

# PRELIMINARY NOTES ON THE PARASITES OF THE SPOTTED AND THE PINK BOLLWORMS OF COTTON IN COIMBATORE\*

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Received August 8, 1941

(Communicated by Rao Bahadur V. Ramanatha Ayyar)

FROM early times spotted bollworm parasites have received considerable attention in the Punjab. Investigations mostly centred round the then wrongly designated *Rhogas lefroyi* D. & G. No connected and comprehensive account of its biology appeared till a long time after. Meanwhile, C. T. Brues rectified the mistake and gave it the correct designation as *Microbracon lefroyi* D. & G. by which name it is now known. Fletcher (1919) and Ballard (1921) make only passing references about this insect. Husain and Mathur (1921) were the first to furnish an account of the ovipositional habits of the *Microbracon*. The same authors (1923) published a cogent account of the bollworm parasites of the Punjab subsequently. The contribution by Ramakrishna Ayyar (1926) was helpful in suggesting the occurrence of more than one species of *Microbracon* as being involved in the parasitization of the bollworms. More recently, Deshpande (1936) has given a short account of the several parasites of the spotted bollworms of South Gujarat. Ahmad and Ghulam (1939) have worked out the development of various stages of the parasite under varying conditions of temperature and humidity.

Much of what has been done and published mostly relates to the parasites of other provinces. Our knowledge of the South Indian bollworm parasites is still incomplete. The aim of the authors in bringing out this paper has been chiefly to add to the knowledge of these insects. The paper deals with the forms found in Coimbatore only. Intensive study and wider survey of the parasites are essential if a complete record is desired. Information on the parasites of other bollworms like *Rabila frontalis*, *Chloridea obsoleta*, has been omitted as they have seldom passed beyond the stages of minor pests of cotton.

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\* Paper presented at the Second Conference of Scientific Research Workers on Cotton in India, 1941.

## A. Spotted Bollworm Parasites

The spotted bollworms *Earias fabia* and *E. insulana* that infest the cotton buds and bolls are subject to field parasitization by the following five parasites—*Microbracon lefroyi* D. & G., *Rhogas aligharensi* Quadri, *Bassus* n. sp., *Elasmus johnstoni* and *Actia hyalinata*. The following is a brief account of each:—

1. *Microbracon lefroyi*.—It appears early in the season from November onwards when the cotton plant just then starts budding and bolling, remains active till February and then fades out. It is not noticed in April and May or thereafter. The incidence of this species has never been marked and is about 2–3% (Table I). However, its incidence is comparatively higher in the shed buds than in the bolls. The total absence of the parasite late in the season may be due to dearth of buds and tender bolls which alone seem to be adapted for the insect to parasitize the host larvæ when inside. Even

TABLE I

*Incidence of Microbracon lefroyi* D. & G. in the *Earias fabia* caterpillars in the shed buds and bolls of cotton (Cambodia)

Year and Month	BUDS AND FLOWERS				BOLLS			
	Total picked	Host population	No. parasitized	Percentage of parasitization	Total picked	Total population	No. parasitized	Percentage of parasitization
1938								
November II ..	679	3	1	33.3	313	23	..	..
December I ..	4,203	635	6	0.94	6,597	715	1	0.14
Do. II ..	2,373	55	2	3.63	18,483	307	2	0.64
1939								
January I ..	2,154	6	..	..	11,993	54	..	..
Do. II ..	114	1	..	..	2,386	16	..	..
May I ..	1,507	59	..	..	710	37	..	..
Do. II ..	7,917	125	..	..	1,597	142	..	..
June I ..	2,972	182	..	..	259	..	..	..
December II ..	1,563	99	..	..	1,037	113	3	2.65
1940								
January I ..	7,028	722	2	0.28	4,963	544	..	..
Do. II ..	5,910	57	..	..	3,687	59	1	1.60
February I ..	752	23	..	..	794	14	..	..
July II ..	560	19	..	..	407	1	..	..
August I ..	228	3	..	..	109	..	..	..

