THE COCONUT BEETLES,

Oryctes rhinoceros and Rhynchophorus ferrugineus.

The Coconut Trees Preservation Ordinance, No. IV of 1890, declares that it is the duty of the owner or person is charge of a coconut tree, dead or attacked by either of the two common coconut beetles to uproot the tree, to burn or to bury it in the ground at a depth of not less than three feet or to submerge it.

The Ordinance and the Amendment, Ordinance No. IX of 1895, give powers to certain inspecting officers to order that this duty be carried out.

A great improvement in the condition of the coconut trees of Singapore was recorded as the result of the enforcing of the Act But now, time having obscured the difference between the former state of the beetle-attacked plantations and their improved condition, it has become a not uncommon thing for plantation-owners to claim that the stumps are not dangerous, and sometimes the order to remove them is met by a grumble that the cost is heavy. In consequence of this, a little reminder of the necessity of removing the stumps appears desirable; and in the following paragraphs with a view to removing misapprehensions it is shown what part they play in furnishing a breeding ground for the common Rhinoceros beetle, and how this beetle prepares the breeding ground for the more destructive Palm-weevil.

The cheapest way of removing accumulations of stumps known to the writer is by the use of explosives. Before recommending it, experiments were tried in Singapore which may be at once briefly described: the experiments were done by Mr. MacQueen, Agent for Messrs. Nobel's Explosives Company, Ltd., in the presence of the writer.

For the purpose in the first instance a row of living stumps was chosen,—stumps of trees newly felled under the Municipal Act: the wood was hard and healthy, and the utmost possible resistance was to be expected. To prepare a place for the explosive, a hole was drilled into each stump on the ground level passing a little beyond the centre, and into this hole the charge was put, and exploded. In the second instance standing dead trees were taken and similarly prepared, charged and the charge exploded. These were the results:—

four cartridges of blasting gelatine, properly placed in the base of a stump, and exploded, blew it so much to pieces that it was not necessary even to pick up the pieces,

four cartridges of blasting gelatine similarly placed in the base of a standing dead tree, and exploded, brought it down leaving in the ground insufficient to serve as a breeding place for the Rhinoceros beetle, and freeing the trunk so that it could be removed easily,

four cartridges of gelignite did not suffice to do the work thoroughly,

three cartridges of blasting gelatine were not quite sufficient.

The cost of thus disposing of coconut trees that have to be removed, amounts to about half of what it costs to fell and subsequently to remove the stump by tediously digging it out. The two operations can be done in one, for the hole for the charge should be drilled in the standing tree and the trunk brought down by the destruction of the butt end.

The two beetles legislated against in the Straits Settlements are *Oryctes rhinoceros*—the Rhinoceros beetle and *Rhynchophorus ferrugineus*, the Palm-weevil. The first is the commoner but individually the less destructive. It feeds as an adult insect in the stems of living palms, generally coconut palms, tunnelling into the softer parts of the stem ; and it sometimes lays its eggs in these tunnels, but for the most part it deposits them in decaying vegetable matter, sawdust, rotting grass, old rotting thatch, wood which is soft enough, especially the central parts of dead palm trunks, and as decay loosens the bark, in the layer of tissue along the line where it and the wood unite. It has been recorded as breeding even in rich vegetable mould. It demands besides the decaying vegetable food, a considerable amount of moisture. As it may happen that the tunnel made by the mature insect in the apex of a palm tree collects rain water and rot is set up, so even if these tunnels are not at first suitable places for egg-laying, they are liable to become so after a short time.

The Palm-weevil lays its eggs on the coconut trees, making for each egg a small hole with its long characteristic snout, then turning round and depositing it to the best of its ability in the hole. The burrows of the Rhinoceros beetle give the Palm-weevil access to the inside of the palm, and full advantage is taken of them, eggs being deposited in or on their walls in preference to any other spot about the palm tree. The eggs give rise to greedy fat white grubs, which eat out galleries through the softest tissue, thereby doing the maximum amount of damage, for they destroy the heart of the palm-cabbage. On the other hand without the aid of the Rhinoceros beetle, they start life in superficial rather hard tissue, at a disadvantage and somewhat exposed to enemies.

