

THE COCO-NUT LEAF-MINER

Promecotheca papuana, Csiki (*antiqua*, Wse.)*

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Marked infestation by *P. papuana* sporadically occurs in various parts of the Territory, but it is usually worst in those parts where no definite dry period occurs throughout the year. Its attacks are not confined to palms of any particular age, occurring from the young plant with one or more expanded leaves to a palm 80 feet or more in height.

Infestation usually begins along the sea frontage, and, if not checked, later spreads inwards. In the early stages, the attack is confined to a limited number of palms, and may be localized in one or more groups of palms. Under normal conditions, the pest is held in control by *Microhymenopterous* parasites of the eggs and larvae.

At the end of 1937, this pest appeared along that portion of the North Coast-road from Rabaul, where coco-nut palms and all other vegetation had suffered severely from the effects of the deposition of pumice dust resulting from the eruptions in Blanche Bay in May of that year. In the early stages of infestation the attack was limited to a comparatively narrow strip along the foreshore, but measures recommended were not adopted by the owners of plantations and groves within the area, and the infestation rapidly developed into severe plague form within the limits of a strip for the most part not more than a quarter of a mile wide from the sea. Small localized infestations occurred later at several sites along the roads leading from the North Coast towards Kokopo, and investigation showed that these were places where natives, carrying produce to and from native markets within this area, were accustomed to stop either to rest or for making a centre for sale. The produce was carried in baskets made from plaited coco-nut foliage, and examination of these baskets proved that many of them carried either *Promecotheca* egg masses or larvae; baskets on being emptied were thrown away into the undergrowth, and, in many cases, the adult beetles had bred out and attacked coco-nut palms in the immediate vicinity. Outside the main infested area a slight attack of the pest was seen, but natural parasites quickly stopped any serious development; within the severely infested area parasites gradually bred up naturally, and were assisted by liberation of adults bred in the laboratory, Rabaul, and, finally, by May, 1938, had the plague under control.

A short account of the life history of the pest and of the *Microhymenopterous* parasite indigenous to New Britain are here given, with directions for control.

The Adult Beetle.

The adult beetles are slightly less than 1 cm. in length (.8-.9 cm.), and about .4-.5 cm. in width; the antennae are dark, the head and thorax iridescent dark blue; slightly more than half of the anterior portion of the elytra (wing covers) is yellow to orange in colour and the remainder dark metallic blue. Colour variations occur in some parts of the Territory, the metallic blue markings being much reduced in extent and intensity, and the orange to almost a yellow-brown.

* *Vide Entomological Bulletin* No. 1, T.N.G., — *New Guinea Agricultural Gazette*, Vol. 2, No. 1, 1936.

At first, the beetles feed only on the younger foliage, and on the under-surface of the leaflets in lines running parallel with the veins in the leaf. The edges of these feeding areas shrivel and tend to contract the surrounding tissues, causing the leaflets to curl. Where the number of beetles is small, the amount of damage so caused is relatively slight, but as the numbers increase with the development of succeeding generations, the damage caused by the adults alone is considerable. As the female beetles become gravid and are ready to deposit eggs, a migration gradually takes place onto the older foliage, where feeding will then also take place.

Normally, the adults cling firmly to the under-surface of the foliage, but may be disturbed by high winds, or by persons approaching close to young palms. The beetles will then drop downwards from the leaf and then fly upwards, but they are not strong fliers and do not travel far on the wing.

Adults kept under observation in the insectaries on growing palms have lived for more than six weeks, but it is possible that this period may be longer under field conditions. Deposition of eggs under insectary conditions in Rabaul continued for nearly the whole life of the female and occurred in from four to six days after emergence from the mine.

After emerging from the pupae, the adults remain in the mine until the body has hardened up and then cut their way through the upper surface of the leaf, generally not eating a hole but cutting sufficient to form a flap.

The Eggs.

