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STUDIES ON *CERATOVACUNA SILVESTRII* (TAKAHASHI) (HOMOPTERA : APHIDIDAE) AND ITS PREDATOR *ANISOLEMNIA DILATATA* (FAB.) ON BAMBUSA ARUNDINACEA

By

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(With 4 Text-figures and 4 Tables)

INTRODUCTION

Ceratovacuna silvaestrii (Takahashi) is chiefly infests bamboo and is known from India, Japan and Taiwan. In India this species occur widely in northeast India infesting bamboo plants of different spceies (Basu, R. C. *et al*, 1974 ; Ghosh and Raychaudhuri, 1971 ; Ghosh *et al*, 1971 ; Ghosh *et al*, 1974 ; Raha *et al*, 1977 ; Raychaudhuri 1973). So far the available information on this aphid was very scanty. In the present work, this aphid has been studied in detail regarding its field activity, nymphal taxonomy and life eycle of a dominating predatory beetle *Anisolemnia dilatata* (Fab.).

In recent times, field observations on aphids have assumed increasing importance because of the fact that such a study reveals the time of immigration, emigration, morph composition and population trend of the aphid species and also provides the information about the time when plants are more prone to aphid attack, symptoms of damage and the activity of the natural enemies. Such information is immensely helpful in planning out suitable control measures and plant protection strategy. However, such studies are lacking on most of the aphid species known from India.

Nymphal taxonomy of this aphid has also been attempted. This study helps in ascertaining the degree of differences between the developmental stages within the same species. Very often adults are not found in the collection of aphid samples. In such cases previous knowledge of the characters of nymphs helps in the identification of the aphids. Besides, nymphal taxonomy is also helpful in understanding the development of different characters within a species.

Life cycle study of coccinellid predator *Anisolemnia dilatata* (Fab.), an important predator of *C. silvestrii*, was also done under laboratory conditions. This predator was so far not known from this part of India and this is the first account of predator's life cycle and feeding habit being presented here.

The text of this communication has been divided into three parts ; first part deals with field observations, second part deals with nymphal taxonomy and the third part is devoted to the life cycle study of the coccinellid predator. This is followed by a summary and a list of references cited in this work.

The work presented in this communication began in the last week of November 1981 and continued till the end of August 1982. The area of study was Jogendranagar situated in the vicinity of College Tilla at Agartala, Tripura.

Following abbreviations have been used in this work :

L. Body	:	Length of body
W. Body	:	Width of body
L. Ant.	:	Length of antenna
L. Ant. III	:	Length of antennal segment III
Base III	:	Basal diameter of ant. segment III
p. t.	:	Length of processus terminalis
U. r. s.	:	Ultimate rostral segment
h. t. 2	:	Length of 2nd segment of hind tarsi
D. Siph.	:	Outer diameter of siphuncular pore
L. Horn	:	Length of frontal horn
F. T. C.	:	First tarsal chaetotaxy

All the material pertaining to this work are in the collection of the first author.

PART I—FIELD OBSERVATIONS

Materials and Methods

Daily observations were made on bamboo plants between November 1981 and April 1982. Thereafter the frequency of observations was increased to one week intervals. Sampling of aphids and their natural enemies was made in 70% alcohol. Predators and the parasites of the aphid were reared into their adult stages in the laboratory. Predatory larvae were brought along with the aphid prey and allowed to grow in

paired petridishes to get the adults. Parasitized aphids were collected in clean dry empty tubes and allowed to rear into the adult stage.

In the begining, daily observations covered 2-3 visits to the study site, spread over 6-7 hours interval. This procedure continued until the decline in population of aphids started in the begining of March 1982.

Observations were made on the immigration, population build-up, emigration of aphid and their natural enemies and association of ants and other insects attending this aphid.

RESULTS AND DISCUSSION

I. *Immigration*

The first appearance of *C. silvestrii* was noted in the first week of December 1981. This comprised a few apterous viviparae infesting a few leaves. Unlike in most aphid species the immigration in this species appeared to have taken place through the apterous morph, perhaps by wind transport, as no alates were found. In this period no ant or natural enemy association was noticed. This situation persisted till the middle of December 1981.

II. *Population build up*

Subsequent observations during December 1981-January 1982 revealed gradual build-up of aphid population. The new aphid colony formation began with the laying of a few nymphs at the basal region of the young leaves. Gradually the colony size increased in the region of midrib but never went beyond $\frac{3}{4}$th length of the leaf. Aphids were more concentrated on the central region of the leaf and less so towards the margin. Between the end of December 1981 and the end of January 1982 population build up was gradual and in this period, most of the young leaves were slowly covered by aphid colonies, comprising more nymphs and fewer adults. In contrast, the older leaves were mainly infested by adults. It was interesting to note that the nymphs laid by the adult on the older leaves, were seen moving towards the younger leaves and branchlets. Several observations along the stem of bamboo revealed continuous movement of first and second instar nymphs in both directions. This movement perhaps constitutes intermediate pathway of nymphs from the older leaves to the young ones and also the movement of nymphs from the overcrowded young leaves to less crowded or newly growing leaves. During the period end of January 1982 to the end of February 1982, population build up was maximum, and most of the leaves, branchlets and culms were covered with aphids.

