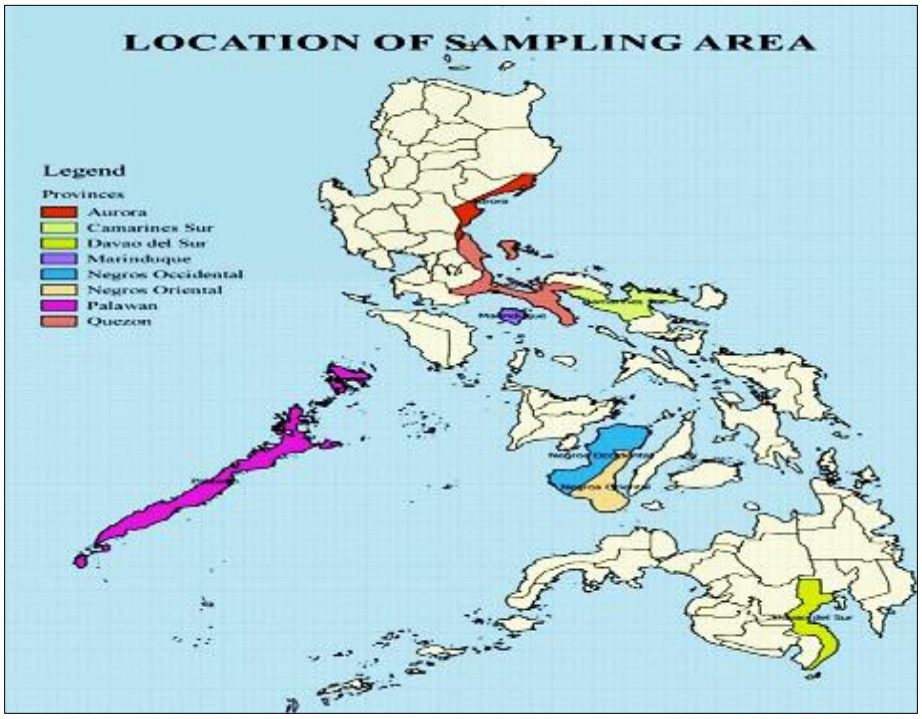

Figure 1 The study sites are shown in colored portion of the Philippines map.

2.2 Damage Assessment

Five criteria were used to determine the level of palm damage based on Bedfort (1980) assessment. At least 50 coconut palms in one (1) hectare were randomly selected and replicated three (3) times from every site. Observation of each coconut palm was taken during the evaluations and assigned a grade according to the damage levels including the age of sampled plants. These levels were described:

- No damage;
- Slight damage (with 1–15 percent of palm leaves removed);
- Moderate damage (between 16–30 percent of palm leaves removed;
- Severe damage (31–80 percent of palm leaves removed); and
- Unrecoverable and dead palms (81–100 of palm leaves or crown removed).

3 Results and discussion

3.1 The Extent of Damages caused by *O. rhinoceros*

The coconut rhinoceros beetle is widely distributed across the country (Table 1) and was present in most fields surveyed. Adulthood is a destructive stage. The adults bore into the crown of the palm resulting in wedge-shaped or "V" cuts (Figure 1) in the fronds that unfurl and feed on tissue juices and the crushed fiber (Figure 2) on the affected plant part was pushed outside the entrance hole, indicating the insect's presence.

Table 1 The assessment of damages and assigned category as affected by *O. rhinoceros* including the average age of coconut plant from selected sites in the Philippines form January 2020 to December 2020.

