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PHYSICAL AND BIOTIC FACTORS WHICH EXERT A CHECK
ON THE POPULATION DENSITY OF ORYCTES RHINOCEROS
LINNAEUS IN INDIA

by

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*Free
incidence
wholly in all places
known.*

From time immemorial, the rhinoceros beetle, Oryctes rhinoceros L., has been recorded as a pest of coconut palm in its Asiatic homes particularly within the tropical and sub-tropical belts of the oriental region. But it is a well known fact that the population density and the severity of infestation of this beetle is more marked and widespread in the Oceanic islands where it had been introduced accidentally than in their original habitat. This reduction in severity of infestation in the main land home is due to the lesser population density of the pest which can be attributed mainly due to the suppression of pest multiplication by the physical as well as biotic factors associated with the breeding sites of the beetle. India being a part of the original home of the pest and the fact that in India the beetle breeds under a diversity of conditions from the sea coast to the far interior and from sea level up to more than 900 metres elevation the chances for the occurrence of natural control factors, both physical as well as biotic, are greater. Besides in India, since the beetles breed in various kinds of decomposing organic matter, the chances for the association of different species of fauna and flora with the different stages of the pest are also more and many of these faunal as well as floral co-habitants under varied conditions may also act as controlling factors of the pest population.

An intensive exploratory survey and concurrent evaluation of the natural physical as well as biotic factors responsible for the suppression of oryctes in India was the object of the study. The venue of the survey was restricted mainly to coconut tracts and to a lesser extent palmyrah gardens in some of the coconut growing states in the main land as well as some of the Islands in the Lakshadweep and Andaman Nicobar groups.

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Review of literature

The earliest report on biological control agents from India was that of Pillai (1923) who recorded a dipteran parasitising the larvae of *Oryctes* in Kerala. Gressitt (1953) in his monograph "The coconut rhinoceros beetle" presented an admirable review up to the year 1953 on all aspects of rhinoceros beetle problems as it exists in all areas throughout the world where the beetle is present. There, in his studies on the invertebrate co-habitants in the breeding and feeding sites of oryctes in Palau Islands he recorded *Pseudozaena tricostata* Montrouzier, *Morion Orientalis* Dejean (Carabidae) as predators, the adult of the former and the adult and larvae of the latter are predacious on the eggs and early stage larvae of oryctes. *Leptochirus* sp. (Staphylinidae) the adult of which is capable of feeding on newly emerged larvae. *Pachylister chinensis* Quensel was introduced from Samoa to Palau since it predate on early instar grubs. An elaterid *Alaus depressicollis* Schwarz in the larval stage is found predacious. He also observed a few species of Blatteria, Orthoptera, Dermaptera, Isoptera, Hemiptera and Hymenoptera as common co-habitants. Ants like *Solenopsis geminata* Fabricius and *Odontomachus haematoda* L., are also predacious on the early stages of oryctes. Gressitt also recorded non-insectan co-habitants such as scorpions, acarnes, crustaceans and molluscs. Venkatasubban and Selvaraj (1954) reports on rearing of *Sarcophaga fusicanda* Bottcher from the adults of oryctes in Kerala. Menon & Pandalai (1958) have reported that no scoliid parasites have been found attacking oryctes. They reported also the occurrence of a few species of carabids, hesterids and elaterids in the breeding places of oryctes and they are of the view that none of them has ever been found to exert any appreciable effect on the population of the pest. Venkataraman (1958) while considering the biological factors with particular reference to insect parasites, predators and other organisms mentioned a scoliid wasp *Scolia* sp. (*rubiginosa*) Fabr. from Assam as a promising parasite of *Oryctes*. The predators he observed in the different parts of India are *Agrypnus fuscipes* Fabr., *Catascopus whitthilli*, *Morion cucujoides* walk., *Pheropsophys* sp., *Velitra* and other species of reduviidae and *Gryllotalpa* sp. He also recorded some unidentified species of acarines feeding on fresh eggs, Centipedes and Lizards as predators on the early stage grubs of oryctes. Manjunath, Kamath & Rao (1969). In a country-wide survey carried out in India for natural enemies of oryctes, 28 species of predators were recorded and no promising parasites were obtained during the survey. They also observed in places where these predators are very common the population of oryctes grubs was comparatively low.

