

BIOLOGY OF COCONUT TREE PEST *ORYCTES RHINOCEROS* (L.)

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**ABSTRACT** Palms are important crops in the tropics. The coconut palm (*Cocos nucifera*) produces nuts which is used directly for food or the contained copra may be crushed to yield coconut oil. The Rhinoceros beetles (Scarabaeidae, Dynastinae) are important pests of palms. Attacks by adults may reduce yield, kill both seedlings and old palms and discourage replanting. Now a days *Oryctes rhinoceros* is an important pest attacking young oil palms in Asia and it cause significant damage on coconut oil palm bringing severe reduction in nut production. The morphological and biological characteristic of *Oryctes rhinoceros* was done in the captive rearing and observed systematically. The morphological and developmental process of *Oryctes rhinoceros* fed with the mixture of cow dung and saw dust under the laboratory conditions  $28 \pm 1^\circ\text{C}$  were recorded. The body weight and length at various developmental stages were measured. It undergo complete metamorphosis and has four developmental stages (Egg, Grub, Pupa and adult) in the whole life period.

**KEYWORDS :** *Oryctes rhinoceros*, larval period, Grubs development, moulting.

**INTRODUCTION:**

The rhinoceros beetle *Oryctes rhinoceros* (Coleoptera: Scarabaeidae: Dynastinae) is an important invasive pest of coconut palms ranging from the Middle East and South East Asia where it is endemic, to the South Pacific where it has been accidentally introduced into island groups such as Fiji (Bedford, 1976, 1980). Adults eat the leaves and burrow into the crown, stunting plant growth (Giblin-Davis 2001). An adult bores a hole into the heart or crown of the palm to feed on the sap, damaging the very immature fronds so that when they later unfurl they show characteristic V or wedge-shaped cuts, reducing photosynthetic. The coconut rhinoceros beetle (CRB) is a major pest of coconut palm, oil palm and other palm species. Tree mortality occurs when beetles destroy the growing tip or meristem. Grubs do no damage. They feed on dead, decaying vegetation in breeding sites. It occurs throughout Southeast Asia and was accidentally introduced into the south pacific countries like Western Samoa (1909), American Samoa (possibly 1912), Fiji (1952), Tonga (1961), Tokelau Islands (1963), Wallis Island (1931), Palau (1942) and Papua New Guinea (1942). Adults fly to the central crown of the coconut palm, crawl down the axil of a young frond and bore through the heart of the palm into the unopened fronds, which unfold later, revealing tattering and v-shaped cutting of the leaflets. These infestation results in reduce yield, kill both young and old palms if heavy and repeated and provides entry points for lethal secondary attacks by other pests and diseases. As a consequence, the attacks discourage farmers from replanting. The eggs are laid and the larvae develop and pupate in the tops of dead standing palms, decaying trunks of coconut and other wood, and heaps of sawdust, compost, manure and other decomposing vegetable matter. *Oryctes* biology, ecology and control have recently been reviewed (Bedford, 1980). It occurs from India and Ceylon eastwards throughout. South East Asia, and also has been accidentally introduced into a number of south Pacific islands (Catley 1969). *O. rhinoceros* grub feed on decaying vegetarian and do no economic damage. They usually are found in dead standing coconut palms, fallen coconut logs, and rotting coconut stumps. Grubs feed only on decaying vegetarian and usually are found in dead standing coconut trees and decaying coconut debris on the ground (Moore *et al.*, 2015).

An ecological study on insect larvae life is limited and has not been widely investigated, in particular on the information on the density and composition of the *O. rhinoceros* stage that occupy the nest (breeding sites) in nature. There is a close relationship between the compositions of the media with the density *O. rhinoceros* in soil habitat. *O. rhinoceros* highest density was found on the ground composed of media from manure and straw or trash. According to Marlina *et al.* (2015) there are some microorganism's play the role on the decomposition of waste the organic compound on the waste is transformed into simple molecules which is beneficial for the availability of nutrients for animals that live in the soil. The nutritive

complex serves as a source of nutrients for the development of the larval stage of *O. rhinoceros*. Rotten organic materials pose a distinctive odor as a result of the volatile chemical compounds. The smell of these chemical compounds attracts the female grubs as a sign of feeding stock so the insects will immediately lay eggs there.