Note.—I and II refer to the first and second fortnights respectively.

at a time when the host population is very high in late December and early January it never shows up prominently and for this reason could not be regarded as efficient.

From the observations made over a period of two years it was found that this species would never accept an open or free larva for oviposition unless it is given in a closed cell. Our finding is in agreement with Deshpande (1936) but is in conflict with that of Husain and Mathur (1921) who state that the caterpillars given in small glass cubes are readily oviposited upon. Host larvæ placed in the improvised cells of cotton bolls were invariably parasitized; the cells are made by partially splitting open the bolls and scooping out the contents therein. The split halves can be held in position by a loop of thread after the host larva is placed in it. When such host larvæ are presented to the parasite it administers 5-6 stings to the host with its ovipositor from outside. The host as a result of these thrusts becomes immobile. The insect soon after tries to lay eggs. They are extruded through the ovipositor into the cell cavity and are often placed in groups close to the body of the host. It has no marked predilection to lay eggs in any particular spot or position. Eggs have been seen from the head end to the tail end of the host in all positions. As a rule, 5-10 eggs are laid at a time. Each parasite is capable of laying a maximum of 75 eggs. The eggs are smooth and have a pearly sheen when freshly laid and are awl-shaped. Each egg is about 2 mm. long and nearly four times as long as broad with one end tapering.

Eggs hatch in 18-24 hours and hatchings emerge. They immediately crawl over the body of the host and fix themselves in any position and start feeding by imbibing the body juice of the host. In about three days they become full grown when they develop a light chocolate colour. Each grub spins a white silken cocoon close to the host and pupates therein. It emerges as an adult a week after pupation by biting holes in the cocoons.

Under Coimbatore conditions, the parasite takes 10-12 days to get through one generation.

The range of larval hosts for this insect is very limited in nature. It has been bred from *Adisura atkinsoni* in the pods of the housebeans, *Rabila frontalis* in the cotton bolls and *Earias* spp., in bhindi pods. It is rather remarkable that *Earias* spp. infesting the pods of *Hibiscus vitifolius*, *Abutilon hirtum* and *A. indicum* have never been parasitized by this species even though the alternate host plants co-existed with cotton in the vicinity, and were subject to similar environmental conditions. The bollworm infestation

in them was continuous and was fairly high. Under laboratory conditions, however, the parasite oviposited on other hosts like the pink bollworm and the *Abutilon gelechiad* with indifference; the development of the parasitic grubs was slow and in several instances, never passed beyond the cocooning stages. In a few cases, where the parasites were bred out, they bore a remarkable identity to the parent indicating that the parasite breeds true to type even on different host caterpillars.

The insect which is said to show considerable colour variations in Northern India is found here to conform to only one pattern of the B variety of Ramakrishna Ayyar (1926). No intermediate forms have so far been noted in the species either in the field or in the laboratory bred specimens. It occurs as a larval parasite of *Earias* spp. in cotton buds and flowers. It has not been reared so far from the pink bollworm though Ballard (1921) has stated so.

2. *Rhogas aligharensi*.—This is a specific parasite of the spotted bollworms that infest cotton buds, bolls and bhindi pods. The parasitic grubs are exclusively internal and do not come out of the body of the host. Like *M. lefroyi* it appears early in the season and continues to show up though sparingly till the end of April. Its period of maximum activity would appear to be in December and January when the host population is also at its highest. A single adult emerges from the affected host. Emergences of *Rhogas* and *Microbracon* are recorded in Table II. The proportion of both of them is about equal. On this basis there is reason to regard the former as more efficient, for, as many caterpillars are destroyed as there are parasites whereas, in the latter, the worms destroyed will be about a fourth of the total number of parasites that have issued. The affected caterpillars continue to feed till such time when they become sluggish and come out of the boll to become bloated. Nearly 7–8 days elapse before the adult comes out from the body of the host; it issues by biting a hole on the upper surface of the tail end.

