Tiracola plagiata *Walk. (Lepidoptera : Noctuidae) A Serious Pest of Cacao in Papua.*

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Distribution.

Tiracola plagiata Walk. is distributed from India to Australia. Commonwealth Institute of Entomology records (in litt. Dec., 1961) include Darjeeling, Bombay, Canara, Ceylon, Sarawak, Java, Moukin, Assam, Central Ceram, New Guinea, Queensland and the Philippine Islands. Tams (1935) lists its occurrence also in Tonga and the Samoan Islands. It is also recorded from Murwillumbah on the north coast of New South Wales (N.S.W. Dept. Agric., 1961).

New World species of *Tiracola* are *T. grandivena* H.S. (South America), *T. lilacea* Dogn. (Colombia) and *T. nonconformens* Dyar. Dr. E. L. Todd has kindly advised (in litt. March, 1962) that *T. grandivena* has often been commonly identified as *T. plagiata* but it is genitalically distinct from the Old World species.

The first published record of *T. plagiata* from the Territory of Papua and New Guinea was by Froggatt (1938) who reared adults from larvae found feeding on cacao. No locality was given with this record but it is believed to be from Keravat, New Britain, Szent-Ivany (1956) described a heavy infestation of the larvae at Ninoa Plantation, Central District of Papua and in 1960, Szent-Ivany and Catley recorded it from Popondetta, in the Northern District of Papua.

Host Plants.

The host range of *T. plagiata* is extremely wide. Weddell (1930) lists 56 hosts from Queensland, Ceylon, Malaya, India, Formosa and the Dutch East Indies. Additional hosts are given by Corbett and Gater (1926), Tams (1935), Froggatt (1938), Kalshoven (1950), Szent-Ivany (1956) and Szent-Ivany and Catley (1960). A complete list of the recorded host plants is given in Appendix I.

Popondetta Outbreak.

Despite occasional local infestations of *T. plagiata* in Papua and New Guinea, it was not considered to be a pest of major status (Szent-Ivany, 1961) until early 1960 when it appeared in plague proportions in new agricultural settlement blocks in the Popondetta area of Papua. Since that time, the caterpillars have continued their attacks with only minor fluctuations in severity and investigations carried out indicate that naturally occurring controlling factors are not exerting any appreciable influence in controlling the pest.

The history of the Popondetta outbreak of *T. plagiata* is similar to that of other outbreaks described in the literature. In Malaya, Corbett and Gater (1926) observed it migrating in army formation from secondary jungle growth into cleared areas where there was an abundant supply of food on the new growth. An outbreak in Queensland in 1927 began on weeds and then spread to cultivated crops (Weddell, 1930), and Kalshoven (1950) mentions that it typically breeds in enormous numbers in young secondary bush and when the native hosts are defoliated, the caterpillars move on to other host plants.

At Popondetta, extensive areas of virgin rain forest were felled for cacao planting. The practice of burning after initial clearing provided ideal conditions for the growth of weeds and soft secondary bush species, and also doubtless, upset the population balance of parasites and predators which are normally found in the primary forest.

After felling and clearing, many weed species including the thistle *Erechthites hieraciifolia* Rafinesque and the milk-weed *Euphorbia cyathophora* Murr. soon became established and these proved admirably suited for the development of *T. plagiata.* The legumes *Leucaena glauca*

Plate I.—Land cleared for cacao planting. Primary forest in background with secondary growth in right foreground and *Leucaena glauca* planted at left.

Benth. and *Crotalaria anagyroides* H. B. & K. were planted as shade trees for cacao and unfortunately these also proved to be suitable hosts for *T. plagiata* and in a very short time, populations of caterpillars built up to enormous proportions and when cacao was planted under the shade trees, they moved on to them as yet another host tree (Plate I)

The peril from insect pests resulting from a monocultural system of agriculture was recognized by Schneider (1939) when he described an outbreak of the drepanid caterpillar *Areta carnea* Btlr. in a plantation of gambier (*Uncaria gambier*) on the east coast of Sumatra. In this instance effective control of the pest by indigenous species of parasites and predators [mainly *Brachymeria euploeae* Wesw. (Chalcididae) and *Cantheconidea acuta* Vollen (Pentatomidae)] was confined to the bush boundaries of the plantation. He expresses the view that a monoculture creates a labile biocoenosis which can be maintained only by continued application of control measures.

