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Studies on the egg-parasites of *Tessarotoma javanica* Thunberg (Hemiptera :
Pentatomidae) with special reference to *Anastatus colemani* Crawford
(Hymenoptera : Eupelmidae)

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STUDIES ON THE EGG-PARASITES OF *TESSARATOMA*
JAVANICA THUNBERG (HEMIPTERA : PENTATO-
MIDAE) WITH SPECIAL REFERENCE TO
ANASTATUS COLEMANI CRAWFORD
(HYMENOPTERA : EUPELMIDAE)*

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During the course of investigations on *Tessaratomia javanica* Thunberg a pest of *Kusum, Schleicheria oleosa* (Lour.) (Mehra and Kapur, 1955; Mehra and Purakayastha, 1958) it was observed that the eggs of this pentatomid were heavily parasitised in the field by three *Anastatus* spp. (Eupelmidae) and two *Ooencyrtus* spp. (Encyrtidae). The present paper records the results of detailed investigations on *A. colemani* Crawford and some observations made on the other four parasites.

Anastatus colemani Crawford

Life history

A. colemani is a solitary parasite.

Oviposition : Oviposition is similar to that of *A. albitarsis* Ashm. (Clausen, 1927). The female first examines the host-egg with the antennae and brings the ovipositor forward in a vertical position and in contact with the egg. The thick shell of the host-egg is then pierced by rhythmic raising and lowering of the abdomen. After penetration, the female examines the interior of the egg by rocking in various directions probably to determine the stage of development reached by the host-embryo or the presence of another parasite-egg or larva therein. It was not possible to induce oviposition into eggs containing advanced stages of or fully developed host-embryos or parasite eggs or larvae. If the host is found suitable the ovipositor is thrust to its full length and the egg deposited. It takes about thirty minutes to deposit an egg.

The number of eggs laid per female was found to be 17.1 on an average (variation 7-46 eggs for 7 females). The maximum number of eggs laid by one female in a day was 9.

*This paper was read at the 45th Indian Science Congress held at Madras in 1958.

Development : The parasite egg is surrounded by a greyish black fluid which is visible through the chorion of the host-egg. The blackness grows in volume with the development of the parasite till the whole of the host-egg appears blackish.

The embryo develops within the egg with its head near the point of attachment of the egg to the pedicel. On hatching the larva floats free in the semi-fluid contents of the host-egg. The larva has no bifurcate process at the caudal end as in the case of *A. albitarsis* (Clausen, 1927). The newly hatched larva does not show the segments clearly but fourteen could be counted in about four hours. The blackness gradually disappears with the growth of the larva. Finally the larva loses its length, appears bloated with the body arched and the two ends with a few setae lying closer. The host-egg at this stage appears white and dry, and hollow in the upper half, which contains the mature parasite larva lying on the solidified remnants of the host-egg fluid, which makes the lower half of the host-egg appear buff. Just before pupation the parasite larva evacuates the stomach contents in the form of a beaded string, which collects in between the larva and the solidified host-egg fluid, loses the beaded appearance and looks like the latter, while the larval body gets deflated and wrinkled (Fig. 4).

The freshly formed pupa is white and its gradual change to black can be followed through the chorion of the host-egg. The pupa has the head and abdomen bent ventrally to fit the outline of the host-egg. The female can be distinguished from the male by its bigger size and the presence of a white band across the abdomen.

The adult emerges by cutting a hole in the host-egg shell, more often at the free pole. The exit-hole of the female parasite is bigger, measuring about 1.05 mm. in diameter, than that of the male, measuring 0.18 mm. in diameter. The exit-hole of the parasite can be easily distinguished by its irregular outline, smaller diameter and the absence of the severed portion of the egg-wall from that of the host, which is regular in outline, bigger in diameter and almost always has the severed portion hinged to one side.

The adult emerges during March-April with the appearance of the host and also disappear with it by about October. The males precede the females by an average of two days. The females are more active than males and capable of jumping great distance as described by Clausen (*loc. cit.*).

Sex ratio : Male to female ratio for specimens bred in the experimental cages was found to be 1 : 3.2 while the same for emergences from the field-parasitised eggs was 1 : 10.3. Thus the females predominated in both cases.