3. *Bassus* n. sp.—The insect occurs as a specific parasite of *Earias* spp. caterpillars infesting tender and medium bolls of cotton; it has not been reared so far from the same hosts in other host plants. It is easily distinguishable by the black and red colouration of the body and by its very long ovipositor. The parasitic grub is an internal parasite and pupates within the body of the host. The adult issues after the latter has cocooned. As in *Rhogas* a single parasite results from each affected caterpillar. Table II gives an idea of its seasonal incidence. It appears in January and is not noted thereafter. It seems to be restricted in distribution in this Presidency and has not been noted to occur in other provinces.

TABLE II

*Emergence record of parasites from shed cotton buds and bolls dumped in a cage on December 26 (1939) and January 14 and 25 (1940)*

Date of Emergence		NATURE OF PARASITES					
		<i>Rhogas</i>	<i>M. lefroyi</i>	<i>Apanteles</i>	<i>Bassus</i>	<i>Actia</i>	<i>Goniozus</i>
1939							
December	28 .. ..	1	..	..	..	..	..
	29 .. ..	1	..	..	..	..	..
	30 .. ..	1	..	..	..	..	..
	31 .. ..	1	..	..	..	..	..
1940							
January	1 .. ..	1	..	..	..	..	..
	2 .. ..	1	4	1	3	..	..
	3 .. ..	1	3	3	..	..	..
	6 .. ..	2	..	..	..	..	..
	7 .. ..	2	3	3	1	1	..
	8 .. ..	3	3	3	4	4	..
	9 .. ..	6	2	4	..	5	..
	10 .. ..	5	1	4	..	4	..
	12 .. ..	11	2	3	..	3	..
	14 .. ..	7	..	5	2	..	..
	16 .. ..	2	..	2	3	..	..
	17 .. ..	3	..	4	4	..	..
	18 .. ..	3	3	10	..	..	..
	19 .. ..	3	..	1	3	..	..
	20 .. ..	2	4	2	2	..	..
	22 .. ..	7	13	2	..	1	1
	23 .. ..	6	16	5	..	1	..
	24 .. ..	5	3	3	1	1	..
	25 .. ..	7	13	1	..	1	..
	26 .. ..	..	11	1	2	..	..
	27 .. ..	3	4	..	..	..	..
	28 .. ..	..	4	5	..	3	..
	29 .. ..	7	5	1	2	3	..
	30 .. ..	3	6	1	2	..	..
	31 .. ..	..	..	1	..	..	..
TOTAL ..		94	95	66	30	27	1

Note.—*Microbracon greeni* and *M. gelechidiphagus* were not recovered during the period

4. *Elasmus johnstoni*.—This black chalcid more commonly occurs as an ectolarval parasite of *Earias fabia* caterpillars infesting *H. vitifolius* pods. It is not much in evidence in the worms attacking cotton or bhindi. Its paucity in the latter must be attributable to its general habit of parasitizing the caterpillars that are surrounded by a thin wall of the cell. The

outer wall of the bolls and bhindi pods is tough and would therefore offer impediment to its effective parasitization. Under laboratory conditions, the insects show a marked preference to the cocooning caterpillars for parasitization; the silken cocoon offers the ideal condition for the parasite to reach the host with their ovipositors. They occur all through the year in limited numbers in *H. vitifolius* pods. Seven to ten is the normal number that is obtained from each host under the field conditions but in the laboratory, as many as 98 have been obtained from a single caterpillar. The population is predominantly female and their longevity does not exceed a fortnight when fed on sugar solution. Each parasite is capable of laying 8–18 eggs at a time. The host is paralysed by several thrusts with the ovipositor from outside and often the parasite takes a feed on the body fluid that exudes through the punctures caused by the stings. The eggs are laid in loose groups on any part of the body of the host; they are small and white. Pupation is naked within the host cocoon and the adults emerge within a week after pupation. Its life-history is completed within a period of 10–12 days. It is easy to breed this parasite in large numbers under laboratory conditions.

5. *Actia hyalinata*.—This small tachinid fly has been noted in very scanty numbers and has been bred out solely from the spotted bollworms. Not more than two were obtained from each affected host; the maggots come out of the body and transform into puparia from which the adults emerge after a week.