Sir Boris Uvarov (1961) makes similar observations and suggests a thorough ecological study should be made before any large scale land development schemes are undertaken and in this way, crops may be selected and agricultural practices adopted to lessen the possibility of providing conditions favourable to the build up of insect pests. The reason for this is borne out in his statement—

> "Any wild fauna is composed of a variety of insects with different ecological requirements, and there are always in it such elements that are able to take advantage of a change, while others go down. In this way, man introduces large scale selection experiments wherever he begins to exploit the land."

Description of Damage.

At Popondetta, the damage to *Leucaena glauca,* although extensive is not serious and only very young seedlings are likely to be destroyed by caterpillar attacks. Very serious damage to cacao does occur under *Leucaena* shade but the feeding is rather selective and only the softer tissues of the plant are damaged—the old hardened leaves and bark are not attacked.

Most feeding takes place on the soft flush growth and growing points, but it has also been noticed on the flowers and young pods. It is at the growing point that the greatest damage is done to the plant. Mature trees are not greatly damaged by caterpillars unless the attacks

are continually recurring. Younger unramified trees, however, often have their growing points completely destroyed when the flush leaves are all eaten and the resulting spindly growth leads to grossly misshapen trees which require extensive pruning and appreciably more maintenance (Plate II). The age at which trees come into bearing is also deferred for varying lengths of time depending on the severity of attack.

Plate II.—Two-year-old cacao tree damaged by repeated attacks by *T. plagiata*.

There are few instances of cacao trees dying from caterpillar attack but it is conceivable that fungi or bacteria could enter the wounds and cause further damage.

The larvae are voracious feeders at all stages of development and begin feeding as soon as they emerge from the eggs, which are laid in batches of up to 1,200 on the leaves of the host plants. The effect of this multiple feeding by several hundred caterpillars is to remove the epidermal tissues leaving only the veins which are presumably too tough for the tender mandibles to penetrate (Plate III).

The appearance of a mature leaf on which a cluster of larvae has fed is very characteristic; with the hardening of the leaf, the attacked surface becomes brown and a delicate lacy pattern is produced on which is to be seen specks of dried faeces produced in large amounts by the young caterpillars. Older caterpillars are able to devour all parts of the flush leaves without any difficulty and frequently all that remains after a wave of caterpillars is the stem and the old hardened leaves.

On papaw, *T. plagiata* feeds on leaves, fruit and even the stems of the plant. The fruit is particularly attractive to the caterpillars and large numbers are often seen clustered about fallen fruit on the ground. Tapioca plants are attacked only infrequently but complete stripping

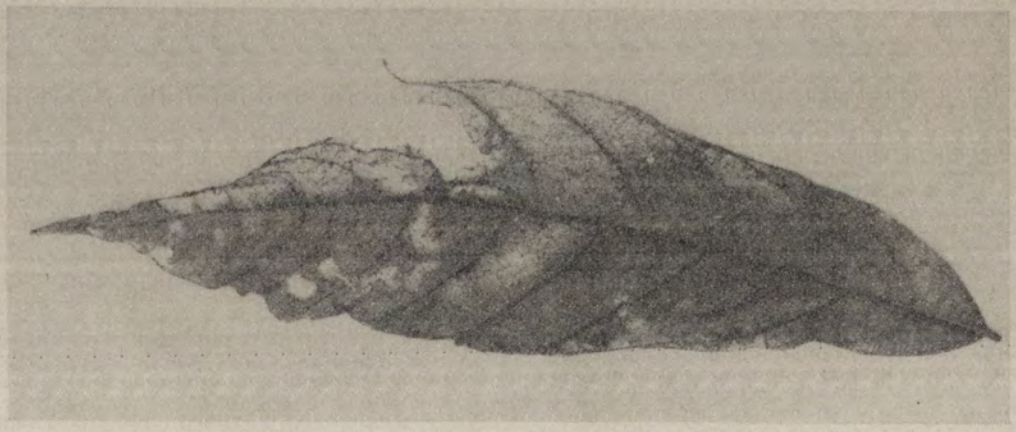

Plate III.—Young cacao leaf damaged by cluster of first instar *T. plagiata*.

of the leaves generally follows. On bananas, the larvae have been found feeding only on the skins of the fruit, as is the case in Queensland (Weddell, 1930).