The Rhinoceros beetle is a common insect from India to the Philippine Islands wherever large palms abound. In Africa its place is taken by *Oryctes monoceros* and *O. boas*, which attack palms in exactly the same way as *O. rhinoceros*. In Madagascar six other species of palm-attacking Oryctes live. In the Island of Reunion there are two species. Tropical America has a closely allied genus—*Strategus*—which furnishes at least one species of similar habits. Allied genera—*Pimelopus* and *Scapanes* in New Guinea, *Camelonotus* in America—attack young palms burrowing into their stems from the ground.

The Palm-weevil of Asia occurs in India, Ceylon and eastward to the Philippine Islands.

It is replaced by *Rhynchophorus phoenicis* in tropical Africa, by the allied *R. palmarum* in Tropical America and also by the smaller *R. cruentatus*. The latter seems to have a predilection for certain palms of small growth, less perhaps on account of their physical nature than its habit of flying low in the moistest air near the ground. Another similar weevil—*Rhabdocnemis obscura*—destructive to sugar cane in the Pacific islands has been found there in coconut palms.

In 1910 or perhaps one year earlier, a mischance took the Rhinoceros beetle to Samoa. It is believed that a consignment of rubber stumps from Ceylon actually carried it thither. Its presence was first noticed on November 4th, 1910, by reason of damage done to coconut palms growing close to the Customs House of Apia. From Apia it spread widely, chiefly in the direction of the prevailing wind, crossing the island of Upolu, from Apia on the north and passing westwards, but not passing so much eastwards. From the island of Upolu the beetle has flown across the strait dividing Upolu from the island of Savaii. Fears that it might reach Fiji have caused legislation to be brought in preventing the importation from the Samoan islands of anything which might carry its eggs or grubs or pupæ.

Against the pest in the Samoan islands the Government has taken energetic measures, a knowledge of which may be useful to us. Much may be learned from the two papers on it, which have appeared in Der Tropenpflanzer and from one in the Bulletin of the Department of Agriculture, Fiji.*

The first paper was by Dr. Gehrmann, an officer of the Government of Samoa, then in charge of measures against the coconut crab. He described how the mature beetle tunnels for the sake of food into the cabbage of the palm and may kill it: "the loss of palms, ... attribute to Heart-rot and to lightning" had in his opinion, he said, "during the preceeding year been due in chief measure to the beetle."

The second paper was by Mr. F. J. Jepson, Government Entomologist in Fiji, who was sent to Samoa in April, 1912, to ascertain the seriousness of the pest, lest it should be introduced into Fiji.

The third paper is by Dr. K. Friederichs, the Government Officer who now has charge of the operations against the beetle, and like the first was published in the Tropenpflanzer.

Jepson gave a map showing the area in Upolu, over which the beetle had spread in April, 1912. Friederichs has published another map bringing our information up to date and graphically showing that in spite of the strenuous measures which have been taken the pest is spreading. Since Jepson wrote it has passed over to the island of Savaii; this required the crossing of nine miles of sea; but

*Gehrmann, in Der Tropenpflanzer, xv. (1911) pp. 92. Friederichs, K., in the same, xvii. (1913) p.p. 538. Jepson, F.J., Bulletin, No. 3. Department of Agriculture, Fiji, (1912).

the strait has two islets in it, whereby the widest interspace is reduced to five miles; yet as on Savaii the beetle appeared in three villages, it is just to infer that more than one female insect had crossed the strait, and that with the wind helping, the flight can be at least five miles. However, abundant evidence shows that it is generally much less, the insect seeking a palm tree to feed in, and finding it usually near to its birth place.