#### *Spotted Bollworm Parasites Associated with Different Plant Hosts*

The spotted bollworms that infest the pods of *H. vitifolius*, *A. indicum* and *A. hirtum* are attacked by *Microbracon greeni*, *Elasmus johnstoni* Ferr and *Polyodaspis compressiceps* Duda; in bhindi by *M. lefroyi*, *M. hebetor* (Say) and *Melcha nursei* Cam.

Of these, *M. greeni* is the most important. Its incidence varies from 8–43% in *H. vitifolius* pods (Table III). This weed maintains a uniform infestation of *Earias fabia* right through the year and the parasite is exclusively associated with the host caterpillars and flourishes in an equal degree all round the year. However, its parasitism in the larvæ infesting *A. hirtum* pods is considerably less even though the larval hosts continue to breed. The total absence of parasitism by *M. greeni* in the spotted bollworms in cotton and *vice versa*, namely, the absence of parasitism by *M. lefroyi* in that of *H. vitifolius*, *A. hirtum* and *A. indicum* coupled with disparity in size and coloration between the two species, would seem to suggest that really two different species were involved, each being closely associated with its

TABLE III

*Incidence of Microbracon greeni (ash) in Earias fabia caterpillars in Hibiscus vitifolius pods for the years 1937-40*

Date of collection of pods				Number of pods collected	Host population	Number affected by parasites	Percentage of parasitization
1937							
November	3	..	..	58	19	3	15.79
	5	..	..	147	48	7	14.58
	9	..	..	229	40	4	10.00
	12	..	..	283	35	18	51.43
	19	..	..	140	12	..	..
	29	..	..	29	6	3	50.00
1938							
January	31	..	..	85	..	..	..
April	5	..	..	211	33	2	6.06
	22	..	..	106	6	..	..
June	21	..	..	88	8	2	25.00
	30	..	..	103	12	1	8.30
July	6	..	..	205	44	2	4.50
1939							
April	1	..	..	205	21	9	4.29
	8	..	..	24	2	2	100.00
	14	..	..	135	17	7	41.18
May	11	..	..	154	25	4	16.00
1940							
January	5	..	..	202	57	..	..
February	1	..	..	332	33	8	24.20
	7	..	..	253	29	2	6.90
July	27	..	..	606	81	1	1.23
August	10	..	..	572	65	12	18.46
September	4	..	..	375	75	11	14.61

Note.—*Microbracon lefroyi* has not been recovered.

own plant host complex. This assumption is further confirmed by their breeding true to type even when the hosts were altered. Lal (1939) is inclined to regard these two species as identical in the absence of any distinguishing morphological character; the color pattern was found to be a varying factor and could be altered at will by changing the temperatures at the time of development. One should agree with him if the species that had undergone transformation of color pattern could transmit the acquired character to its progeny without further recourse to the temperature. In all our rearings in the laboratory and under identical conditions, both the species retained their specific color pattern even where the hosts were different. One outstanding morphological character by which *M. greeni* of Coimbatore could

easily be marked off from the other is by its long ovipositor which is nearly one and a half times as long as the abdomen; the males exhibit a color pattern not noted to be present in the other species. The former has well-developed smoky clouds on all the abdominal segments. There was not much of variation in the duration of life-cycle in both the species.

*Microbracon hebetor*.—This is comparatively very small in size and was obtained only once from the caterpillars of *Earias fabia* infesting bhindi pods. Unlike *M. lefroyi* and *M. greeni* it would seem to freely accept the free forms of both the types of caterpillars for oviposition; it is most reluctant to oviposit on caterpillars when given in enclosed cells. Eighteen to twenty eggs are usually laid on the paralysed body of the host in any situation. They are lemon-yellow in colour. The grubs after full development spin cocoons near the host and pupate in them. It was also noted to be a parasite of the caterpillars of *Stomopteryx nerteria* in groundnut and *Antigastra catalaunalis* in gingelly.