Province	Municipality	Average % damaged	Damage category
AURORA	Baler	8.38	1.88
	Dingalan	8.19	1.87
QUEZON	San Francisco	8.79	1.86
	Lopez	7.53	1.78
MARINDUQUE	Buenavista	6.47	1.70
	Boac	7.15	1.85
PALAWAN	Aborlan	7.72	1.87
	Puerto Princesa	6.92	1.85
CAMARINES SUR	Goa	10.67	2.01
	Ragay	8.68	1.85
NEGROS ORIENTAL	Valencia	7.43	1.83
	Bacong	7.47	1.86
DAVAO DEL SUR	Matanao	7.15	1.85
	Padada	7.09	1.89

During the rapid survey, the percentage of leaf damage caused by beetle was found ranging from 6.47 to 10.67%. Among the coconut fields surveyed, Goa, Camarines Sur site got the highest percentage of damage with 10.67% followed by San Francisco, Quezon, Ragay, Camarines Sur, Baler and Dingalan, Aurora, Lopez, Quezon with 8.79% 8.68%, 8.38%, 8.19%, and 7.53% respectively. In contrast, a relatively low percentage of damage was recorded in Buenavista, Marinduque with 6.47%. Only few numbers of damaged coconut were found unrecoverable.

In terms of leaf damage category, the highest was also observed in Goa, Camarines Sur with 2.01 followed by Padada, Davao del Sur (1.89), and Baler, Aurora (1.88). The same category was observed in Dingalan, Aurora and Aborlan,

Palawan with 1.87 while the lowest damage category was recorded in Buenavista, Marinduque with 1.70. These results show that the damages caused by *O. rhinoceros* to all studied coconut areas belonged to slight category, which indicates that the coconut palm can survive the effects of the beetle attack and would not cause any severe reduction on coconut yield.

As supported by Ramachandran et al. (1963), a loss in yield of 5.5% to 9.1% due to beetle attacks from artificially pruned leaf damage simulation of studies and damage to 50% fronds corresponds to leaf area reduction of 13% and decrease in nut yield by 23%. This findings is also supported by Samsudin et al. (1993) that this was possibly caused by the reduction in the canopy size of more than 15% for moderately serious to higher damage levels. Moreover, Zelany (1979) described that an average of 10% damage to fronds by cuts resulted in a 3% reduction of the leaf area and a 4-5% loss of nut production. Similarly, 30% of fronds destroyed resulted in a 7% decrease in the leaf area and 13% nut yield reduction (Bedford, 1980 & Wood, 1968).

Figure 2 Damage characteristics done by the coconut rhinoceros beetle, *O. rhinoceros*, showing V or wedge-shaped sections missing from the fronds eaten by the adults as they tunnelled into the crowns of mature palms.

Figure 3 Crushed fiber pushed outside the entrance hole indicating damage by adult *O. rhinoceros* in young coconut palm.

In this study, these percent of damage and category may change over time, depending on the factors affecting their infestation, including the source of the adult populations, breeding areas and environmental condition. This result was attributed to the breeding sites observed in the study areas such as abundant decomposing fallen coconut logs and other organic materials where large numbers of different larval stages were seen.

In geographic regions where both coconut and the beetle are indigenous, the common pest caused minimal damage. In contrast with areas where the coconut is native, the beetle is invasive. The loss can be extreme and ultimately lethal for the trees. In an area with no natural enemies of this beetle, the damage can be extreme. In Palau, where the beetle first invaded in 1942, the coconut palm was eradicated entirely on some islands, with overall mortality across the archipelago reaching 50% (Marler, 2018). To avoid the spread of this insect, regulatory control such as establishing a quarantine facility to eliminate the movement of export of coconut-based materials like coco coir and coco coir dust and reduce human assisted spread of *O. rhinoceros*. Untreated host material from within the quarantine area would be prohibited from moving outside the country wherein this insect is not known, except under a permit issued by plant quarantine of the importing country.

Camarines Sur and Baler coconut areas with high percentages of damage were regularly visited by typhoons particularly during the last quarter of the year. This factor found to contribute to the outbreak were the presence of undisposed felled and damaged palm trunks and other debris, which served as breeding places for the pest under favorable conditions at certain times of the year. Results from the study of Pille (2016) in Leyte, Philippines revealed that the damage reached the highest percent incidence and percent severity (68%) caused by beetle after the Typhoon Yolanda. These findings are also supported by Catley (1969) and Bedfort (1976, 1980) who proved that the adult beetles can deposit their eggs in various substrates, typically rich in decomposing plant material that is found at the base of palm

fronds or in piles on the ground that the larvae then feed upon. Furthermore, Pille (2016) tested and assessed different organic waste substrates such as sawdust (control), corn cobs, rice straw, decaying vegetables, decomposing banana stumps and leaves, and animal manure as *O. rhinoceros* attractant in log traps. Giblin-Davis (2001) also indicated that one factor that can contribute to infestation is the location of palm populations near the dumping site for left-over coconut logs.