Present study

Exploratory surveys of some of the major coconut growing regions of the Indian Union revealed that the most common and abundantly present organic material for the breeding of *Oryctes rhinoceros* in the mainland, except forest area, is cattle dung. (1) Decaying stems and stumps of coconut and other palms also form alternate feeding materials for the grubs of oryctes. So also, most of the waste organic matter, community refuses, sugarcane wastes, paddy straw, wood wastes, compost etc. which are subject to decay attract the beetle for oviposition and breeding. In the Lakshadweep groups of islands where coconut is the only major crop, coconut logs and stumps and also other coconut palm refuses which are subject to decay form the major source of breeding material for the multiplication of the pest. In these islands, alternatively the beetle is also seen breeding in the rotting logs of bread fruit and drum stick which are also grown in the islands and which are either fallen down or killed by some tissue borers. In the Andaman Nicobar Islands the forest areas adjoining to coconut plantations provide a large number of fallen soft wood trees which are subject to decay and accumulated heaps of leaves form materials for the breeding of the beetle. Near human habitations wood refuses from sawmills and plywood factories are the main source for the large scale breeding of oryctes. Coconut logs and stumps and also cattle dung wherever present form additional sources for the beetle. Compost heaps/pits, which are left untreated with insecticides, turned out to be ideal sites for breeding. India being an agricultural country with great cattle wealth, cattle dung and crop wastes under neglected and exposed conditions are the ubiquitously present breeding media all around the year.

Physical factors

Exploratory studies made in some of the prominent coconut growing states of the Indian Union also revealed that the cattle dung which forms the major source for the breeding of the pest is stored in different ways depending upon the local climatic conditions, cattle population, agricultural practices etc. in each of the locality and also based on the economic status of the cultivator. In Karnataka, Tamilnadu and Andhra Pradesh where herds of cattle are reared, huge quantities of dung are stored, mostly under exposed condition subject to sun and rain. In Kerala, which is under the influence of the heavy showers of the two monsoons where cattle population is sparsely distributed the dung is stored comparatively in smaller quantities in pits or as heaps under roofed condition. So also in areas under multi-cropping cattle dung is seldom stored for long periods. Progressive farmers use 'Pucca' manure pits for storing cattle dung. Thus cattle dung which forms the major source of breeding media for all stages of oryctes is subject to varied conditions of physical factors particularly temperature and moisture. Temperature and moisture up to a particular level is congenial for the multiplication of the pest whereas beyond and below that level it is detrimental. An observational study of the temperature and moisture of cattle dung under different conditions of storing and the population density of the pest under varied conditions revealed that beyond or below certain limits of temperature and moisture the pest cannot breed even though the breeding as well as the feeding material for the grubs are in plenty. Breeding of the beetle was observed in cattle dung under a temperature range of 10-50°C and 30-60 percent moisture. But maximum breeding was observed in comparatively smaller quantities of 5-10 cft. of cattle dung having a temperature range of 20-40°C and a moisture level of 40-50 percent. Above 80 percent and below 5 percent moisture no breeding took place. So also at a temperature above 60°C and below 10°C no stage of the pest was observed in the breeding sites. Another factor which is responsible for the destruction of the different stages of the pest is the physical removal of the breeding material particularly cattle dung and compost. So also because of the different cropping patterns the agricultural practices are such that particularly in Kerala the necessity of keeping cattle dung for very long periods seldom arises.

So the sites are disturbed and material disposed off frequently for manuring thus exposing the various stages of oryctes to its natural avian and mammalian enemies.