As to the extent of the damage done by the beetle about the beginning of 1912, an official statement was made that one hundred and fifty trees had then been destroyed and six to eight thousand, or one-fifth of the others in the affected districts had received damage enough to put their yielding back one or two years. In April of that year, Jepson stated that about Apia and Saleimoa—the worst localities—75 per cent. of the coconut palms showed signs of attack, 30 per cent. had had their yield reduced to a great or small extent, and 1 to 2 per cent. had been killed (some doubtless by the excessive zeal of the natives in their cutting out of the beetles from the crowns). In other districts 25 per cent. of the trees had been attacked and 10 per cent. had had their yield set back.

The measures taken to cope with the beetle have been as follows. On the eighth of November, 1910, the Government of Samoa issued a proclamation in vernacular to the effect that the beetles and their grubs should be collected and promising a reward of one mark (36 cents) for every twenty beetles and the same for every fifty grubs. Seventeen days later a law was promulgated stopping coconut planting, ordering the cleaning up of all existing plantations, forbidding the using of coconut trunks for bridges and pig-styes, and arranging for inspections. About £2,000 was the cost of this method of dealing with the pest up to the end of January, 1912, and yet no satisfactory impression had been made on its numbers. Therefore on the first of February, 1912, it was made compulsory to search for and destroy the insect. Following this there was issued on April 19th, 1912, a decree calling into being a commission with powers to inspect and compel owners of coconuts to keep their estates clean, and to remove structures made of coconut trunks, or standing dead trees at the owner's expense. Then on the 10th of May, 1912, appeared an order requiring all able-bodied persons in the affected districts to turn out at six o'clock on every Wednesday to search for beetles and grubs which were to be brought to the village headmen, counted and destroyed by fire or hot water. Into this great holocaust passed the grubs of beetles which happen to be similar to those of Oryctes. Friederichs names them specifically; but their number is a matter for estimation. From the 1st of April, 1912, to the 31st of March, 1913, roughly, ten million grubs and a quarter of a million beetles were collected and killed on the island of Upolu; allowing for the grubs of the similar beetles, Friederichs puts down the Oryctes larvæ destroyed as six million and the beetles as two hundred thousand—a nice little family originating in a few grubs imported in 1910 or possibly 1909.

To this figure has yet to be added the number of the grubs and beetles collected on the European Plantations. On the estate of the Deutsche Handels- und Plantagen- Gesellschaft der Sudsee-Inseln zu Hamburg over the same period were collected and destroyed about 350,000 grubs and 23,200 beetles. Further the number of insects trapped by the Commission over the same period was 180,000 eggs, 776,000 grubs, 220 pupæ and 11,300 beetles. The traps will be described next.

For the making of a trap a hole is dug in the ground from nine to twelve feet square, and about two and a half feet deep. Rotten coconut stumps, plantain stems, and soil are put into it; and over the top large leaves such as coconut leaves, breadfruit leaves, and plantain leaves are placed rising perhaps a foot above the surface of the soil. Into these pits the female beetles penetrate to lay eggs and the male beetles to find the females. What beyond digging the traps is necessary is that they should be opened at regular and a not too distant periods, or that the beetles in them may be in some way killed.

At distances of about one hundred yards along some of the roads in Samoa these traps have made in series, and on the plantation of the Deutsche Handels- und Plantagen- Gesellschaft there is one trap to every hundred standing trees.

On the latter estate the traps are opened every six weeks or two months.

Jepson states that it takes six men about two and a half hours to open and remake one trap; therefore six men can attend to four traps only per diem, or in rotation 160 to 200. He suggested that the traps might be treated with bi-sulphide of carbon and not unpacked at all. Six ounces of carbon bi-sulphide were accordingly injected into a full sized trap, which after an interval of twenty-four hours was opened. Then all the larvæ in the trap—450 in number—were found dead; three mature beetles were partially asphyxiated, but recovered; rats and mice were found dead. The trap was remade, and re-examined eighteen days later, when to that officer's satisfaction it was found to be again full of beetles, showing that the treatment did not destroy its usefullness, but rather increased it, as a record catch was made. A second trap treated with nine ounces of carbon bi-sulphide at the same time, but opened thirty six hours later, contained 249 dead grubs and one dead beetle.