The eggs are laid flat on the under-surface of the leaflets, and covered with fine portions of undigested leaf tissue set together by a mucous secretion from the female. From one to four eggs may occur in mass, but two or three are the more common. The egg mass on the leaf presents a dome-shaped structure with the long axis of the mass slightly more than 3 mm. in length and the shorter width of about 2.5 mm.

The eggs are laid side by side, and measure slightly over 1.5 mm. (average 1.7 mm.) in length. The period from deposition of eggs to emergence of larvae has been from 11 to 17 days (average 12 days) in Rabaul, and 13 to 16 days in Manus.

The Larva.

On emergence, the larva breaks the surface of the leaf and commences to feed on the green tissue in between the two surfaces, which are thus caused to separate and form a "blister". The leaf tissue so affected dies and turns brown. A single mine may extend the whole length of a leaflet, but is often very much shorter, depending largely on the number of larvae present. They feed straight ahead, the excreta being cast behind, but on such occasions as may arise where the mine comes against another older one, the larvae may turn and continue in another direction in fresh tissue; also, when they come to the tip of a leaflet, they may return through the mine and start out afresh from the other end or from some place on the side; such cases mostly occur when the infestation has developed into plague proportions.

The adult larvae are dull, creamy white in colour with a brown head-capsule, and measure slightly more than 1 cm. in length (average 1.2 cm.). There are three larval instars, which may be readily distinguished by the size of the head capsule, the average of a series of measurements being—

1st instar	..	..	..	..	..	.5421 mm.
2nd	„	..	..	..	..	.7276 mm.
3rd	„	..	..	..	..	1.0519 mm.

The larvae prior to moulting on the completion of each instar (stage of growth when the old skin is shed), and also before pupation, retreat from the head of the mine into the old channelling for two to three days. This habit often causes the death of many of the first instar larvae in particular, due to the drying of the tissues at the head of the mine forming a barrier that the newly-moulted larva cannot penetrate.

This dry band persists in the mines, even after the next stage larva passes on, as a faint dark line, and forms one means of determining what stage of development the larvae have reached in any mine. An examination of the cast head capsules in a mine also determines the stage of development of the larva.

The number of larvae present in a mine varies from one to four, a series of counts giving the following percentages:—

1 larva per mine	..	..	..	..	..	14.7
2 larvae	„	..	..	..	..	45.9
3	„	„	..	..	..	33.9
4	„	„	..	..	..	5.5

Under insectary conditions in Rabaul, the larval stage varied from 17 to 23 days (average 18 days). In Manus this period has varied from 17 to 29 days.

The Pupa.

The pupa is light brown in colour, and measures slightly less than 1 cm. in length (.8 cm. average), and externally exhibits the structure of the adult, tightly compacted together. It is capable of a certain amount of movement within the mine, which is especially noticed if the walls of the mine are touched in the immediate vicinity of the pupa.

Under insectary conditions in Rabaul, the pupal period varied from 12 to 24 days (average 21 days). In Manus, this has varied from 15 to 16½ days.

Life Cycle.

From the figures obtained by breeding the beetles in insectaries in Rabaul, it has been found that the life cycle (the period from deposition of egg to emergence of adult) varies from 44 to 52 days, with an average of 48 days. In Manus, the life cycle has varied from 48 days to 60 days (average 55 days).

Control.

In order to control the pest before material damage is caused, it is essential that measures be undertaken as soon as the pest is first noticed. The pest population is then small and limited in spread, so that the extent of the work that has to be done is so much less than is the case once the pest has started to spread from the original centre of infestation.

There are three lines of attack that may be adopted, either singly or in conjunction with one another—mechanical measures, the use of insecticides as either spray or dust, and biological measures.

MECHANICAL MEASURES.

Wherever *Promecotheca* appears in numbers beyond normal for the locality, and while natural enemies, wasp parasites, are in insufficient numbers to hold the pest in check, cutting off and burning infested fronds, combined with collecting and destroying all the adult beetles possible, will check an infestation satisfactorily. This work must, however, be carried out thoroughly and extensively over the affected area. Such measures were carried out with success over a very large extent of coco-nut lands in the Philippines in 1930-31, and have also proved successful on more than one occasion in this Territory in the initial stages of an outbreak. If the fronds are cut carefully, the greater majority of the beetles will come to the ground on the fronds and can there be readily collected and destroyed.