In one of the areas in Davao City, the coconut palms were found adjacent to Cavendish banana plantations and were noted to be heavily infested by the coconut rhinoceros beetle. These palms might be killed as a result of the repeated attacks by the beetles by destroying the growing point of the palm. The coconut palms between 5 and 10 years old found near the piled decomposing pseudo-stems might serve as breeding sites for the beetle. This condition can contribute to the increase in beetle populations resulting in frequent attack to the plants. According to Wood (1968), in young palms where the spears are narrower, penetration may occur lower down and the effects of damage can be much more severe than in older palms. The immature palms affected by beetles are believed to have a delayed immaturity period (Liau & Ahmad, 1991) and the general photosynthetic activity of the tree diminishes or completely halts nut production. Additionally, the damage caused by beetle may offer entry points for secondary attacks by the palm weevil or by pathogens.

The level of damage incidence of the coconut rhinoceros beetle to coconut palm might be affected by climatic conditions. According to Catley (1969), correlation was found between the beetle larval population and average rainfall on the incidence of the beetles and palm damage. With superior and improved larval diet combined with suitable temperatures, the duration of the larval stages can be shortened from 6 to 5 months (Sharma & Gupta, 1988). Similarly, Wood (1968) demonstrated that the larvae required about 5-7 months to mature in palm log tissue, while a shorter maturity period of 4-5 months was observed in a habitat mixture of cow dung and sawdust. Bedfrort (1980) confirms that the conditions suitable for larval development are temperature (27-29°C) and RH 85-95%. In this foregoing study, the average temperature, relative humidity and rainfall of all sites were within the range of the requirement for the *O. rhinoceros* growth and development. This means that the damage caused by beetle were not only affected by the climatic condition but by the presence of favorable food supply.

Figure 4 Damage by adult coconut rhinoceros beetle on young and matured coconut palm observed during rapid damage assessment on select coconut areas in the Philippines.

Figure 5 Unrecoverable coconut palm caused by beetle damage. This photo was taken in Boac, Marinduque and San Francisco, Quezon.

3.2 Identified Host Plants of *O. rhinoceros*

Field surveys and observations conducted from January 2020 to December 2020 showed that the insect pest was found from different sites on wild host crops growing in and around the coconut plantation ecosystem. In this study, the presence of possible hosts for *O. rhinoceros* in the area was determined. As shown in table 2 and figures 6 to 9, host plants were African oil palm (*Elaeis guineensis*), nipa palm (*Nypa fruticans*), fan palm (*Saribus rotundifolius*), *Alocasia* spp., pineapple (*Ananas comosus*), betel nut (*Areca cathechu*), buri palm (*Corypha elata*),banana (*Musa* sp.), and papaya (*Carica papaya*).

All the identified host plants were found in all areas except oil palm, which was not present in three sites (Table 2). Among the identified host plants, only four species such as betel nut palm, fan palm, buri palm and African oil palm were found affected by *O. rhinoceros* through the presence of physical damage. The most affected palm species was noted in African oil palm by *O. rhinoceros*, particularly in Palawan and Davao del Sur sites where this palm species is being periodically planted as replacement for sugarcane, banana, coconut palm and other forest species in the said areas.

Table 2 Surveyed and identified host plants of *O. rhinoceros* observed from the different coconut areas in the Philippines January 2020 to December 2020.