Unfortunately the German officers discovered that the cost of carbon bi-sulphide in Samoa is too high to make the method worth adopting. The building of traps, however, is a useful proceeding so long as the organisation for inspecting them is efficient; for as we saw above by their means in 1912 the Commission collected 180,000 eggs, 776,000 grubs, 220 pupæ and 11,300 beetles.

Friederichs further gives the following figures to show that the traps are efficient for catching the male insects as well as the female:—out of 1,000 insects taken, 566 were females and 434 males.

Of the lessons to be learned from this Samoa outbreak, the outstanding one is that the beetle is enormously prolific when unchecked. Regretfully we learn too that man cannot keep it down, for it has gained ground in spite of strenuous direct efforts against it; it ought probably to be attacked through its natural enemies—parasitic ichneumon flies and Tachinid flies. These, however, will never serve instead of cleanliness about the plantations and the removal of that in which the grubs prefer to mature.

In German East Africa the method of collecting the grubs and beetles by paying so much for them was adopted some years ago.

It seems that there planters had put out coconuts on virgin forest soil which was full of grubs living in rotten wood in or on the soil, and so they had courted the beetle. At any rate its abundance alarmed them and rewards were offered for the collection of the grubs and beetles. Preuss (Der Tropenpflanzer, xv. 1911, p. 73), says that in October, 1899, on the Muea Plantation of the German East Africa Company 140,000 were taken from the ground at a fixed sum; . . . in Dar-es-Salam in June, 1907, as the result of an offer of a sum for each grub . . . there was a grub-fever among the natives and within a few days 25,000 to 30,000 were collected and destroyed.

In the region of the natural distribution of the Rhinoceros beetle, viz, India to the Philippine islands, a not inconsiderable amount of attention has lately been directed to the damage done by it in various quarters, not so much because of any outbreaks as because Economic Entomology has come to the front. Messrs. J. McKenna and K. D. Shroff do indeed claim that it has lately invaded Tenasserim (Bulletin No. 4 of the Department of Agriculture, Burma, 1910, p. 3), but it is hard to believe that this should have been the case; rather is it more likely that the increase of industries which leave vegetable refuse about, such as saw milling, are responsible for an increase in the numbers of the insect. This might particularly be the case about Rangoon, where it was said that so abundant had the beetle become in, and from 1907 that the very existence of palms in the neighbourhood was threatened.

The laying out of new coconut plantations in Ceylon by European planters brought the beetle to notice through the colony, but especially in the Batticaloa District, where the new plantations chiefly were: and 1903 saw an agitation for legislation against those who allow it to mature.

In the Philippine islands at the other end of the insects limit American enterprise brought to bear on the backward agriculture, turned the light on to it; and of the coconut groves, heavily grassed over and full of fruitless trees, Mr. C. S. Banks said, in 1906, that he found scarcely a tree not marked by its ravages.

From the latter's pen and from that of Mr. C. C. Ghosh, Assistant to the Imperial Entomologist, Agricultural Research Institute, Pusa, India, have come new studies of the life history and manner of working of the insect.

The insect is too familiar to need any description, but there are still several points in its life history, whose obscurity will be brought out by the following paragraphs.

