Biological Suppression of Rhinoceros Beetle and Leaf Eating Caterpillar - Two Major Pests of Coconut

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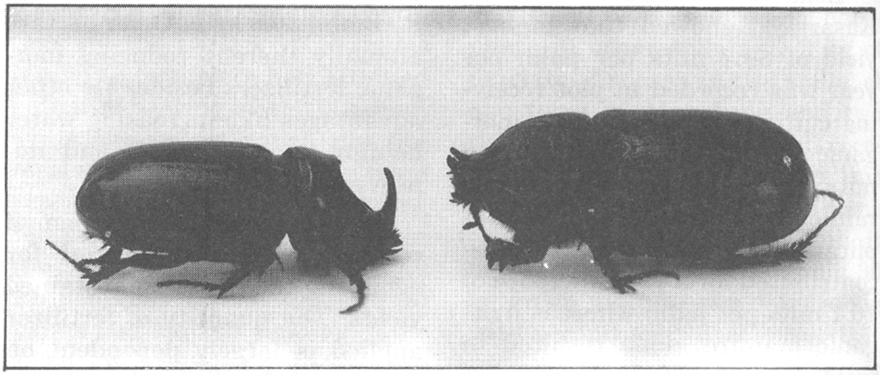

Fig. 1. Rhinoceros beetle *Oryctes rhinoceros*

Coconut palm is infested by a host of pests which damage the crop from the nursery to the adult stage. Pests contribute a lot in decreasing the productivity of the palm. Being a perennial crop, coconut provides food and shelter to them. Chemical method of control is adopted for the control of the major pests, particularly, the rhinoceros beetle, leaf eating caterpillar, red palm weevil and white grub. Other management schedules include biological methods of control, whereby the use of poisonous chemicals could be minimised and the major pests such as rhinoceros beetle and leaf eating caterpillar could be brought under control. Integrated Pest Management Technology (IPM) was developed for these pests giving stress to the use of promising bioagents.

Fig.2. Coconut palm showing damage by rhinoceros beetle

Rhinoceros beetle *Oryctes rhinoceros (Fig. 1)* is ubiquitous in distribution. It damages the unopened leaves and inflorescences. Characteristic geometric cuts on the opened leaves are diagnostic symptoms of damage *(Fig. 2).* Beetle damage was estimated to cause 10 per cent loss in production of nuts. Injuries by rhinoceros beetle on palm crown may attract the red palm weevil which is a dreadful enemy of coconut palm. The rhinoceros beetle is a prolific breeder. It multiplies in accumulations of cattle dung, compost, decaying organic debris, dead and decaying coconut palms etc.. Life cycle is completed in 3 to 6 months,

Many indigenous predacious beetles were recorded from the breeding sites of rhinoceros beetle. The immature and adult stages of these predators feed on the eggs and early larvae of the rhinoceros beetle. *Santalus parallelus*, species of *Harpalus, Pheropsophus,* *Scarites* and *Agrypnus* are some of the important indigenous predators. Considering their low feeding potential on the prey it is not economical to breed these predators in the laboratory and release in the field for the successful control of rhinoceros beetle. But conservation of these predacious fauna is quite essential for effecting a natural check on the multiplication of the rhinoceros beetle in its breeding site.

Platymeris laevicollis, introduced in India from Zanzibar, is one of the exotic predators which feed on the adult rhinoceros beetle. The beetles visiting the palm crown are killed. These bugs are mass multiplied and released on palm crowns. Only six bugs are released on a palm at a time. Releases are repeated at regular intervals. By release of these bugs at Kayangulam, Pandalam and Sooranadu in Kerala; Vittal in Karnataka and Androth in Lakshadweep, the incidence of the rhinoceros beetle on palm crowns could be brought down significantly. These predators failed to establish under the ecological conditions in Kerala and Karnataka and for this reason they are not recommended for large scale release at present.

Entomopathogens are successfully employed for the control of rhinoceros beetle. The green muscardine fungus *Metarhizium anisopliae* occurs in nature and produces epizootics in larvae and adults of rhinoceros beetle, particularly during monsoon. Low temperature (27-28°C) and high humidity (RH 90%) conditions favoured the multiplication of the fungus in the breeding sites of the beetle. The fungal infection occurs through the cuticle, particularly, through the membraneous areas of the joints and it develops in the haemocoel of the host and produces toxin. The visual symptoms of infection in the host are mainly loss of appetite, sluggishness, blackening at the site of infection and finally mummification. The dead insects show a bluish green colour.