Longevity : In the experimental cages, where the parasites fed on natural food, namely probably the sap of the tree oozing at the punctures made by the bug, liquid drops deposited as a result of transpiration, dew drops and rain drops, they lived longer in winter than in summer. Also the longevity of females was about double that of males in summer and about three times in winter. The males fed on 4 per cent sugar solution in the laboratory lived as long as those in the experimental cages on natural food but the life span of the females was cut short to about one-third (Table I).

TABLE I
Longevity of *A. colemani*

Season	Female			Male		
	Number under observation	No. of days		Number under observation	No. of days	
		Range	Average		Range	Average
(i) <i>On natural food in experimental cages</i>						
Summer (March to August 1952 and 1956)	190	1-44	7.3	101	1-23	3.3
Winter (September to November 1955)	172	1-33	10.3	196	1-20	3.0
(ii) <i>On 4 per cent sugar solution in laboratory</i>						
Summer (March to August 1955)	559	1-10	2.5	222	1-6	3.4
Winter (September to November 1955)	54	1-5	3.2	23	1-20	2.6

Developmental period : The egg stage covers a period of about 3 days. The larva matures in about 5 days and it is in this condition that hibernation takes place. The pupal stage extends over about 8 days.

The life-cycle of the female parasite usually extends to 55.8 days on an average--about 15.9 days during summer (March to August), 16.7 days during early winter (September to November) and 134.8 days during late winter (October to February). The male parasite completes this cycle in 55.1 days on an average--about 14.3 days during summer (March to August), 16.8 days during early winter (September to November) and 134.3 days during late winter (October to February) (Table II).

TABLE II
Duration of egg to adult of *A. colemani*

Season	Female			Male		
	Number under observation	Range in days	Average in days	Number under observation	Range in days	Average in days
Summer (March to August 1952 and 1956)	122	11-23	15.9	148	11-27	14.3
Early winter (September to October 1955)	245	12-26	16.7	238	11-25	16.8
Late winter (November 1955 to February 1956)	34	117-157	134.8	11	115-152	134.3
Average			55.8			55.1

Pre-oviposition and oviposition periods : The average pre-oviposition period was found to be 9.4 days (variation 4-15 days for 5 females). The average oviposition period was found to be 5.4 days (variation 2-12 days for 5 females).

Generations : In some cases ten generations were bred in the experimental cages and in others only nine during 13 months from March to March. The winter mostly intervenes in the tenth generation but in some cases it intervenes in the ninth generation. Thus, the parasites starting the ninth generation in the first week of October complete their life cycle in the second week of November and the winter sends the mature larvae of the tenth generation into hibernation which then complete the cycle towards the end of March next year. Others which start the ninth generation towards the end of October complete this cycle also towards the end of March next year.

