Observations of the Biology and Control of the Armyworm Tiracola Plagiata *Walk. (Lepidoptera : Noctuidae)*

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SERIOUS damage to agricultural crops by the armyworm caterpillar *Tiracola plagiata* Walk. is described by Corbett and Gater (1926), Weddell (1930), Kalshoven (1950) and Catley (1962). In each instance the pattern of attack is similar and it appears to be typical for this species. The caterpillars breed up very quickly in enormous numbers on weeds and other secondary growth plants, from which they migrate to cultivated plants and cause considerable damage. Despite the widespread distribution of this pest in tropical and sub-tropical countries, little has been published regarding its biology. Temperley (1930) made a preliminary study of the life history in association with Weddell's investigations in Queensland in 1927, but no studies have been undertaken in tropical areas. From Malaya, W. P. Panton advised (in litt. June 1962) that all that is known about the species there is that the pupal stage is from 16 to 18 days. The lack of knowledge of the biology of *T. plagiata* can be ascribed to a major degree to its relative unimportance as a pest in tropical countries, where it is usually controlled in a very short time by naturally occurring parasites and predators.

Recently, however, it has assumed the status of a major pest of cacao at Popondetta in the Northern District of Papua (Catley, 1962). During the course of investigations into this sustained outbreak some observations on the biology of the species in the field and in the laboratory were made and are herewith recorded.

Eggs.—The eggs are laid at night in batches of from 200 to 1,200 on the leaves of the host plants. The favoured site is on the undersides of the youngest leaves, and on cacao the new flush leaves are selected, although eggs are also found on older leaves. It appears that some trees are more attractive egg-laying sites than others and frequently a tree will have up to eight batches of eggs whereas adjacent trees will be completely free of them.

In Queensland, Weddell (1930) found eggs were generally laid singly in the field and these were on the upper and lower surfaces of inkweed leaves which was the commonest weed species involved in the Queensland outbreak.

The colour of the eggs is white with a faint green tinge. (Plate I.) Shortly before hatching, they become progressively darker until they are almost black. This is due to the dark colour of the head capsule and prothorax of the caterpillar becoming visible through the shell of the egg

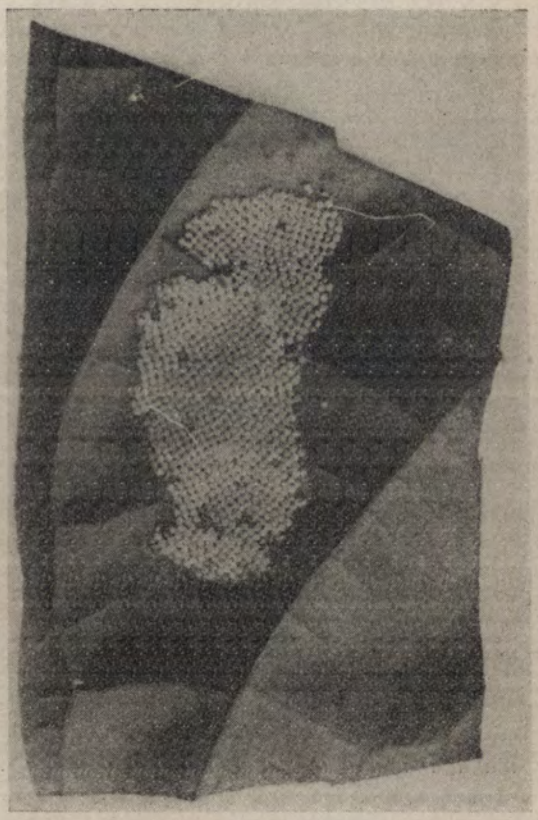

Plate I.—Egg batch of *Tiracola plagiata* on underside of cacao leaf.
[Photo : A. Catley]

which retains its colour. (Plate II.) They are globular in shape and about 0.7 to 0.8 mm. diameter. The surface is ornately patterned with longitudinal striations radiating down the egg from the top to the bottom with smaller lateral striae in between. Under field conditions at Popondetta, the incubation period is three and one-half to four days.