Parasites and Predators.

Throughout its range of distribution, *T. plagiata* has many recorded parasites and predators and Kalshoven (1950) states that during plagues, the percentage of caterpillars attacked by parasites, particularly tachinids, can be very high but it varies greatly in different localities.

Temperley (1930) records the ichneumonids *Lissopimpla semipunctata* Kirby and *Paniscus testaceus* Grav. as larval parasites and the eulophid *Euplectrus kurandaensis* Girault as a pupal parasite from Queensland in the 1927 outbreaks.

In addition, Thompson (1947) lists the parasites, *Apanteles tiracolae* Ashm. (Braconidae) from Ceylon ; *Sisyropa thermophila* Wd. (Tachinidae) from Malaya ; *Sturmia inconspicua* Mg. (Tachinidae) from Malaya[1] ; *Sturmia inconspicuoides* Bar. (Tachinidae from Malaya ; *Tachina civiloides* Bar. (Tachinidae) from Malaya ; *Trichogramma minutum* Riley (Trichogrammatidae) from Dutch East Indies.

Dr. L. P. Mesnil (in litt. 1962) also includes *Exorista fallax* Meig.-(*civiloides* Bar.) and *Sisyropa thermophila* Wk., the latter from Northern Australia, as parasites of *T. plagiata.*

A thorough search for natural enemies of *T. plagiata* was made in 1961 and 1962 at Popondetta but none was found in significant numbers.

A mite, *Caloglyphus* sp. (Tyroglyphidae) is commonly found associated with the egg masses of *T. plagiata* and they sometimes attach themselves to newly emerged larvae but they have only been observed to feed on decaying eggs and dead larvae. They could prove to be of value in disseminating pathogenic organisms from diseased to healthy insects.

The most active larval predators are *Hexacentrus unicolor* Walker (Tettigoniidae), *Platynopus melacanthus* Boisd. (Pentatomidae) and *Pristhesancus femoralis* Horv. (Reduviidae). Others noticed in fewer numbers were *Helenotus exsugiens* Stal. (Reduviidae), *Nerthra ampliata* Montr. (Gelastocoridae), *Maira* sp. (Asilidae), *Eumenes pyriformis petiolaris* Schulz. (Vespidae), *Sceliphron laetum* Sm. (Sphecidae), the ants, *Pheidole megacephala* (Fabr.) and *Anoplolepis longipes* (Jerdon) and the spiders *Oxyopes striatus* (Dol.) (Oxyopodidae) and *Mopsus mormon* Karsch (Salticidae). Another suspected predator is the brown tree ant, *Oecophylla smaragdina* F., although it has not actually been seen feeding on *T. plagiata* larvae. It is significant, however, that extensive damage has not been noticed on trees colonized by this ant and its reputation as a vicious attacker of any intruder supports the view that it could prove to be a useful predator in cacao plantations.

Very dense populations of *Nerthra ampliata* sometime occur but it is a strictly terrestrial species and hence its value as a predator is limited.

The only parasites collected at Popondetta were the tachinid *Exorista fallax* Meig. and the ichneumonid *Echthromorpha insidiator* Smith. The former species is one of the most important parasites of the "Poinciana moth", *Pericyma cruegeri* Butl. (Noctuidae) in the Port Moresby area (Szent-Ivany, personal communication). Up to three larvae of *Exorista fallax* have been found in a single *T. plagiata* larva and specimens of adults are frequently collected on the wing in cacao plantations but they do not exert much controlling influence. Dr. J. J. H. Szent-Ivany reared only 12 specimens from 500 pupae during experiments conducted at Popondetta in 1961.

In November and December, 1961, a total of six consignments of *Drino inconspicuoides* puparia were introduced to Popondetta from the Commonwealth Institute of Biological Control station at Bangalore but they failed to survive the journey and none was released in the field.