**MATERIALS AND METHODS:**

*O. rhinoceros* were collected from coconut plantation area of Thondamuthur village located in Coimbatore District, Tamilnadu State, India. The light trap which was used in this study and uses a lamp producing white light at 200 watts. A collection jar was attached to the light trap structure to collect all attracted *O. rhinoceros* beetles. Apart from that the *oryctes* grubs were collected from the compost, rotten palm wood and saw dust. These are the primary sources of my study. The study was conducted in Government Arts College in Coimbatore District, Tamilnadu State. Breeding one male and one female beetle were confined together in a wooden box of dimensions  $18 \times 18 \times 25$  cm. The lid was a wooden frame covered with strong wire mesh. The box was two-thirds filled with rotted sawdust as the oviposition medium. Two pieces of sugar cane were placed on the surface as the food for the adults and were renewed twice weekly. These female beetles laid eggs in nature prior for the purpose of collection.

Eggs were collected with pigeon quill feather and sterilized with 2% alcohol with two times. The eggs were sterilized and inoculated to the medium and it used with cow dung and saw dust. Cow dung and saw dust are taken in the ratio of 3:1 with the help of 750 grams of measuring jar. The rearing tank with the size of 19.4 cm length, 16.5 cm width and 11.4 cm height. The cement rearing tank top was closed with wire nets to prevent the eggs and grubs from predators and aeration. The temperature of the room was  $28 \pm 1^\circ\text{C}$ . The egg hatching and the grubs were observed for every 24 hrs in daily basis from the time of introduction into the rearing tank. The eggs were weighed, the length, weight and developmental time of grubs, pre-pupa, pupa and adults were done regularly.

**RESULTS AND DISSCUSSION**

*O. rhinoceros* life cycle contains full metamorphosis. The grub stages are usually whitish in colour and it turned to yellowish colour pupal stage and it turned to brown coloured adult. The results are tabulated in the tables.

**Table: 1 - Duration of immature stages of *O. rhinoceros* developmental stages**

Stage	No. of specimen	Duration period in days (mean)	Range
Egg	30	9±2.261	8 -12 days
G1	30	13.7±3.86	12 - 19 days
G2	30	17.9±2.424	15 - 21 days

G3	30	123.3±13.744	90 – 126 days
Pre - pupa	30	9.8±2.573	7 – 18 days
Pupa	30	32.8±4.826	26 – 40 days

**Eggs:**

Newly laid eggs are very soft, whitish in colour and oval in shape. Later after a week the eggs are turn to harden. It was taken 8 to 12 days for hatching. The availability of organic materials as food and abundance of nutrients strongly support the existence of *O. rhinoceros*, pile of rotting wastes, rotting palm plant are suitable place for insects breeding (Yustina *et al.*, 2012). According to More (2013), manure or compost, rotten palm wood, and sawdust is best breeding ground for *O. rhinoceros* grub. Also, female *O. rhinoceros* lays her eggs in garbage piles, decayed leaves, dry leaves, and wood debris (Bedford 2013; Wan *et al.*, 2009). According to sanders *et al.* (2015), *O. rhinoceros* female beetle will lay eggs in a hidden place rich in organic materials. Eggs were whitish brown and 3 to 4 mm (Giblin-Davis, 2001). Eggs are initially soft and oblong but swell into a rubbery circle four to five days after being laid (Hinckley, 1973).

**Grubs:**

The grubs are very soft in the first instar, the membrains are very thin and transparent and it looks like whitish yellow in colour. Then the membrain got stronger in 3<sup>rd</sup> instar compared to 1st instar. Very thin newly hatched grubs are arrived from the eggs, it may take 12 to 19 days for the development. First instar grubs are 3.5mm to 6mm length and 0.62 to 0.68 grams in weight. After 1<sup>st</sup> moulting the grubs turned to 2<sup>nd</sup> instar, in this stage the grubs are moderate in size around 3 to 4 grams weight and 20 to 35mm in length, but it taken 15-21 days developmental duration after that it goes to 2<sup>nd</sup> moulting.