The mature beetle is noctural, generally shunning light and very anxious to hide when exposed to daylight. Ridley (Report on the Destruction of Coconut Palms by Beetles, Journ. Asiatic Society, Straits Branch, No. 20, 1889) says that the insects may be attracted to fires lit in the plantations by night; and Ghose states that they fly to light in Behar, in the Ganges valley, and suggests that they may be trapped by light traps; but others have concluded that lights have not influence enough on the beetle to be worth using. At night both sexes fly abroad in search of food and in search of each other. By preference they do not fly far. Both sexes for the purpose of feeding alight in the tops of coconut palms and other palms†; there they seek the softest spots and commence to burrow with their powerful mandibles. After half an hour's work they are about one quarter of an inch into the tissues; at dawn they have penetrated at least more than their own considerable body-length. Young palms, which are growing fast and so expose a greater length of rather soft tissue than do the old palms are on this account more exposed to attack; perhaps also, they are more attacked because their soft parts lie in the still damp air near the ground, whence the beetle may have emerged and whither, if female, it probably will go to lay eggs. The beetle chews the tissues as it burrows swallowing the juice but ejecting from its jaws the fibrous parts. At first it burrows chiefly for the sake of a lair, but as it wants fresh food throughout its life, it continues its tunnel to feed. It is a matter of chance in what direction the tunnel goes; if by chance it reaches to the centre of the growing apex of the stem, the tree is killed; again if the hole so lies open that rain water gets into it rot sets in and again the tree is killed. But fortunately for the most part the beetle finds food enough in the young leaves enwrapping the apical bud, and by boring transversely through these, tangentially to the apical bud, cuts them while folded so that on emerging from the bud they appear as trimmed,

† The following palms are recorded as attacked by the Rhinoceros beetle:—

Cocos nucifera—the Coconut, *Cocos plumosa, Martinezia caryotæfolia, Phœnix dactylifera*—the Date palm, *Phœnix sylvestris, Livistona chinensis, Verschaffeltia splendida, Dictyosperma album, Hyophorbe amaricaulis, Elaeis guineensis*—the African oil palm, *Corypha umbraculifera*—the Talipot palm, *Corypha Gebanga, Borassus flabelliformis.*

topped, or belted. The damage so done can be measured in the proportion of leaf tissue cut off; in severe cases it amounts to a set back of one year. Rarely does the insect directly kill the tree; but we do not know how often. In Malaya it is certainly common to ascribe to lightning the work of the Rhinoceros beetle.*

The beetle must be attracted to the trees by some chemical substance; and it has been suggested that this is to be found in the odour of the sap, but Friederichs experimented with palm toddy fermented and fresh, and did not take a single beetle thereby. The observation is curious, for it is known that attacked trees may become favourite trees and one boring is followed by another. However, as Friederichs found that the sex odour of the beetles is attractive, we perhaps find an explanation for the repeated attentions of the beetles to one tree in the attraction of a beetle for more individuals of the other sex than one, and the surplus insects being unwelcome in the mating burrow, excavate one of their own in the same tree top.

The beetles of course find some attraction in the decayed material which they seek for egg-laying. Friederichs combining the attraction of rotten cocoa husks with the smell of a large number of imprisoned beetles of both sexes, and placing a light over the cage caught in eight nights ten females and twelve males which were attracted. The catch seems small, and as he remarks hardly worth making.

It is certainly no odour of the flowers, which attracts the beetles, for long before flowering they are attacked; and a writer in the Tropical Agriculturist (Beven, on p. 111 of N.S. vol. xxiv., May, 1905) says that the king coconut is particularly liable to attack in the alternate years between flowering.

The beetles mate in the holes that they make, but rarely lay eggs in them. The eggs are deposited in decayed vegetation wherever that may be; and it is possible that the undoubted cases of egg-laying within the burrow have been induced by some decay within it. Perhaps the burrower has struck an old hole with decay in its sides; but events which take place in the tops of palms are rather hidden from the eye of man. Let it suffice to say that undoubtedly the female rhinoceros beetle does sometimes lay eggs within the burrows, and that then destruction of the tree follows. The writer knows well that the very first signs of decay in a felled palm top are signals for the appearance of young larvæ from eggs there deposited.

Into the holes penetrate the Palm-weevils to lay eggs, and in giving them access to the soft tissues is the unpardonable crime of the Rhinoceros beetle.

---

* Cf Koningsberger, J. C., Mededeelingen van 'Slands Plantentuin, xxii. (1898) p. 42.