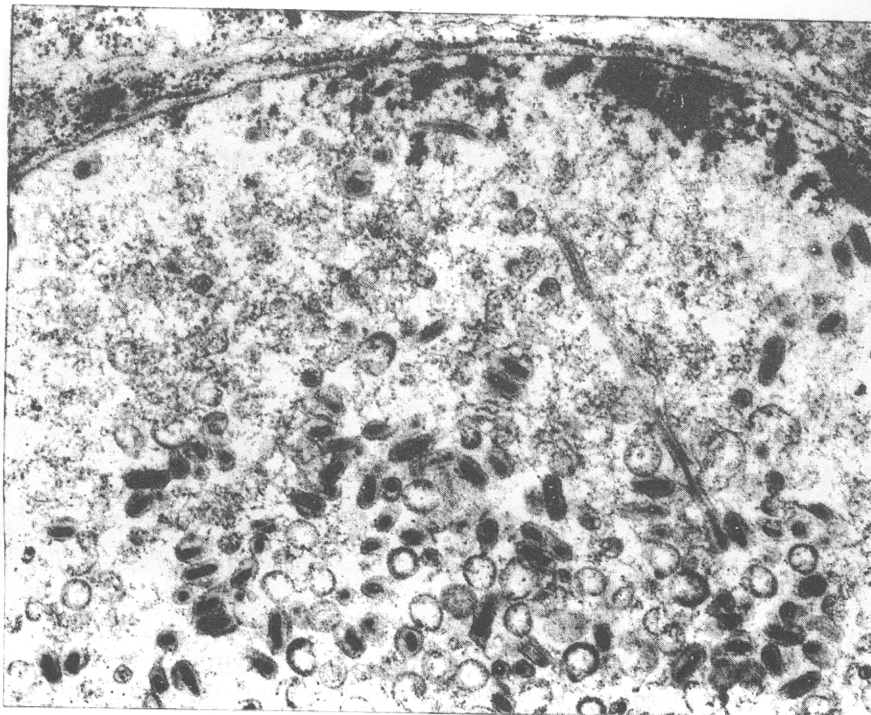

Fig. 3. Baculovirus oryctes - EM

The fungus could be cultured in the laboratory on culture medium such as potato dextrose agar. For field application mass multiplication could be done on cheaper solid and liquid substrates. The solid medium used includes cassava chips and rice bran fortified with urea or fish meal extract. Coconut water, which is wasted from copra-making industry is a perfect liquid medium for mass multiplication of *M. anisopliae*. The fungal spores harvested from these media shall be applied to the breeding sites @10^{11} spores/m^3 of the breeding material. The fungus could be used individually or integrated with other pathogens like baculovirus. The fungus gets established in the breeding medium within six months. The fungal spores are capable of surviving in the soil containing 60 to 70 per cent moisture for more than two years. In treated sites, while the farmyard manure is being removed for agricultural purposes, a portion of the treated manure is to be retained in these sites so that on addition of fresh manure, the fungus multiplies naturally.

Baculovirus of the rhinoceros beetle is cited as one of the major landmark examples used in the biological suppression of an insect pest. The pathogen is *Baculovirus oryctes*. In Kerala and adjoining states, baculovirus infection ranged from 30 to 80 per cent in adults and 10 to 80 per cent in larvae of rhinoceros beetle. Pupae are not generally affected by the virus. These virus particles consist of rod-shaped nucleocapsid (235 x 10mm) surrounded by an envelope *(Fig. 3)*. The genome is a double-stranded, supercoiled DNA molecule. The virus is normally non-occluded, however, inclusion bodies like virions may be seen in the cytoplasm of fat body and midgut epithelium. Baculovirus infects the midgut epithelium of the larva and adult rhinoceros beetle