**Table: 2 – Developmental stages and morphological difference of *Oryctes rhinoceros***

S. No.	Stage	Developmental Duration	Length (mm)	Weight (g)	Season
1.	Egg	9 ± 2.261 d	-	-	Summer
2.	Grub 1	1 3.7 ± 3.86 d	4.098 ± 0.174	0.64 ± 0.021	Summer
3.	Grub 2	17.9 ± 2.424 d	28.50 ± 0.269	3.78 ± 0.195	Summer
4.	Grub3	123.3 ± 13.744 d	65.04 ± 0.419	12.30 ± 0.20	Summer
5.	Pre pupa	9.8 ± 2.573 d	55.50 ± 0.56	10.40 ± 0.128	Summer
6.	Pupa	32.8 ± 4.826 d	50.68 ± 0.64	9.58 ± 0.44	Winter
7.a	Male	36.2 ± 0.720 d	38.48 ± 0.66	3.84 ± 0.32	Winter
7.b	Female	37.8 ± .058	40.30 ± 0.84	4.18 ± 0.22	Winter

In this 3<sup>rd</sup> instar grubs are got maximum weight and length 11.5 to 13 grams and 60 to 72 mm length respectively. In this stage the grubs are “C” shaped and ventral part of the body was bluish grey colour. After 3<sup>rd</sup> moulting occurs the grubs turned to pre-pupal and pupal stage. Early pupal stage contains non feeding stage, slightly yellowish in body colour, and outer cuticle getting strong than the grubs cuticle. It was taken 7 – 18 days retain in the pre-pupal stage. In this stage 10 to 12 grams weight and 50 to 59 mm in length.

Plate: 15. Life Cycle of *Oryctes rhinoceros*



Newly hatched larvae are 7.5 mm long (approx. 5/16 in) (Lever, 1979). “The large (60 to 105 mm long [approx. 2 3/8 to 4 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). 1<sup>st</sup> Larval instars are differentiated by the size of their head capsules (Gressitt, 1953). 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).

**Pupae**

Pupal stage was a middle stage for getting full metamorphism occurs and beginning for adult stage. In this stage pupa body turned from yellowish orange to yellowish brown and in this stage sclerotization of exoskeleton occurs. After the sclerotization the larval soft nature of body turned to hard beetle. Maximum of the adult structures are detected. For this changes taken around 26-40days, its weight 8.5 to 10.5 grams and 48 to 55mm in length.

“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 9/16 to 2 in] long, 19-23.6 [approx. 3/4 to 15/16 in] wide, and 16 to 19.4 [approx. 5/8 to 3/4 in]. 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)

**Adult:**

Adults are black in colour, and it has horn backward curved in both male and female, in male little longer horn than female. In this stage takes 30 to 37days developmental duration, its weight 3 to 4 g and length 35- 44mm was observed. Some reddish fine pubescence on the ventral side was observed. It seen more in female than male.

Adults range from 30 to 57 mm (approx. 1 3/16 to 2 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).

According to Moore *et al.* (2015), *O. rhinoceros* is a major pest of the coconut palm. Adult beetles bore into crowns to feed on sap. The adults will be in the top of coconut tree to mate and eat. Female beetle will fall from a coconut tree to lay eggs on the ground which content by the organic material until the end of the Pupal stage (Moore, 2012). The existence of the past will be difficult to detect because the larvae live in the soil together with the rest of the rotten coconut plant stems (Indriyanti *et al.*, 2015). *O. rhinoceros* larvae or grub will hide in substrates that contains lots of 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 non-feeding pre-pupal stage lasting 8 to 13 days before pupation occurs (Schmaedick, 2005).

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) (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).

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 3/16 x 1 3/8 x 1 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. 3/4 to 19 11/16 in), averaging around 21 cm (approx. 8 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).

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.

Adult females deposit eggs inside dead palms, decaying plant material, soil with high organic matter content, and, occasionally, wooden structures (Manjeri et al. 2014). In approximately 11 days, eggs hatch into larvae which begin feeding on surrounding organic material. Eleven to 15 weeks later, the larvae will have grown up to 16 times larger and have stopped eating, after which they enter the pupal stage and are immobile for approximately six weeks (Hickley, 1973). Upon emerging, adults fly to a new tree, feed, and mate, sometimes mating just after their first feeding. Adults spend most of their time feeding on fresh leaves. Adult females live up to nine months, over which period they can lay up to 100 eggs. Thus adult progeny may be present with the mother and the population consists of overlapping generations (Manjeri et al. 2014). Multiple overlapping generations are common under favorable conditions, e.g. when no diapause is needed. Since coconuts occur in regions where there is no cold season and a minimal dry season, the beetles can be active and reproductive throughout the year.

## CONCLUSION:

*Oryctes rhinoceros* is an important pest of coconut palm plants in India. Its biological studies are the basis of selecting pest prevention and control technologies. The results of this study may provide a foundation for *Oryctes rhinoceros* control.

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