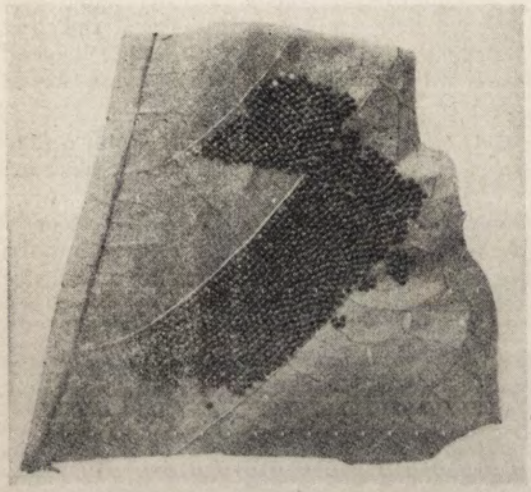

Plate II.—Egg batch of *Tiracola plagiata* prior to hatching.
[Photo : A. Catley]

Larvae.—The larva emerges from the egg by chewing around the topmost side which is then pushed back on itself to enable the larva to crawl out. Eggs of a particular batch hatch within minutes of one another and feeding commences immediately—generally the shell of its own and neighbouring eggs is first devoured and unhatched eggs may also be attacked. Provided the host plant is acceptable, the larvae are able to rapidly skeletonize the leaves by feeding between the veins, which are too hard for the mandibles to penetrate.

The young larvae are positively phototropic and in the laboratory they congregate on the lighter side of breeding jars.

Shortly after hatching, the larvae begin to wander away from their fellows and silken threads are produced from labial glands. These threads give the caterpillars much greater powers of dispersal and they can drop and swing from them and even ascend them by rolling the threads into compact balls between their thoracic legs. By the time the larva gets to the fourth instar the silk thread is no longer used as a medium for dispersal, possibly because the insect is too heavy for the thread at this stage.

Six larval instars have been observed for *T. plagiata.* In the first two instars the body is straw coloured with rows of dark tubercules along the dorsal and lateral sides of the body, giving an overall appearance of black stripes on a grey background. The colour of the third, fourth, fifth and sixth instars is similar—the head is reddish brown and the body smoky black with a prominent cream to yellow coloured band along both sides of the abdomen. On the dorsal surface of the first abdominal segment are two irregular white spots either side of the mid-line. There is also a diffuse white area at the tip of the abdomen on the dorsal surface. (Plate III.)

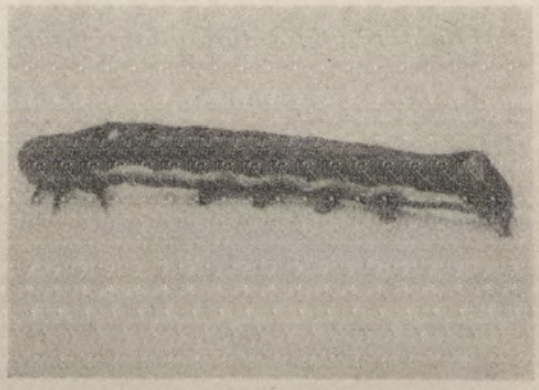

Plate III.—Sixth instar larva of *Tiracola plagiata.*
[Photo : A. Catley]

The larvae are very easily disturbed and in the early stages they will drop on their threads at the slightest pretext. The older larvae will drop to the ground and curl up upon themselves with the head withdrawn into the body. Another defensive reaction when approached is the expulsion of a green fluid from an eversible gland which opens on the ventral surface of the body immediately behind the head. This reaction is often accompanied by the caterpillar rearing up on its abdominal prolegs in a threatening attitude.

After from fifteen to seventeen days under field conditions at Popondetta, the larva is fully grown and about two and one-half inches long. At this stage the body colour often lightens somewhat to a pale smoky brown colour with almost white lateral stripes.

Prepupa.—At the completion of feeding, the larva becomes sluggish and either walks or falls to the ground where it excavates a cell in the earth and enters the prepupal stage. The body shrinks considerably and after about four days the skin splits longitudinally and the pupa wriggles free into the earthen cell.