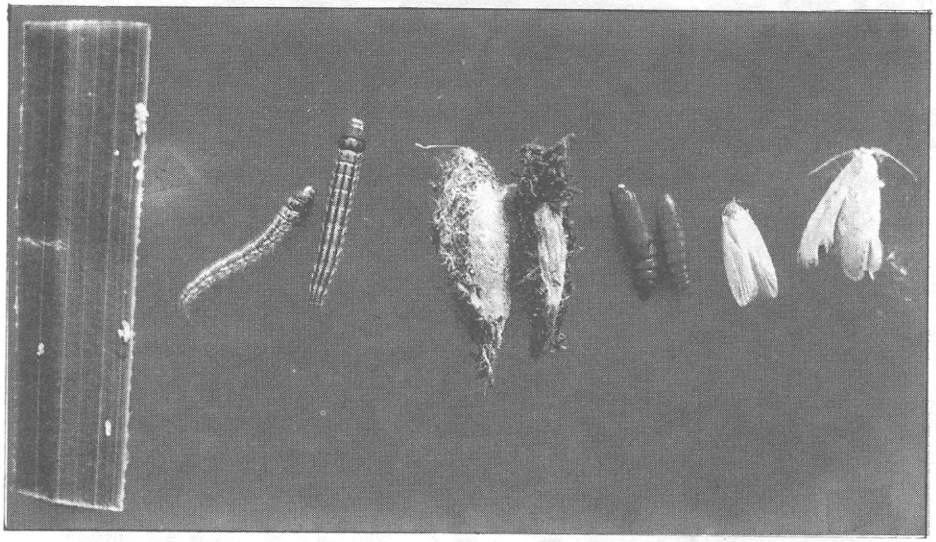

Fig. 4. Leaf eating caterpillar, *Opisina arenosella*

and it multiplies mainly in the nuclei of the midgut epithelium.

Baculovirus infected grubs become lethargic, stop feeding, abdomen become turgid and glassy, fat body disintegrates and the larvae appear transluscent. Infected grubs become devoid of food and chalky white bodies may be visible under the abdominal integument. The infected adults become inactive, lay few or no eggs and their longevity is reduced by about 40 to 50 per cent. Infected beetles defaecate the virus @ 0.3mg/beetle in a day through sloughed off gut cells into the surrounding medium and they serve as flying reservoir of baculovirus.

Viral infections could be detected visually by examining the midgut. Infected larvae at the advanced stage of the disease become pale white, transluscent and the gut devoid of food. Midgut becomes pale white, dilated and filled with mucoid milky fluid as compared to the thin brown midgut filled with food of the healthy larvae. Infected adults show similar gut symptoms. Infection could easily be detected by microscopic examination of midgut aspirate, even before the manifestation of the visual symptoms. Giemsa stained smears of the midgut aspirate show nuclear hypertrophy, vacuolation of nuclei and cytoplasm and ring formation of chromatin material. Disease incidence could also be detected by the sloughed off gut epithelial cells present in the excreta of diseased beetle. Immunofluorescence, immunoelectrophoresis, ELISA and EM techniques are some of the usual tools in confirming the disease even at the early stage of infection.

Oryctes baculovirus is a self perpetuating pathogen transmitted mainly through contaminated food. Under laboratory conditions, the virus could be mass multiplied by rearing the grubs in virus contaminated decaying wood or cattledung. Diseased beetles cross-infect during group feeding or visits in the breeding sites, resulting in the transmission of the virus to the new generation. Artificial inoculation of the beetles can be done by allowing the adult beetles to wade through in the inoculum or by oral application of the inoculum. The inoculated beetles are kept incubated for 12 hours before field release. For field dissemination of the virus, the inoculated beetles are released @ 10 -15 beetles/ha of the coconut plantation. Release may be done at dawn or dusk. The released beetles will start excreting the virus from the seventh day of release.