In such cases as those in which flares on poles can be handled with reasonable ease, scorching of the undersurface of the fronds will kill large numbers of the beetles, and destroy larvae in the mines. Comparatively tall palms have been treated in this way by fastening half a dry coco-nut husk to the end of a long bamboo to the top end of which two long ropes were tied; one native held the base of the pole, and two others held the ropes at different points out from the base of the pole and drew the flare along the fronds and around the palm.

In areas where palms are sufficiently small to be reached from the ground or from low stages, the egg masses can be rubbed off the leaves, the adults collected, and the larvae crushed by drawing the mines through between the thumb and fingers; this would obviate the removal of the foliage.

In all cases where the parasites are found to be multiplying, any measures that lead to the destruction of the mines will kill large numbers of the wasps, and hinder the rate of natural control of the pest.

Any source from which the pest may travel into cultivated areas should be searched for and, when found, should be thoroughly treated.

A method that can be used with advantage to destroy numbers of the adult beetles where plentiful, is to cut fresh young fronds of any palms that may be attractive to the adults (e.g., "sak-sak," *Metroxylon saga*, or "nipa" palms, *Nipa fruticans*), and standing these upright in the ground in rows between the

palms; the beetles come to rest on the fronds, on which they can be destroyed by spraying with strong soap solution, or other contact insecticide, or by hand collection.

USE OF INSECTICIDES.

Stomach poisons (such as lead or calcium arsenate), or contact insecticides (such as soap solution, lime sulphur fluid, or nicotine sulphate), can be applied as sprays or dusts, where power spraying or dusting machinery is available and, with the former, where sufficient supplies of soft water are readily obtainable. Nicotine sulphate (i.e., "Blackleaf 40") can be mixed with the arsenicals to make a combined stomach poison and contact mixture. It must be remembered that the action of a contact insecticide is relatively transitory, although the action may be fairly rapid, but the arsenicals remain on the foliage for an appreciable time after application.

For spraying, arsenate of lead is mixed at the rate of 1 lb. of the powder, or $1\frac{1}{2}$ lb. of the paste form, to 50 gallons of water. Unless a "sticker" is already mixed with the powder, it is advisable to add some preparation that will assist in making the poison spread out on and adhere to the foliage; calcium caseinate is a general-purpose preparation that can be used for this purpose with safety.

Nicotine sulphate is obtainable as a standard preparation under the name of "Blackleaf 40", and is generally used at a rate of 1 part to 800 parts of water.

Using dry dusts, derris preparations can be used in addition to arsenicals, and, in tests carried out, it has been found that 10 per cent. arsenate of lead, using fine ground lime as a filler, and a preparation containing 1 per cent. "cube" content, killed 90 per cent. of the beetles treated within two days, and calcium arsenate killed 60 per cent. in the same time. Arsenate of lead and the derris preparation, combined in one dust, killed the same percentage as either alone.

Arsenate of lead sprayed on to foliage killed over 95 per cent., and the foliage so treated remained toxic for at least a week, even after being exposed to rain. Both nicotine sulphate and lime sulphur fluid killed the adult beetles quickly, but the foliage did not remain toxic for more than a few hours after application.

BIOLOGICAL CONTROL.

The value of parasitic insects in the control of scale insects has been known for many years, but their use for the control of beetle pests is only of recent date.

During the course of observations on coco-nut pests in 1930, a small *Hymenopterous* parasite of the larvae of *Promecotheca* was found at two centres on the south coast of New Britain, and, later, the same parasite was collected at other centres on New Britain. At none of these places was there more than a trace of the pest, and the number collected was very small. Specimens sent to the Imperial Institute of Entomology, London, were determined as belonging to the family *Eurytomidae*, genus *Eurytoma*. The number of specimens available were

insufficient to enable a specific identification to be made, but a larger series has since been despatched for this purpose. From information on hand, it is evident that this is the natural control of *Promecotheca papuana* in New Britain.