Pupa.—During the pupal period which lasts about twelve days, with a range of ten to fifteen days, the tissues of the larva are broken down and reconstituted to form the substance of the adult moth.

The pupa is a reddish-brown colour and about 2 cms. long (range 1.9 to 2.3 cms.). The last four segments of the abdomen are capable of movement and when handled the pupa wriggles considerably. At the rear of the pupa are two spines surmounting four stouter ones.

Adult.—Emergence of moths always occurs at dusk or during the night. They are strictly nocturnal creatures and only very rarely are they seen in plantations during the day, although a few have been seen resting on the undersides of cacao leaves and on the trunks of *Leucaena glauca* shade trees with which they blend very well. They are not attracted by white light.

The moths are about 2.8 cms. long with a 4.7 cm. wing span. The colour is grey to pinkish-fawn with a distinct dark brown to black V-shaped mark on the fore margin of the fore wings. The lateral margins are somewhat darker than the rest of the wing. The hind wings are smoky grey with lighter fore and lateral margins. The dorsal surface of the abdomen is smoky grey and darker than the sides and underside. (Plate IV.)

Moths have not been induced to mate or oviposit in the laboratory but field observations indicate there is a preoviposition period of about four days after emergence from the pupae.

Total duration of the life cycle from egg to egg occupies about thirty-five to forty days in the field but experimental lengthening of the larval period has been obtained by withholding food so it seems probable that under adverse conditions of poor nutrition the length of the life cycle could be extended considerably but this is not considered to be applicable to the plague outbreaks at Popondetta where there is an abundance of food.

In Queensland where rearing experiments have been undertaken by Temperley (1930), the length of the life cycle averaged 91.9 days under laboratory conditions with each stage

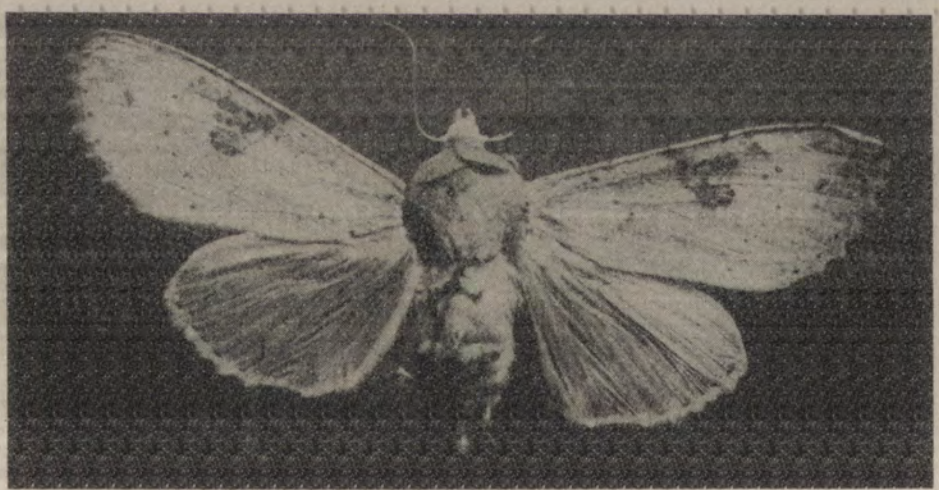

Plate IV.—**Adult moth of *Tiracola plagiata*.**

[Photo : N. Moderate]

occupying a greater period than that observed at Popondetta. The main cause of these differences can be attributed to differences in climatic conditions since not only feeding stages but also the morphogenetic ones were lengthened considerably. (See Table I.)

Control.

Investigations into the nature of the outbreak at Popondetta revealed many natural controlling factors acting against *Tiracola plagiata* but none of these was in sufficient numbers to exert a satisfactory degree of control. (Catley, 1962.) Accordingly, trials were undertaken to determine the most satisfactory insecticide which could be employed against the pest.