Occasionally, specimens of larvae killed by a mycosis caused by the fungus, *Spicaria rileyi* (Farlow) Charles have been found but it too is of no significant value in controlling *T. plagiata.* Dr. E. A. Steinhaus detected weak to moderate growth of *Mucor* sp. on the body of a moth submitted for study but in his opinion it was a saprophyte and did not contribute to the death of the insect. An unidentified species of *Fusarium* was also isolated from batches of unhatched eggs but this too is not considered an insect pathogen.

There do not appear to be any prospects of naturally occurring organisms exerting an appreciable degree of control in the immediate future

(1) Dr. L. P. Mesnil advises that *Drino* is now the valid name for the genus *Sturmia,* and *Sturmia inconspicua* is probably a wrong identification since it does not occur outside Europe.

and until such times as that does occur, planters will have to rely on insecticides for control of the pest. Since December, 1961, the severity of attacks by the caterpillars has diminished and the outbreaks have settled down to virtually a "one stage" condition in which generally only one or at the most two successive stages of development (eggs, larvae, pupae, moths) are present in an area at any one time. Although this one stage condition is general throughout the district, there may be a difference of up to ten days between the appearance of an individaul stage in separated areas. This indicates that no large scale migration occurs, otherwise the "one stage" condition would be upset by the influx of the "stragglers" from areas where the insects are a little later in development. Outbreaks can thus be more or less accurately predicted so that planters can time their insecticide applications to obtain the maximum effect.

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Appendix I.

Host Plant Records of *Tiracola plagiata* Walk.

Locality.	Host Plant.		Recorded by.
	Common Name.	Botanical Name.	
Ceylon	Brinjal or Egg Plant	*Solanum melongena* L.	Hutson (1924)
	Tea	*Camellia theifera* Dyer	Department of Agriculture, Ceylon (1923)
	....	*Erythrina lithosperma* Bl.	
	Plantain	*Musa* sp.	
	Lima Bean	*Phaseolus lunatus* L.	
	French or Kidney Bean	*Phaseolus vulgaris* L.	
	Wasteland weeds	* N.B.N.	Jebaratram (1926)
	Cassava	* N.B.N.	
	Coffee	* N.B.N.	
	Rubber	* N.B.N.	
Malaya	Castor Oil	*Ricinus communis* L.	Department of Agriculture, Malaya (1921)
	Castor Oil	*Ricinus communis* L.	Gater (1926)
	Castor Oil	*Ricinus communis* L.	Susainathan (1924)
	Lime	*Citrus medica* L. var. *acida*.	Gater (1926)
	Tapioca	*Manihot utilissima* Pohl.	
	Para rubber	*Hevea brasiliensis* Muell-Arg.	
	Banana	*Musa* spp.	
		Melastoma polyanthum Korth.	
	Cassava	* N.B.N.	Greenstreet & Lambourne (1933)
	Coffee	* N.B.N.	Corbett (1934)
Dutch East Indies	....	*Ballota* sp.	de Jong (1927)
	Tobacco	*Nicotiana* sp.	van Hall (1925)
	Tobacco	*Nicotiana* sp.	Palm (1926)
	....	*Trema amboinensis*	
India	....	*Emilia* sp.	Hampson (1894)
	Tea	*Camellia theifera* Dyer.	Andrews (1924)
Formosa	Tea	*Camellia theifera* Dyer.	Shiraki (1920)
Queensland	Banana	*Musa* spp.	Weddell (1930)
	Maize	*Zea mays* L.	
	Pumpkin	*Cucurbita pepo* L.	
	Watermelon	*Citrullus vulgaris* Schrad.	
	Cabbage	*Brassica oleracea* L.	
	Cauliflower	*Brassica oleracea* L. var.	
	Tomato	*Lycopersicum esculentum* Mill.	
	Cape gooseberry	*Physalis peruviana* L.	
	Passionfruit	*Passiflora edulis* Sims.	
	Beetroot	*Beta vulgaris* L.	
	French bean	*Phaseolus vulgaris* L.	
	Papaw	*Carica papaya* L.	
	Pear	*Pyrus communis* L.	
	Pigweed	*Portulaca oleracea* L.	
	....	*Sloanea australis* F. v. M.	
	Red Ash	*Alphitonia excelsa* Reissek	
	Tulipwood	*Harpullia pendula* Planch	
	....	*Eucalyptus* sp.	
	White Passionfruit	*Passiflora alba* L. & O.	
	Native Bryony	*Bryonia laciniosa* L.	