Biotic factors

Among the metazoans, particularly insectan and non-insectan co-habitants found associated with the different stages of oryctes rhinoceros in its breeding sites, particularly cattle dung, compost, decaying logs and stumps of palms and other soft wood, the most common and widely present natural enemies are the insect predators. These include the histerid, Santalus parallelus Payk., the elaterid Agrypnus (near) bifoveatus candeze, four species of Scarites including Scarites indus (Carabidae). Indoscitalinus anachoreta Er. and Philonthus Cinctula Gr., and two other species of staphylinids, Harpalus (pardileus) indus Bates, Harpalus sp., Pheropsophus sp and Catascopus sp. of the Carabids, Chelisochea moris F. of forficulidae, Gryllotalpa africana P. de B., Gryllidae; Psychytripes portentosus Licht. Gryllotalpidae and one species each of Asilidae and Formicidae. No scoliid parasite of primary importance has so far been observed from any of the regions explored except in one or two instances where Scolia eyanipenis Fabr., and Campsomeriella collaris Fabr. has been found associated with the breeding sites of oryctes.

The non-insectan metazoan groups are the acarines and nematodes. The mites of the family ascidae and the nematode rhabditid species were also observed associated with the early stages of the beetle. Mites and nematodes attacking the advanced stage grubs of oryctes were met with in the Lakshadweep islands. Other metazoan co-habitants which are seen enemicial are the centipedes, scorpions crabs and reptiles such as calotes, Mabuya etc.

Death of rhinoceros grubs due to fungal and bacterial pathogens are also quite numerous. The most common among the pathogenic organisms are the fungus Metarrhizium anisopliae (Metschnikoff) sorokin and the bacteria Serratia marscens, Pseudomonas sp.



Habits and habitats

Observations made on the habitat and feeding habits of these indigenous predators on the various stages of oryctes are worthy of mention.

Santalus parallelus Payk., has been observed associated with the egg and larval stages of oryctes in cattle dung and compost. Both the larva and adult of this species are predacious, the larvae being predacious on the eggs and early first instar grubs and the adult both on eggs and grubs of all ages and stages. A single female, during its life span of nearly 350 days consumed as many as 398 eggs and the total consumption of the larva during its 2 instars ranged from 26-72 eggs. Pachylister luterius Er., is another historic which is also predacious on eggs and early stages of the grubs of oryctes which is generally seen in cattle dung along the Pattukottai area of Tamilnadu. Agropyne near bifoveatus candeze the larvae of which has been recorded commonly from most of the breeding sites particularly from cattle dung. The larval population in the breeding sites are very sparse, on an average, 1-2 larvae in an average-sized pit or heap. Under caged condition a full grown predator larva was capable of consuming 7-21 eggs or attacking and killing seven first instar grubs or three second instar grub or one full grown third instar grub within 24 hours. At the same time they are not so much predacious as those that attack and kill all those that they come across. The early instar larvae of the predator is not predacious on any of the stages of oryctes. The larval period is very long with about eight instars having life span of 355-559 days. Other species of elaterid met with the breeding sites are Melanotus and Melanoxanthus sp. Some four species of scarites including Scarites indus both in their larval and adult stages are commonly seen associated with the early stages of oryctes in their breeding sites mostly in compost and other decaying matter. The rate of feeding of the different species on the eggs as well as grubs upto the second instar stage was found varying. One species in the adult stage, under caged condition preyed at the rate of 12 eggs or 4 early first instar/3 advanced first instar/or one second instar early grub per day. The predator larva unlike the adult preferred grubs to eggs of oryctes. Among the predators other carabids of importance are Pheropsophus occipitalis Macleay and a dark brown species of pheropsophus. The adult of these are predacious on the first and early second instar grubs, but on the eggs they feed only at times. The larvae are never seen predacious on any stages of oryctes. These are generally seen near water sources particularly along the coastal and back water areas mostly in community refuses. Harpalus pardileus Bates and another Harpalus sp are very commonly seen in cattle dung, the adult beetle sucks up the egg contents leaving behind the shell and the larvae are seldom observed predacious. Catascopus sp. in the adult stage is predacious on the early stages of the grub.