Host Plants	Aurora	Quezon	Marinduque	Palawan	Camarines Sur	Negros Oriental	Davao del Sur
Buri *(Corypha elata)*	/	/	/	/	/	/	/
Anahaw *(Saribus rotundifolia)*	/	/	/	/	/	/	/
Betel nut *(Areca cathecu)*	/	/	/	/	/	/	/
African Oil palm *(Elaeis guineensis)*	-	-	-	/	/	/	/
Nipa *(Nypa fruticans*)	/	/	/	/	/	/	/
Banana *(Musa sapientum)*	/	/	/	/	/	/	/
Pineapple *(Ananas comusus)*	/	/	/	/	/	/	/
Alocasia spp.	/	/	/	/	/	/	/
Sugarcane *(Saccharum tuberosum)*	/	/	/	/	/	/	/

(-) not present; (/) present

Meanwhile, no damage or injury was observed from other possible host plants such as sugarcane, banana, pineapple, papaya, nipa palm and *Alocasia* spp. Betel nut palm, fan palm and buri palm have been reported as alternate hosts for this pest. However, only one (1) of the mentioned palms was found infested with *O. rhinoceros* based on the damage observed. This implies that the injury or infestation caused by *O. rhinoceros* was more concentrated on coconut and African oil palms. Damages to these plants were caused by adults and not by the larvae, which feed on young plant material (Giblin-Davis, 2001). According to the report by Bedfort (1980), there were 29 host genera known to be attacked readily by this beetle in case there was a scarcity of the preferred host, majority of which were palms (family Arecaceae) such as royal palm (*Roystonea regia*), buri palm (*Corypha elata*), betel nut, (*Areca catechu*) oil palm (*Elaeis guineensis*), sago palm (*Metroxylon sagu*), palmyra palm (*Borassus flabellifer*), fan palm (*Corypha umberaculifera*), nipa palm (*Nipa fruticans*), and Fish tail palm *Oncosperma tigillaria*) (CABI, 2015). Other ornamentals such as the latanier palm (*Livistona chinensis*), and the raphia palm (*Raphia ruffia*) were also attacked by the same pest (Khoo et al., 1991).

On the other hand, it was recorded that *O. rhinoceros* occasionally damaged banana (Sharma and Gupta, 1988), sugarcane, papaya, sisal, and pineapple (Khoo et al., 1991). Although banana plants were abundant in all visited sites, no symptoms of damage were noticed. As indicated in the study of Sivakumar and Mohan (2013), attacks on banana by this pest have been noticed both in mono-cropping as well as intercropping under coconut since 1950s in India. The adult beetle was found boring into the stems of banana plants, and this was the first detailed report on the occurrence, extent of damage, and varietal preference of *O. rhinoceros* on banana in India. This implies that the coconut rhinoceros beetle preferred coconut and oil palm as their main hosts. If coconut and oil palm were adjacent in the area, they rarely attacked other palms. In Malaysia and other countries with oil palm plantations, this beetle was considered as a significant pest as cited by Manjeri, et al. (2014) and created a constant dilemma faced by oil palm planters. Thus, the beetle attacks resulted in loss of productivity, irreversible damage to plants and lead to plant death.

Figure 6 African oil palm and damage on the leaf by *O. rhinoceros* during the survey in Matanao, Davao del Sur.

Figure 7 (a) Nipa palm as host plant of *O. rhinoceros* in Baler, Aurora; and (b) fan palm in Pili, Camarines Sur.

Figure 8 (a) *Alocasia* spp. and (b) Pineapple crop intercrop with coconut in San Francisco, Quezon, Province.

Figure 9 (a) Betel nut (*Areca* sp.) shown a damage caused by *O. rhinoceros* at Pili, Camarines Sur; and (b) Buri's palm (*Corypha elata*) in Aborlan, Palawan.

4 Conclusion

Based on the results and analysis of findings, the followings conclusion were deduced:

- For the host range of *O. rhinoceros*, only those families that belonged to Arecaceae were considered as alternate hosts for these insects and the most affected other host plant was African oil palm in Palawan and Davao del Sur.
- Based on the rapid survey, the level of damage and category of an infestation are considered of non-importance to the coconut farmers particularly on the yield effect. Infestations on young plants should be controlled physically at lower levels than later infestations to achieve the same economic result.

Compliance with ethical standards

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