Host Plant Records of *Tiracola plagiata* Walk—*continued.*

Locality.	Host Plant.		Recorded by.
	Common Name.	Botanical Name.	
Queensland—*continued.*			
	Cobblers Pegs	*Bidens pilosa* L.	Weddell (1930)
	Stinking Rodger	*Tagetes glandulifera* Sch.	
	Milk Thistle	*Sonchus oleraceus* L.	
	Scotch Thistle	*Cnicus lanceolatus* Hoffm.	
	Black Currant	*Solanum nigrum* L.	
	Wild Tobacco	*Solanum auriculatum* Ait.	
	Wild Tobacco	*Solanum verbascifolium* Ait.	
	Wild Gooseberry	*Physalis minima* L.	
	Wild Tobacco	*Nicotiana suaveolens* Lehm.	
	Lantana	*Lantana camara* L.	
	....	*Amarantus viridis* L.	
	Inkweed	*Phytolacca octandra* L.	
	....	*Kibara macrophylla* Benth.	
	Kamela Tree	*Mallotus philippinensis* Muell-Arg.	
	Peach-leafed Poison bush or Poison peach	*Trema aspera* Bl.	
	....	*Pseudomorus brunoniana* Bur.	
	....	*Pollia macrophylla* Benth.	
	Cunjevoi	*Alocasia macrorrhiza* Sch.	
Samoa	Castor Oil	* N.B.N.	Tams (1935)
	Sisal hemp	* N.B.N.	
	Tapioca	* N.B.N.	
	Tobacco	* N.B.N.	
	Banana	* N.B.N.	
	Limes	* N.B.N.	
	Rubber	* N.B.N.	
New South Wales	Banana	* N.B.N.	N.S.W. Department of Agriculture (1961)
Indonesia	....	*Trema* sp.	Kalshoven (1950)
	....	*Zingiberaceae*	
	Wild bananas	* N.B.N.	
	Tobacco	* N.B.N.	
	Rubber	*Hevea brasiliensis*	
	Sumatra Pine	*Pinus* sp.	
	Pepper	* N.B.N.	
	Coffee	* N.B.N.	
	....	*Passiflora* sp.	
	Wild Amaranthus	* N.B.N.	
	Spinach	* N.B.N.	
	Beetroot	* N.B.N.	
	Flax	* N.B.N.	
	Derris	* N.B.N.	
	....	*Aleurites* sp.	
New Guinea	Cacao	*Theobroma cacao*	Froggatt (1938)
Papua	Rubber	*Hevea brasiliensis* Muell-Arg.	Szent-Ivany (1956)
	Sweet Potato	*Ipomoea batatas* Poir.	
	Cassava	*Manihot utilissima* Pohl.	
	....	*Alstonia* sp.	

Host Plant Records of *Tiracola plagiata* Walk—*continued.*

Locality.	Host Plant.		Recorded by.
	Common Name.	Botanical Name.	
Papua—*continued*	Crotalaria	*Crotalaria anagyroides* H. B. & K.	Szent-Ivany & Catley (1960)
Papua (Popondetta)	Cacao	*Theobroma cacao* L.	
	Leucaena	*Leucaena glauca* Benth.	
	Momordica	*Momordica charantia* L.	
	Pumpkin	*Cucurbita pepo* Lith.	
	Coffee	*Coffea canephora* Pierre ex Froehner	
	Banana	*Musa* sp.	
	Fig	*Ficus* sp.	
	Cassava	*Manihot utilissima* Pohl.	
	Milkweed	*Euphorbia cyathophora* Murr.	Catley (New records)
	Thistle	*Erechthites hieraciifolia* Rafin.	
	Papaw	*Carica papaya* L.	
	Sweet Potato	*Ipomoea batatas* Poir.	
	Pipturus	*Pipturus argenteus* Wedd.	
	Native Passionfruit	*Passiflora foetida* L.	
	Taro	*Colocasia* sp.	
	Croton	*Codiaeum variegatum* Blume	
	Beans	*Vicia faba* L.	
	Zinnia	*Zinnia* sp.	

* N.B.N.—Signifies that no botanical names were recorded.