The Rhinoceros beetle probably lives long as a mature insect; but observations are wanting. Without food Ghosh found it to live for three weeks. If dissected, very few eggs can be found in the female at any one time, and Ghosh observed that they are laid, say, three on one day, two on the next, two on the following day, and so on, each egg apart from any other.

But unless this slow egg-laying continues over a long period how could one get the millions of grubs which were collected in Samoa? The eggs, Ghosh found, were laid at night. The grubs hatched out after ten to twelve days, at the beginning of June. On the twentieth of October, grubs from these same eggs appeared to him to be full grown. Where Ghosh worked, a cold dry weather sets-in, in October, and is followed by a hot dry weather lasting until June. Ghosh's beetles made no progress during the cold dry season, though they were not dormant. One beetle only survived it and emerged on the fifth of May, having taken nearly twelve months to complete its cycle.

Yet it seems probable that in warmer damper countries such as the Malay Peninsula, growth is continuous and the life-cycle shortened to fewer moths; if this were not so we should find a greater proportion of large full grown grubs than we do, and the writer has some reason for thinking that six to seven months are enough for the beetle to pass from one generation to another: and again supposing that four grubs were introduced into Samoa in 1909, two of each sex, and that they matured and laid eggs, so large a supply as was present in 1913 requires that each female should have deposited considerably more than two hundred eggs, if the period of one generation be twelve months; but if the period of one generation be six months, fifty-four millions might be reared from two females laying fifty eggs apiece.

The grubs are blind, and very soft-skinned behind the head. Five minutes exposure to sunlight kills them at maturity. They have a breathing apparatus capable of being closed, which is an adaptation for living in almost liquid decaying matter. Their demand for moisture is very great. We can kill them easily by letting them dry, and conversely we can greatly encourage them by supplying to them damp coconut stems. There is a no more mischievous practice than that of lining the banks of a ditch or stream with coconut logs and every such place must be ruthlessly destroyed. The practise of using coconut logs for bridges is only a little less obnoxious, and should be stopped. The leaving of stumps in the ground in dry places through dry weather is not obnoxious; but the leaving of stumps in the ground in wet places and in wet weather is; and as sooner or later wet weather comes on the once dry stump becomes damp enough for the beetle-grubs to grow in it. The necessity for removing such stumps depends on the length of time that they are likely to remain damp enough for the grubs—whether it may be a period approaching their (apparently) six months course of growth or less.

Upright tall dead trunks commonly harbour grubs, for the wood decays faster than the bark and a cup which catches rain is formed just suitable to the beetle.

Now it is not to be thought that the coconut stump is the only one to be removed; the beetle can live in many palms apparently as well as in saw-dust of soft woods of trees that have no relationship to the palms. It can live in manure heaps, and old tan heaps; all such heaps should be turned over (if it is necessary to keep them) at least once within the period of the life time of a grub, viz., six months (which period it were better to reduce to three for safety). In turning over the heaps, grubs exposed to the sun will be killed. Old decaying thatch in which it can live, should not be left to breed the beetle. When full fed the grub makes for itself a case in varying fashion; it seems as if it took to rotation and when lying in fibrous material thereby arranged the fibres more or less concentrically, or if lying in earthy material compacted for itself a wall. In this case it turns to a pupa and from it emerges a mature insect, ready to attack the living palms.

The Palm-weevil—*Rhynchophorus ferrugineus*—also has been studied by Ghosh, at Pusa in the Gangetic plain. He bred it in March, April and May and he found that it passed through a life cycle in about two months. As well as from its more destructive habits as from so rapid a course it is more dangerous as a pest than the Rhinoceros beetle; and when, as there has been recently in Singapore, an outbreak of it occurs, we cannot afford to let three months go by as in the case of the Rhinoceros beetle, but must pay constant attention to the infected spot. It breeds at all seasons, and there is no evidence that the cold weather of the Gangetic plain retards its growth, though there is some evidence that egg-laying may be retarded as is the case with the American Palmetto weevil *Rhynchophorus cruentatus.**