Staphylinids are also important among the co-habitants as predators. The two known species viz. Indocitalinus anachoreta Er., and Philonthus cinctual Cr. are important as predators on eggs and first instar early stage grubs. Two other undetermined species are also observed predacious on the eggs of oryctes. A fifth one bigger than all the others was collected from the forest area of Achankovil from cattle dung which fed both on the eggs and early stage grubs.

Earwigs, Cheliscoches moris and two other species of forficulids were commonly seen in cattle dung and decomposing coconut logs and crowns which are killed by the attack of red weevil, Rhynchophorus ferrugineus F. in association with the early stages of oryctes. These in their nymphal as well as adult stages are predacious on eggs and first instar grubs.

Blattids, particularly Pycnocelus surinamensis L., are very common in the main land in all sorts of decaying organic matter and cattle dung. Gryllotalpa africana P. de B., of Gryllotalpidae is predacious on eggs and grubs and Brachytrupes portentosus Licht., of Gryllidae feeds on the eggs of oryctes. Few species of reduviids are also seen mostly in compost and decaying soft wood logs. From the Andaman regions particularly from the forest area one species of reduviid was collected from the larval galleries in the decayed wood which was later found under laboratory conditions feeding on second instar grubs of oryctes. Asilids the larvae of which are generally seen in association with the early stages of oryctes in the coconut husks buried in soil as a soil mulch and also in coir dust which are subject to decomposition. No scoliids of primary importance were so far observed on any of the stages of oryctes. The only two cases of natural parasitisation by Scolia cyanipennis Fabr., and Comptoseriella collaris Fabr. were observed on early second instar and advanced first instar grubs respectively of oryctes. Along the interior regions in Kerala formicids, particularly Odontomachus haematoda L., were observed in decomposed palm logs and stumps associated with the eggs and early stage grubs of oryctes. Acarines : Mites of the sub-order Mesostigmata, family Ascidae are found associated with the egg and early stage grubs in cattle dung, compost and decomposed coconut logs and stumps during the latter part of the summer months and with the onset of monsoon. They are seen congregating on eggs and just hatched grubs. During August-September nearly 60 percent of the eggs of oryctes in the breeding sites are found destroyed by them having sucked the content leaving behind the shell. Fresh eggs are found preferred than the older ones. Mites are seen also in association with advanced stage grubs causing mortality in the Lakshadweep islands. Nematode : Rhabditid sp. are generally found in all stages of oryctes in the breeding material. The eggs are also found parasitised by nematodes in the cattle dung particularly after the monsoon rains. Adult grubs of oryctes are found killed by sp. of rhabditids in the Lakshadweep islands.

Thus considering the large number of associates it is essential to understand the ecological relationships of the beetle in all its breeding environments so as to make the best use of the physical as well as biotic factors for a natural suppression of oryctes population. The proliferation of the pest can be checked by restricting the breeding material which is the source of larval food supply. So by ecological manoeuvring of the environment by creating sub-optimal or unfavourable conditions in the breeding sites facilities for the easy multiplication of the pest can be denied and co-habitant enemies encouraged so that they exert their effect on the population of oryctes. Thus physical as well as biotic factors either individually or collectively are responsible for effecting a natural check on the population of density of the pest at various stages of its growth in the main land of the Indian Union. Had it not been for these limiting natural factors, the population of Oryctes rhinoceros along the coconut growing regions in India would have assumed enormous proportions. So by proper pest management practices over all coconut growing areas, with adequate enforcement of regulations concerning breeding sites, this pest can be controlled economically.



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Rabditid virus.

Nematode DD136.

0.01% BHe or Cambayl. breeding places

5% BHe. with seed in equal proportion. leafax

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