In the early stages of the *Promecotheca* outbreak on the North Coast-road, Rabaul, in 1937, this parasite was found in small numbers over the greater part of the infested area, but was definitely numerous outside that area. On the northern side of the infestation nearer to Rabaul, these wasps were more numerous than elsewhere within the affected sector. In those parts where the parasites were plentiful, the number of mines was so small that the possibilities of distribution of the wasps from these centres were strictly limited. In March, 1938, it was evident that the parasite had increased very considerably, and the effect of its work became marked over a large section of the area by early April.

With the supply of material available, breeding of the parasites was taken up in the laboratory in Rabaul, partly to study the life history and habits, and partly to breed up for liberation in the field. The wasp bred readily in captivity, especially in 2nd and 3rd instar larvae. The mines carrying the larvae were placed in glass tubes with parasites, which were fed on slightly-diluted honey, or sugar syrup; exposure of the mines to the parasites was maintained for three to four days, when the mines were placed in new tubes, and the parasites transferred on to new mines.

The adults of *Eurytoma* sp. are small metallic black wasps with an iridescent green sheen on the body: the joints and tarsi of the legs are whitish. The female measures up to 3.7 mm. (.15 of an inch) in length, with the male rather smaller (2.8 mm. = .1 of an inch). The antennae of the two sexes are quite distinct, and form a ready means of identification for separating the sexes in arranging the proportions in the breeding tubes.

The female wasp punctures the upper surface of the *Promecotheca* mine with the lancet-like ovipositor and deposits the eggs on the outside of the host larva. The parasite grubs, on emerging, attach themselves to the body of the *Promecotheca* grub and suck the body substance until only the mere skin remains. When the host larva is attacked, it retreats from the head of the mine, and becomes dormant, and exhibits little, if any, movement when disturbed.

The wasp larvae are elongated whitish bodies about 3 mm. in length when full grown; there are usually 4 to 5 per host larva, but there are often more. Pupation usually takes place on the site of feeding, each pupa being attached separately to the wall of the mine by the anal end of the body. The pupae are jet black in colour and are about the same size as the adults.

On emergence from the pupa, the adults remain for a short time within the mine, and then eat a small circular (emergence) hole through the leaf tissue, usually on the upper surface, although some emerge through the lower surface, immediately over the site of pupation. There may be any number of emergence holes from one to seven, but usually there are two to four per mine. As many as 25 adults have been bred from a single mine, but the number will obviously vary according to the number of *Promecotheca* larvae present.

The life-cycle has varied from 15 to 19 days (average 17 days) in the laboratory in Rabaul; the adults have lived for six to seven weeks, males usually dying before the females. Strong colonies have been bred, using female wasps six weeks old.

Eurytoma sp. is apparently only a larval parasite, more readily developing in the second and third instar larvae. Pupae placed in the tubes with the live parasites matured into adult beetles, although in a few mines dead pupae of *Promecotheca* have been found which appeared normal, but may have been attacked by wasp larvae which, although unable to penetrate the pupal integument, yet caused the death of the pupa.

OTHER PARASITES RECORDED FROM THE TERRITORY.

In the Rabaul-Kokopo and Gasmata areas other species of small wasp has been bred from *Promecotheca* larvae; the species has been identified as belonging to the family Eulophidae, *Closterocerus splendens*, Kovv.; this species has also been bred from *Promecotheca* larvae in Manus.

In the Manus district, two other larval, and one egg, Hymenopterous parasites have been bred from *Promecotheca* mines and egg-masses collected in the field. Both the larval parasites belong to the family Eulophidae, one a *Derostenus* sp., and the other *Entedon* sp.; the egg parasite has been identified as *Anastatus* sp.) (family Eupelmidae); *C. splendens* has also been bred from *Promecotheca* eggs collected on New Britain.

Small ants have been found destroying *Promecotheca* egg masses.