Since only the cacao flush growth was being seriously damaged, it was decided to concentrate on the protection of this as each wave of caterpillars appeared, at five to six-week intervals. The rhythmic cycle of attack made control much easier since outbreaks could be predicted with a fair degree of certainty and the spray could be applied at the most opportune time. With *T. plagiata* this is when the insect has just hatched from the egg. A spray applied to the tops and undersides of the flush leaves, particularly at the latter site, can kill many hundreds of caterpillars since they are then clustered together and they are very susceptible to the action of the insecticides.

In the Territory of Papua and New Guinea, the choice of insecticides is very much restricted because of the difficulty experienced in getting plantation workers to wear protective clothing, consequently the more toxic materials are not generally used. For the purposes of the Popondetta trials, D.D.T., Sevin, Dieldrin and Endrin were selected.

Two-acre trial blocks were selected and tops and undersides of flush cacao leaves were sprayed with high volume apparatus (knapsack or pneumatic type sprayers) when the eggs and young larvae appeared.

Results.

The concentrations selected for the trials were 0.25 per cent. D.D.T., 0.15 per cent. D.D.T., 0.2 per cent. Sevin, 0.15 per cent. Dieldrin, 0.025 per cent. Endrin and 0.05 per cent. Endrin.

Of these materials, Dieldrin was found to be markedly inferior to the others and this appears to be generally the case with Dieldrin when used against noctuid caterpillars in Papua and New Guinea.

Endrin, D.D.T. and Sevin all gave satisfactory control of the caterpillars, but the residual effect of Endrin even at 0.05 per cent. concentration was only about three days as against six days for D.D.T. at 0.25 per cent. concentration and Sevin at 0.2 per cent.

Although 0.15 per cent. D.D.T. was effective in controlling the caterpillars, the residual effect lasted for only about three days and this was insufficient to protect the flush growth until it had hardened and become resistant to attack.

Sevin at 0.2 per cent. did not give any better results than 0.25 per cent. D.D.T. and in view of its greater cost and its wettable powder formulation, it was decided to make 0.25 per cent. D.D.T., applied with high volume apparatus, the standard control recommendation.

The effect of insecticide applied to the egg batches on the leaves was also studied and it was found that Endrin, D.D.T. and Sevin at all concentrations killed the eggs if applied before the "dark stage" shortly before hatching. However, even though larvae still emerged from the eggs, they were invariably killed by contact with insecticide deposits about the eggs.

High volume sprayers are quite satisfactory for use on young cacao trees where only about eight to twelve gallons of spray are required per acre, but once the trees have ramified, considerably more spray is required to cover the flush leaves and cartage of water can be a real problem.

In view of this, low volume spraying trials were undertaken using 2.5 per cent. D.D.T. in water and applied with portable motor driven spraying machines. Satisfactory control was obtained although there was some difficulty in controlling the direction of the spray and it was rather wasteful. Another factor which mitigates against the use of low volume apparatus is the necessity for skilled operators, and these are difficult to obtain in plantation labour lines.

Another material tested against *T. plagiata* at Popondetta, although not generally considered as an insecticide, was a commercial preparation of the insect pathogen *Bacillus thuringiensis*

Berliner. This was obtained from the United States of America where it is marketed under the name of "Thuricide." The preparation tested was a wettable powder formulation containing 30 x 10^9 viable bacterial spores per gram of material. Larvae of all stages were fed on leaves dipped into a heavy suspension of the spores in water but no abnormal symptoms developed after ten days of feeding. The only effect observed was an initial distaste for treated leaves but this was probably due only to the gritty texture of the carrier material. Normally susceptible caterpillars begin to show symptoms of infection within twenty-four hours of feeding and death occurs after three or four days.

Table I.

Duration of Developmental Stages of *Tiracola plagiata* in Queensland * and at Popondetta **

Locality	Length of each stage in days					
	Egg	Larva	Prepupa	Pupa	Pre-oviposition	Total length of life cycle
Queensland (laboratory averages)	8.2	45.7	8.3	29.7	—	91.9
Popondetta (laboratory and field observations)	4	16	4	12	4	40

* Based on Temperley (1930)

** Estimates based on field and laboratory observations at Popondetta

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