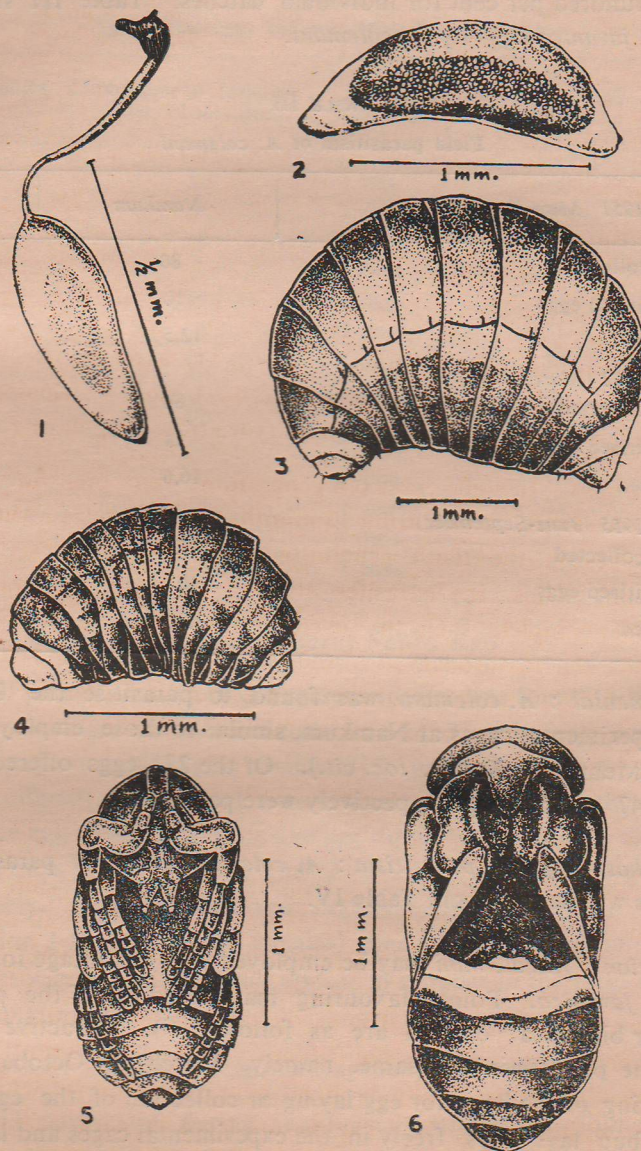
Description of immature stages

Egg (Fig. 1) : Slightly curved and floating in the embryonic fluid while attached to the chorion with a pedicel. The egg measures about 0.45 mm. in length and 0.15 mm. in width and the pedicel about 0.56 mm. in length.

Larva (Figs. 2 and 3) : The newly hatched larva is slightly curved with the caudal end tapering, the anterior end is blunt. It measures about 1.62 mm. in length and 0.52 mm. in width. Body is light ochraceous-brown with the light yellow digestive tract visible through it. The mature larva is dark ochraceous-brown bean shaped with blunt ends close together and measures about 2.46 mm. in length and 1.77 mm. in width.

Pupa (Figs. 5 and 6) : It is also curved in almost a semicircle with the two ends appressed ventrally. The male pupa measures about 2.13 mm. in length and 1.09 mm. in width and the female pupa about 2.45 mm. in length and 1.28 mm. in width.

PLATE I
Anastatus colemani Crawford



Figs. 1—6. 1. Egg. 2. Newly hatched larva 3. Mature larva 4. Mature larva before pupation 5. Male pupa (Ventral view) 6. Female (Dorsal view).

Parasitism

Natural : Observations on the incidence of *A. colemani* in the field were taken in two localities, namely, Namkum and Hesal (Ranchi District, Bihar) nine miles apart. The parasitism ranged from 11.7 per cent at Hesal to 22.6 per cent at Namkum in 1955. Generally 14 host-eggs comprised a batch and in some cases parasitism was hundred per cent for individual batches. Table III shows the field parasitism of *T. javanica* eggs by *A. colemani*.

TABLE III
Field parasitism of *A. colemani*

	1951 (May-June)	Namkum	Hesal
Number of eggs collected		80	—
Number of parasitised eggs		10	—
Per cent parasitised		12.5	—
<i>1952 (March-June)</i>			
Number of eggs collected		84	—
Number of parasitised eggs		14	—
Per cent parasitised		16.6	—
<i>1955 (June-September)</i>			
Number of eggs collected		473	33,585
Number of parasitised eggs		107	3,958
Per cent parasitised		22.6	11.7

Experimental : *A. colemani* was found to parasitise the host-eggs quite freely in the experimental cages at Namkum, similar to those employed for rearing of *T. javanica* (Mehra and Kapur, *loc. cit.*). Of the 281 eggs offered in 1952 and 1466 in 1955, 147 and 560 eggs respectively were parasitised.

Age of host-eggs and parasitism : *A. colemani* generally parasitised 1-2 day old host-eggs as will be seen from Table IV.

Conclusion : *A. colemani* may be employed with advantage for the biological control of *T. javanica*. Points favouring mass breeding of the parasite and its employment for biological control are as follows : (i) The active season of both the host and the parasite is the same, namely, March to October. This makes easy the procuring of the bugs for egg laying or collection of the eggs laid in the field, (ii) The bug lays eggs freely in the experimental cages and lays throughout the active period. Thus a continuous stock of eggs can be maintained for rearing

the parasite, (iii) The host-eggs are easily parasitised by this chalcid under laboratory conditions, (iv) The parasite completes eight to nine generations during the active period. Thus a continuous supply of the parasite can be maintained for release in the field, (v) A very simple technique is required for mass breeding of the parasite.