The "Kurukum" ant, *Oecophylla smaragdina virescens*, F., has often been stated to destroy *Promecotheca*, but our observations do not support this statement. Plantations and groves badly attacked by *Promecotheca* have been examined in which this ant was in swarms, not only in the heads of the palms, but on other vegetation amongst the palms. An experiment was carried out in the Talasea district, where an island on which *Promecotheca* infestation was present was selected, and these ants introduced from other parts, and left untouched for several weeks; the infestation at the end of the period had increased to severe proportions in the interim.

The Pentatomid *Amyotea reciprocus* Walk has been found attacking *Promecotheca* adults; this predator is, however, relatively scarce.

PROMECOTHECA PARASITES IN OTHER COUNTRIES.

Taylor records two parasites of *Promecotheca reichei* Baly in Fiji—*Oligosita utiles* Kaw. of the eggs, and *Elasmus hispidarum* Ferr. of the larvae—and also a mite, *Pediculoides ventricosus* Newp. All the parasites referred to, except the mite *P. ventricosus*, are minute wasps.

The mite attacks the parasites as well as the *Promecotheca* larvae, and negatives the value of the wasp parasite to such an extent that Taylor was sent to Java to study any *Promecotheca* parasites in that country. Three primary parasites of *Promecotheca nuciferae* Maulik. were found,* of which *Pleurotropis*

* *Biological Control of an Insect Pest*, T. H. C. Taylor, 1937.

parvulus Ferr., a larval and pupal parasite, was successfully introduced into Fiji in 1933. This species was also introduced into the New Hebrides at the end of 1937 from Java by Dupertuis.

Larval parasites of *Promecoltheca cumingi* Baly have been recorded from the Philippine Islands.

INTRODUCTION OF *P. PARVULUS* INTO THE TERRITORY OF NEW GUINEA.

In 1936, the possibilities of introducing this parasite into this Territory from Fiji were investigated, but a combination of circumstances then prevented it being carried out.

Early in 1938, a colony of *Promecoltheca* larvae, parasitized by *P. parvulus*, was sent from the New Hebrides through the courtesy of M. Dupertuis, but owing to extended delays in transit they were all dead on arrival. Later in the same year, through the assistance of W. R. Carpenter & Co. Ltd., and of the Department of Agriculture, Suva, another colony of adult *P. parvulus* was introduced from Fiji, by steamer to Sydney and thence by aeroplane to Rabaul, but these died *en route*. Finally, another colony from Fiji arrived alive on 6th September, 1938, partly as adults and partly as pupae in parasitized adult larvae of *Promecoltheca*. This package was despatched in ship's cooler from Fiji to Sydney, where, on the ship's arrival, W. R. Carpenter & Co. Ltd. kept the parasites packed in ice, and, without delay, freighted them by mail plane to Rabaul.

The introduction of these parasites over so great a distance without personal and daily attention was due to a set of exceptionally favorable circumstances, that are rarely to be met with, owing to the synchronizing of steamer arrival and plane departure from Sydney. Any further period of cold storage in transit would almost certainly have been fatal to the parasites.

The adult parasites received were set on larvae of *Promecoltheca papuana* the same day as received, and breeding work continued until all the parasites died. The first generation was not as large as was hoped for, possibly due to the effect of the long transit in cold storage. The second generation was, however, highly satisfactory, and liberations in the field were commenced within eight weeks of the receipt of the original colony.

A few notes are given on the life history, habits, &c., of this parasite, ascertained during the breeding work in developing the colony for acclimatization and distribution.

The adult females are about one-twentieth to one-twenty-fifth of an inch in length, with the males smaller; the former lived for a period up to 21 days, and the latter a few days less.

The adults are very active, the females being strongly attracted to light; they have fed freely on slightly diluted honey.

The life cycle occupied from 17 to 23 days, with an average of 19½ days.

The highest number of parasites from a mine containing three *Promecoltheca* larvae was 39 in the first generation, and from a four-larvae mine 79 in the second generation.