The mature beetle seeks the tops of the palms chiefly by night, but also by day, and with its long snout makes a small puncture, into which to the best of its ability it places an egg. If entry is to be had to the inside of the palm by a ready-made hole so much the better for the weevil and the worse for the palm; full advantage is taken of all such holes. In a hole, according to Banks, it does without making any appreciable puncture, but pushes the egg into the tissue a little way. The eggs are laid several upon one tree, near together but not in contact, and if laid from the outside, not within one of the Rhinoceros beetle's borings,—are placed ¼ to ¾ inch deep in the tissue, right at the bottom of the puncture. Eggs were laid in Ghosh's laboratory by day as well as by night. One insect deposited 276 eggs in a life time of 49 days, another 127 in 46 days and four kept together 213 in 24 days. The greatest number of eggs laid

*Summers in Canadian Entomogolist, v., p. 123.

by a single female on one day was 32. The grub, like the grub of the Rhinoceros beetle, shuns light and is easily killed by exposure to the sun; it likes much moisture so that the hacking open of stems in which they have been growing and the exposure of them, is a good preliminary operation whenever an attacked palm has to be cleared away. They seek the softest tissues of the palm and therefore the very heart, and if left undisturbed they kill the tree with a certainty which is foreign to the Rhinoceros beetle. They do not need the tissue to be absolutely healthy, but finish their growth in dying palm stems among most obvious decay. At maturity they make a case twisting fibres from the stem round themselves and to reach the fibres they have to approach the outside of the trunk which they do close to some place from which they can emerge. The twisting on the eve of pupation is only an exaggeration of the grubs ordinary movements in progression. The pupa stage lasted, under Ghosh's observations, about 25 days.

The most rapid growth recorded by Ghosh was of one insect which emerged as a perfect beetle, 48 days after the egg was laid; 54 and 56 days were quite common periods.

The palm weevil feeds on other palms as freely as on coconut palms. It is recorded as destroying *Oreodoxa regia*,—the Royal palm, *Borassus flabelliformis*, *Phœnix sylvestris*, and the writer has found it in *Arenga saccharifera* and *Elaeis guineensis*. Such palms require watching as do the coconuts for signs of the presence of the grubs, because outbreaks may commence in them and spread to the coconut palms.

Blanford, in an interesting paper on the American Palm Weevil (Kew Bulletin, 1893, p. 37), refers to a very reasonable belief that the period when that insect became a most serious pest in British Honduras began with the giving over to cultivation of ridges where the *Attalea* palm grew. The Attaleas were felled and left to decay, whereupon the weevils multiplied excessively, and flew when their food on the ridges existed no longer, to the near coconut plantations, doing there very extensive injury.

As in the case of the felling of the *Attalea* palms in Honduras, so now in Malaya during the current vogue of removing coconut palms from among rubber, we have a menace to the coconut plantations. A young coconut, such as is so often cut, affords to the palm weevil a splendid breeding ground; it is nutritious from top to bottom, and the beetle is very prompt to take advantage of it.

This is a fact worth remembering; and experience lately in Singapore Island has shown that double vigilance in coconut tree inspection is required, while land owners, of small means and small knowledge, or it may be wanting in public spirit, continue the felling of coconut palms on their properties.

SUMMARY.

The Rhinoceros beetle, though laying eggs slowly, can multiply with great rapidity and as it in all places seems to kill a few coconut palms, when it is unchecked the amount of destruction done may mount up to something appreciable (upwards of 1—2 per cent. in the worst localities in Samoa); beyond the destruction there is a reduction of the yield in less severely attacked palms. Young palms are more liable to its attacks than old ones, partly because they stand in the still or moist air near the ground where the mature beetle seems chiefly to fly, but more because of the greater length of relatively soft tissue which they offer to attack.