TABLE IV
Age of host-eggs and parasitism by *A. colemani*

Condition of females	Number of females under observation	Age of host-eggs	Number of eggs offered	Number of eggs parasitised
Mated	52	1 day	353	126
Unmated	9	1 day	287	96
Mated	28	2 days	248	131
Unmated	7	2 days	276	127
Mated	59	3 days	124	44
Unmated	5	3 days	51	19
Mated	44	4 days	74	29
Unmated	7	4 days	61	28
Mated	10	5 days	47	16
Unmated	2	5 days	11	4
Mated	15	6 days	31	2
Unmated	4	6 days	34	11
Mated	11	7 days	31	1
Unmated	—	7 days	—	—

Anastatus amarus Subba Rao

The field parasitism during the present studies was found to be 0.18 per cent (61 eggs found parasitised of the total collection of 33,585 eggs), which was much less than in the experimental cages, namely, 21.5 per cent (48 eggs were parasitised of the 200 eggs offered). The females and males took almost the same time to develop from the egg to adult and the average duration was found to be 19.5 days (variation 14-35 days for 40 females) and 20.1 days (variation 17-26 days for 25 males) respectively. The females lived slightly longer than the males, namely, 6.7 days (variation 2-16 days for 12 females) and 4.5 days (variation 1.14 days for 12 males) respectively. The two sexes appear in number in the ratio of 1 to 2.7, the females predominating.

Anastatus dentatus Narayanan, Rao and Rao

The field parasitism during the present studies was found to be 0.12 per cent (41 eggs found parasitised of the total collection of 33,585 eggs), which was

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much less than that in the experimental cages where parasitism was found to be 18.0 per cent (27 eggs parasitised of the 150 eggs offered). The females took 19.2 days on an average (variation 14-24 days for 9 females) and males 20.1 days (variation 19.26 days for 8 males) to develop from egg. The females lived longer than the males, i e. 9.1 days (variation 4-20 days for 18 females) and 3.0 days (variation 2-5 days for 16 males) respectively. Sex-ratio was found to be 1 to 2.5, the females predominating.

Ooencyrtus sp. I.

The head, thorax and abdomen of both sexes are black with legs and antennae blackish yellow. Females measure 1.52 mm. in length and 0.43 mm. in width and the males 1.82 mm. and 0.52 mm. respectively. The field parasitism was studied from the egg-collection of *T. javanica* from Hesel and Namkum in 1955 and was found to be 0.74 per cent on an average (number of eggs collected 33,585 and number of parasitised eggs 250) and 17.5 per cent on an average (number of eggs collected 473 and number of parasitised eggs 83) respectively. The parasitism in the experimental cages was found to be more, namely, 50.9 per cent (28 of the 55 eggs offered were parasitised).

The duration of egg to adult was observed to be 14 days on an average (variation 11-22 days for 28 parasites). On an average 12.23 adults emerged per host egg (variation 7-18 parasites for 50 eggs) and each host egg had 7.9 exit holes (variation 3-13 holes for 80 eggs). The male exit-holes were bigger, measuring 0.6 mm. in diameter, than those of the female, measuring 0.43 mm. The adult parasites lived for 4.5 days on an average on 4 per cent sugar solution in the laboratory (variation 1-13 days for 106 adults).

Ooencyrtus sp. II

Five eggs of those collected at Hesel, as mentioned under species I, were found to be parasitised with this chalcid. The head, thorax and posterior half of the abdomen of females are black and anterior half of abdomen, legs and antennae yellow. They measure 1.34 mm. to 1.69 mm. in length and 0.43 mm. to 0.52 mm. in width. Males were not found. About 40 parasites emerged from these five eggs.

SUMMARY

Five chalcid egg-parasites of *Tessarotoma javanica* Thunberg, a pentatomid sporadic pest of *kusum* (*Schleichera oleosa* (Lour.) have been recorded in Chota Nagpur, Bihar. Life history of *A. colemani* Crawford, one of the parasites, has

been presented in detail. The possibility of employing *A. colemani* for biological control of the bug has been discussed. Some observations on the other four parasites, namely, *Anastatus amarus*, *A. dentatus* and two species of *Ooencyrtus* have been recorded.

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