Survey on the incidence of baculovirus of *Oryctes* in India revealed that it is prevalent in all coconut growing states except the islands of Andamans and Lakshadweep. This pathogen was introduced to Lakshadweep in 1983 and Andamans in 1987. In Lakshadweep, the virus was introduced in Minicoy (1983) and Androth(1988).In Minicoy, the overall reduction in leaf and spathe damage and fresh incidence on palm crown was to the extent of 82,98 and 96 per cent respectively, after three years of introduction of the baculovirus. In Androth also, the leaf damage came down to 7.7 per cent, spathe damage to 0.3 per cent and fresh incidence to zero, as compared to 55, 7.3 and 29.5 per cent respectively, of the pre-release condition. In both the islands 62-85 per cent of the natural beetle population contracted the disease. Re-release of the baculovirus only once in an already infected contiguous area at Chittilappilly, Trichur, Kerala also revealed remarkable decline in crop damage after three years of release. Drastic decline in leaf and spathe damage and population of beetle on palm crown and breeding sites was observed in all the areas where baculovirus infected beetles were released.

The leaf eating caterpillar Opisina arenosella *(Fig.4)* is widely distributed in the coastal, backwater and river belts. The caterpillars feed on the leaves. They make galleries on the lower leaf surface and hiding inside the gallery. They eat the green parenchymatous tissues. The affected leaves and in servere infestation the palm itself will present a scorched appearance *(Fig. 5)*. In epidemic outbreaks all the leaves, leaf stalks, inflorescences and even the rind of green nuts form feeding materials of the caterpillar. Summer season is the period of pest abundance, but during delayed monsoon it may go upto June. High humidity favoured the pest build up. Life cycle is completed in about two to two and a half months.

Forty parasitoids, twenty predators and three pathogens were recorded as natural enemies of *O. arenosella*. Many of them are capable of suppressing the pest population. Among the promising species, the larval parasitoid *Goniozus nephantidis* (Bethylidae), pre-pupal *Elasmus nephantidis* (Elasmidae) and pupal *Brachymeria nosatoi* (Chalcididae) are being extensively used for the control of the pest. These parasitoids possess all the desirable attributes of successful parasitoids such as high host searching ability, host stage specificity, tolerance to adverse weather conditions, preponderance of females, high fecundity, long life span, short life cycle, absence of super-parasitism and negligible level of hyperparasitism. These parasitoids are amenable to laboratory rearing and mass multiplication on *O.arenosella*. *Corcyra cephalonica* is also used for mass multiplication of *Goniozus*. Laboratory - reared parasitoids are released in Opisina infested gardens at fixed norms and intervals . Bethylids are to be released @ 20 per cent, elasmid @ 50 per cent and chalcidid @32 per cent in relation to the target stages of the pest viz. larva, pre-pupa and pupa, respectively. Eighty to ninty per cent reduction in pest incidence could be achieved by such releases. Release is to be made at the early stage of pest build up. Repeated releases at fixed norms and at fixed intervals are essential to achieve maximum efficiency of releases.

Fig. 5. View of the plantations showing epidemic outbreak by *O. arenosella*

In addition to these three parasitoids, there are ichneumonid pupal parasitoids such as *Xanthopimpla punctata, X. nana nana* etc. which are very effective under certain ecological conditions. *Apanteles taragamae* is one of the early stage braconid parasitoids checking the pest at the initial stage, before the larva can cause appreciable damage to the leaf. The carabid beetles *Parena nigrolineata* and *Calleida splendidual*; thocorid and chrysopid predators exert considerable check on the pest. Salticid and sparassid spiders have high predatory potential. The immature and adult spiders feed on all stages of *Opisina*. Conservation of these natural enemies is quite essential for the biological suppression of the pest.

Bacterial pathogens such as *Serratia marcescens* and *Bacillus thuringiensis* HD strain; nuclear polyhedrosis virus and the fungus *Aspergillus sp.* kill the pest in the laboratory and field. During rainy season heavy mortality of the caterpillars is observed due to *S. marcescens*. Detailed studies are yet to be taken up on these pathogens in the control of the pest.

Toxic hazards of the insecticides used hyperparasitism occurring in nature limit the efficacy of bioagents in the suppression of the pest. IPM strategy is always feasible, if we can combine the biocontrol programmes together with less toxic chemicals. As for example, only if there is absolute need of a chemical pesticide, particularly during outbreak conditions, we may require one spray of the less residual insecticide such as DDVP (dichlorvos 100EC in 101 of water for spraying four palms) initially and followed by release of appropriate species of parasitoids (at fortnightly interval after one month of the spray).