*Melcha nursei*.—This ichneumonid was obtained only once as an internal parasite from *Earias fabia* caterpillars in the bhindi pods; it emerged after the host larva had cocooned.

*Polyodaspis compressiceps*.—This chloropid fly was obtained as a parasite on *Earias fabia* larvæ in *H. vitifolius* pods. Though its incidence is low it occurs all round the year. Not more than 3–4 maggots were obtained from a single host; they come out of the body and pupate within the pods close to the affected host.

#### B. Pink Bollworm Parasites

The caterpillars of *Platyedra gossypiella* Saund. have their own parasite complex. They are attacked in nature by the following parasites: *Goniozus* n. sp., *Apanteles pectinophoræ* and *Microbracon gelechidiphagus* Rank.

*Goniozus* n. sp.—This bethylid appears early in the season from November and does not show up prominently till late in May and June. It appears to be a blossom infesting type and it associated with the host infested cotton flowers. It appears to differ from the species recorded by Fletcher (1919); from the Plate given by him his bethylid appears to be a species of *Perisierola*. As high as 49% of the pink bollworms that infested the open and unopened flowers were found parasitized in July 1940. The insect seeks caterpillars of the fourth and fifth instar stages for egg-laying. It is predatory in habit and preys upon the blossom thrips and other young caterpillars found inside the flowers. It has been noted to feed on the nectar that collects in the nectar glands of the cotton flowers.

Though these bethylids attack the free caterpillars given to them in the laboratory and paralyse them prior to egg laying they suffer damage at



the hands of the hosts and become maimed but they seem to be quite well at home inside the flowers; cent. per cent. parasitization is recorded if the hosts are given with flowers. The female usually approaches the host from behind, seizes the host by the nape on the upper surface with its mandibles and curves round its abdomen. Series of stings are given in quick succession in the neighbourhood of the first thoracic segment on the ventral side. The worm soon quiets down and becomes motionless. The parasite escapes injury in the flowers as the filaments of the staminal column act as a bar to the host reaching the insect. Thereafter, the parasite takes pain to smoothen the intersegmental rings of the distal segments by running over its mandibles transversely across. The object for this behaviour would appear to be its desire to clear off any projecting setæ that might hinder the egg from being firmly glued to the segment.

Eggs are, as a rule, placed transversely across on the intersegmental rings of the abdominal segments 5-6, 6-7, 7-8, 8-9. It lays 6-13 eggs at a time; each segment carries 2-4 eggs. They are translucent white in colour and are difficult to make out when freshly laid. The host caterpillar invariably recovers consciousness after egg-laying is over and moves about carrying the eggs; it lives till it is finally consumed by the feeding parasite grubs. In such movements the eggs and the grubs of the parasite are partially shed.

The eggs hatch in 56-72 hours and the grubs start feeding immediately from the same place and never leave their positions. Soon they swell into light amber-colored vesicular bodies and get the salmon-pink colour afterwards. Each grub spins a cocoon after full development and pupates therein; the cocoon is white except when spun in cotton bolls when it turns light chestnut brown. The adult emerges from the cocoon in about seven days by biting a hole in it. Emergence of males first was not the feature as recorded by Sweetman (1936) nor mating observed inside the female cocoons. Parthenogenesis is fairly common. The life-cycle is completed in 12-15 days.

In nature, the bethylids have been observed to parasitize other hosts like *Antigastra* and *Adisura* caterpillars.

2. *Apanteles pectinophoræ*.—This internal parasite emerges from the host after it has cocooned. The parasitic grub comes out of the body of the host and spins a white solitary cocoon within that of the host. Only a single parasite issues from a cocoon. It is not possible by external symptoms to say whether a particular caterpillar is parasitized or not. The parasite is in evidence right through from December to June though not in appreciable numbers as will be seen from the Tables II and V. It appears to be an exclusive parasite of the pink bollworm.