The mature beetle tunnels in palms for the sake of food, making its tunnel a lair; it usually burrows through the enfolded young leaves and does not reach the heart of the cabbage and so does not kill the palm: it probably lives for several months, the female steadily laying eggs throughout the period, but the duration of life and the continuance of egg-laying are matters of conjecture. The beetles, and their grubs, shun day-light: they mate in the feeding tunnels or else in the places where the eggs are laid. They sometimes fly to light at night, but not with sufficient readiness for lights to be used as traps. There is something about a palm attractive to them, but it is not the odour of the drawn sap nor of the flowers. The opposite sexes have an attraction for each other; but the caging of the one to entrap the other is only moderately effective. Eggs are laid in decaying vegetation, and when as sometimes happens they are laid in living coconut stems, it may be that some decay had already been set up in an old wound. The smell of decaying vegetation, particularly of decaying palm stems is very attractive to them and may be used for the making of traps. The eggs hatch in 10-12 days, and the grub seems to require about five months for maturing; then it pupates and remains for a brief time as a pupa, emerging a beetle, it would seem, within seven months of the laying of the egg, unless cold or dry weather delays it.

The grub is very thin-skinned, and requires moist food; it can live in very moist food (slush). Exposure to dry air very rapidly kills it.

The way to attack the insect is to remove its food-supply, for although within the region of its natural distribution there are doubtless parasites and enemies, which do something in the way of keeping its numbers down, we know nothing of them, nor are we likely at present to use them to effect. Where the insect has appeared in excessive numbers, the cause has been man, in most, if not in all cases; usually man by putting an exceptional amount of food in the way of the insect, has given it the means of unduly increasing. It behoves us to keep all vegetable refuse under control both in the plantations and about neighbouring tan-yards, saw-mills and villages, for the beetle is not of restricted flight. Old coconut stumps and trunks

sooner or later become vegetable refuse, which must be removed. Traps such as those described above, are effective in direct proportion to the cleanliness of the area in which they are.

When many stumps have to be removed the cheapest method of destroying them is by the use of explosives.

The Palm-weevil goes through its life-history more rapidly than the Rhinoceros beetle; and it would seem that it should multiply more rapidly, as the female can lay nearly 300 eggs within fifty days, but that it is less in evidence is probably due to the circumstance that it is so much more particular about its food; it may be also that it has more enemies, but this we do not know. In any case it is to be remembered that an outbreak of it would be more rapidly destructive than one of the Rhinoceros beetle.

The female lays her eggs in living palm tissue, taking advantage of wounds, of which the commonest are those made by the Rhinoceros beetle; the mature beetles also feed on the palm tissue. If the female finds no hole in the palm, she makes one for herself, but only ¼ to ¾ inch deep; into it she places one egg; if she finds a Rhinoceros beetle tunnel she pushes eggs into its walls. The nearer to the heart of the tree the eggs are placed, the more serious must the attack be; the heart of the attacked palm is then tunnelled through by the fat greedy grubs, and its top falls over, declaring the presence of the invader only when the damage done is past repair. Though the grubs may not be mature when this happens, they finish their course in the tissues. The eggs may be laid also in palm tissues commencing decay.

Soft decaying palm-tissue should never be left lying about the estates to the advantage of the beetle, neither of coconut palms, nor in a general way of other large palms, for though there are palms in which the tissues hold abundant needle-crystals, until a palm, whatever it be, has been proved unpalatable to the grubs, it should be looked upon as possible food for the weevil.

I. H. BURKILL.

CLEROME GRACILIS,

a Butterfly destructive to Palms.

A social caterpillar with a yellow head, black body, densely covered with long hairs which are rusty red above the base, and freely come out, irritating the human skin, had been found doing damage to Rhopaloblaste palms in the Botanic Gardens. It was reared to maturity and proved to be *Clerome gracilis* Butler.

The caterpillars, both when feeding and when resting, take line from each other: they stand parallel on the lower surface of the leaf that they are or have been eating. They feed at night and rest by day.