In the IPM technology for the control of the rhinoceros beetle also priority can be given to biocontrol programmes. The toxic insecticide such as HCH applied to the breeding sites of the rhinoceros beetle kills the pest and the predators existing in the breeding sites. This can be avoided by using carbaryl spraying which is less toxic to predators such as *Santalus* and *Agrypnus*. A combination of mechanical method of hooking the beetle from palm crown during the peak period of pest abundance (June to August), treatment of breeding places with carbaryl 0.01 per cent, if needed, initially and release of microbial pathogens *Metarhizium* and *baculovirus* can be adopted. These two pathogens are not antagonistic and it was also observed that Metarhizium infection could enhance the death of baculovirus infected grubs.

The promising natural enemies are being multiplied at the Biocontrol Laboratory of the Central Plantation Crops Research Institute, Regional Station, Kayangulam. The nucleus cultures of these bioagents are supplied to the Zonal Parasite Breeding Stations, State Universities and other Research and Development organisations on request. The scientists of the institute also impart training to the research and extension officials, and farmers on the management of pests of coconut, particularly on biological pest suppression.

The synthetic pesticides used for pest control are highly toxic to the environment and the living organisms and these are very expensive. Hence, recent studies have been directed to the more potential, less expensive natural biological control agents which may lead to target-specific, eco-friendly and cost-effective technology for the management of the rhinoceros beetle and leaf eating caterpillar pests on coconut. These natural enemies could be mass produced by using simpler mass multiplication procedures which could even be done in homesteads. This would add to the employment potential and economic assets of rural people, particularly to the unemployed youth in the country.

'El Nino has Little Direct Impact on Monsoon'

Does El Nino, the mysterious meteorological phenomenon that fouls up with climatic conditions in several parts of the world, cause any harm to India?

Not directly. But indirectly. El Nino pinches on India's monsoon system, which stays just out of its immediate sphere of influence, says Dr.P.V. Joseph, former director of Indian Meteorological Department, who has made extensive studies on the phenomenon.

He was speaking on 'El Nino and monsoon' at a seminar on 'Weather, oceans and human activity' held at the Naval Physical Oceanographic Laboratory in Kochi recently. The seminar was organised by the Indian Meteorological Society's Kochi chapter to mark the World Meteorological Day.

El Nino is "an anomalous warming up of the top layers - up to 100 metres - of the equatorial East Pacific oceans in a 10,000km long and 3000km wide stretch of water."

According to available scientific data, Dr.Joseph said, almost a half of the drought years in India in the past coincided with El Nino years' and a quarter of the deficient-rainfall years too. But, the other quarter had disproved this trend, thus thwarting any attempt to derive a definite scientific conclusion about its impact. This has so far handicapped a food-proof monsoon forecasting.

For Instance, Dr.Joseph pointed out, though 1997-98 has been a severe El Nino year, it did not lead to a fall in the monsoon rainfall in India as had been forecast by the US weathermen. Despite the El Nino, last year India had an excess monsoon-rainfall. The impact of this particular El Nino, which had been set off in March 1997 and had peaked in December, was three-times stronger than the usual ones and was the severest of this century, Dr.Joseph pointed out.

He said the impact of El Nino is direct on Indonesia and Australia as they fall under its sphere of influence. The El Nino impact manifests itself mainly in the form of a fall in rainfall, thus leading to drought. The recent extensive forest fires in Indonesia which lasted several weeks were among the fallout of the El Nino effect.

He said the El Nino warms up the ocean layers; which in turn warm up the clouds' which leads to disturbances in the atmosphere and winds; and ends up disturbing the ocean. This drives off, or dries up, rain clouds leading to a reduction in rainfall and, among other things, a drought ensues.

Dr.Joseph said forecasting monsoon in India on the basis of the impact of El Nino was very difficult as of now, because only two of the 16 monsoon parameters were provided by El Nino.

Dr.L.H. Prakash presented papers on 'Medium-range forecasting of monsoon' and Dr.R.R. Rao on 'Response of ocean to atmospheric forangs.' Dr.V.Chander, director, Naval Physical Oceanographic Laboratory, opened the seminar and Dr.H.S. Ram Mohan of Cochin University presided at opening ceremony. Prof.K.Mohankumar and Dr.C.V.K. Prasada Rao spoke.

- The Hindu