3. *Microbracon gelechidiphagus* Ramk.—This occurs as an exclusive parasite of the advanced caterpillar stages of the pink bollworm infesting the medium and large-sized bolls of cotton. It is easily distinguishable from the other two *Microbracons* by the lightness of the body color and the two faint fuscous patches on the second and third abdominal segments of the female. Under the field conditions the paralysed caterpillars are uniformly found deep inside the boll, and hence it is to be presumed that the parasites reach the host through any exit hole present in it; otherwise it is very difficult for this small insect to reach the host from outside with its ovipositor. Under laboratory conditions, however, it is able to parasitize the pink bollworm when given in tender bolls just as the other two species do. Adults have also been reared from other hosts like that of *Earias fabia* and *E. insulana* and they are found to conform to the color pattern of the parent. The incidence of field parasitization rarely exceeds 22.5% [Tables IV and VI]. The insect appears very late in the season when the host population is generally high. There is no material difference in the duration of the life-cycle between this and the other species.

TABLE IV

*Incidence of Microbracon gelechidiphagus Ramk. in the Platyedra gossypiella caterpillars in the shed buds and bolls of cotton (Cambodia)*

Year and Month	BUDS AND FLOWERS				BOLLS			
	Total picked	Host population	No. parasitized	Percentage of parasitization	Total picked	Total population	No. parasitized	Percentage of parasitization
1938								
November II ..	679	4	..	..	313	3	..	..
December I ..	4,203	17	..	..	6,597	50	..	..
Do. II ..	2,373	10	..	..	18,483	100	..	..
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Do. II ..	114	..	..	..	2,386	14	..	..
May I ..	1,507	136	11	8.8	710	310	69	22.25
Do. II ..	7,917	151	5	3.31	1,597	128	1	0.83
June I ..	2,972	60	..	..	259	68	1	1.47
December II ..	1,563	25	..	..	1,037	10	..	..
1940								
Januray I ..	7,028	83	..	..	4,963	48	..	..
Do. II ..	5,910	35	..	..	3,687	21	..	..
February I ..	752	3	..	..	794	10	..	..
July II ..	560	117	..	..	407	353	7	1.98
August I ..	228	28	..	..	109	93	..	..

Note.—I and II refer to the first and second fortnights respectively.

TABLE V

Emergence record of parasites from the shed buds and bolls of cotton 600 each picked on 22nd July 1940

Date of Emergence					NATURE OF PARASITES			
					<i>Microbracon gelechidiphagus</i>	<i>Apanteles pectimorphæ</i>	<i>Goniozus</i> n. sp.	<i>Elasmus johnstoni</i>
1940								
July	23	..	..	..	5	11	19	..
	26	..	..	..	6	12	15	2
	27	..	..	..	16	5	2	..
	28	..	..	..	6	4	2	..
	29	..	..	..	4	3	2	..
	30	..	..	..	3	..	3	..
	31	..	..	..	..	3	..	..
August	1	..	..	..	..	1	..	..
	2	..	..	..	..	1	..	..
	3	..	..	..	..	4	..	..
	4	..	..	..	..	9	..	..
	5	..	..	..	..	..	..	..
	9	..	..	..	..	5	..	..
	10	..	..	..	..	3	..	..
	12	..	..	..	4	3	..	..
	13	..	..	..	1	6	1	..
	14	..	..	..	..	..	..	..

Note.—*M. lefroyi*, *Bassus*, *Actia* and *M. greeni* were not recovered during the period.

TABLE VI

Incidence of *Microbracon gelechidiphagus* in the *Platyedra* caterpillars in the standing large-sized bolls of Cambodia for the years 1933 and 1934

Year and Month					Host population	Number affected by parasites	Percentage of parasitization
1933							
January	..	..	..	..	65	..	..
February	..	..	..	..	63	..	..
March	..	..	..	..	163	..	..
April	..	..	..	..	26	2	7.69
May	..	..	..	..	422	39	9.24
June	..	..	..	..	575	41	7.10
July	..	..	..	..	857	28	3.26
1934							
January	..	..	..	..	..	..	..
February	..	..	..	..	115	2	1.60
March	..	..	..	..	173	1	0.58
April	..	..	..	..	184	1	0.54
May	..	..	..	..	170	2	1.18

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