During this period the population structure was stable and no visible increase or decrease was noticeable. From a distance, part of the bamboo plant looked blackish.

A decline in population was noticed towards the beginning of March when many of the older leaves were devoid of aphids. In the beginning of April, aphid population also dwindled on the younger leaves and towards the end of April aphid movement along the stem was minimum and only some leaves were infested by a few aphids. This condition continued until the third week of May. Thereafter until the middle of June only a few aphids were noticeable. In the last week of June there was no trace of aphid on the bamboo plant.

III. *Emigration*

Emigration of *C. silvestrii* appeared to have taken place through the nymphs. At no stage of this study, alate-morph was noticed. It is presumed that nymphs either sporadically or in batches left the bamboo plants with the help of wind. Aoki (1979) noted dispersal of *Pseudoregma alexandri* (Takahashi), another bamboo aphid species, through first instar larvae in the wind. The reason for such presumption is that adults were first to disappear from the older leaves and younger nymphs were last to leave the bamboo plant.

IV. *Predators and parasites*

i. *Predators*

a. *Syrphid larvae*

A few syrphid larvae were seen feeding on aphids on the leaves and branchlets. Throughout the month of December, syrphid larvae were the sole predator of this aphid on bamboo. But most of these larvae were soon parasitised by *Diplazon orientalis* (Cameron). In January only a few syrphid larvae could be noticed and the attempts to rear them to adult in laboratory failed.

b. *Anisolemnia dilatata* (Fab.)

This large, beetle species first appeared in the first week of January 1982. These beetles swiftly moved from leaf to leaf and along the branchlets devouring the aphids voraciously. In the 3rd week of January many grubs of this species were also seen predating on aphids. This predator occurred throughout the period of maximum aphid population. With the decline in aphid population in the beginning of March, a corresponding decline in predators' population of this

species was also noticed. During January-February batches of ovoid shaped eggs of this beetle occurred attached to leaf surfaces and branchlets.

c. *Scymnus* spp.

The larvae and adults of this beetle group were seen feeding on bamboo aphids during January to April. Mostly adults were seen moving along the stem and feeding on the nymphs. One interesting difference between this beetle and *Anisolemnia dilatata* was that the former preferred feeding on aphid nymphs while the later fed mostly on the adults of aphid. This difference in the feeding habit may be directly co-related with the size of the beetle. However, it can be mentioned here that Scymnus beetle fed on adult of other aphid species like *Aphis nerii* (Kaltenbach), *Aphis gossypii* Glover, *Aphis craccivora* Koch and *Toxoptera aurantii* (Boyer)

d. *Micromus* sp.

The larvae of this species were few in number and occurred mostly on the stem feeding on the nymphs sheltered on the adventitious roots and lower parts of the bamboo stem. A few larvae were also noticed on the young leaves at the basal region.

Previous to this, *Calliphora paltoni* and *Synoncha grandis* were known as the predators of this aphid from India (Raychaudhuri *et al.* 1978).

ii. *Parasites*

Only *Trioxys indicus* Subba Rao and Sharma could be reared as parimary parasitoid of *C. silvestrii*. The parasitic activity was restricted to a brief period in March 1982. Several attempts before and after that did not succeed in the rearing of any other parasitoids.

Previous to this *Ephedrus plagiator* (Nees) was recorded as a parasite of this aphid (Agarwala *et al.* 1981) from India.

V. *Attendance of Ants and other insects*

Following insects were noticed attending on this aphid :

I. Hymenoptera :

Formiciidae

i. *Camponotus* sp.

ii. *Triglyphothrix lanuginosa* (Mayr)

II. Diptera :

Tebritidae

i. *Dacus diversus* Coquerel

Some members of following families also attended

C. silvestrii :

Drosophilidae

Muscidae

Empidae

Culicidae

It was interesting to note that ant species attended the aphids between sunrise and sunset whereas all other insects were seen attending on aphids on the dark hours. This combination of aphid attendance was hitherto unknown from India.

OTHER OBSERVATIONS

i. The nymphs of *C. silvestrii* caused painful irritation when they fell on the hand and some other exposed parts of the body. The feeling of this irritation continued for a few minutes. Adults, however, caused very minor irritation and it lasted a few seconds only. Aoki (1979) observed biting of man in *Astegopteryx styracicola* making gall on *Styrax suberifolies*. But he assigned this biting behaviour to soldier morphs of the aphid. In *C. silvestrii*, however, no such morph differentiation was noticed after a careful study.

ii. Mosquitoes, fruit flies and certain other flies attended the bamboo aphid in their own ways. Mosquito attendance was marked by their overriding a small group of closely placed aphids and "sucking" the honey-dew in an up-right position without disturbing its body for a long time. Other flies attended the aphids by frequently moving from one colony to other and halting at each colony for a brief period only. These flies moved in groups.

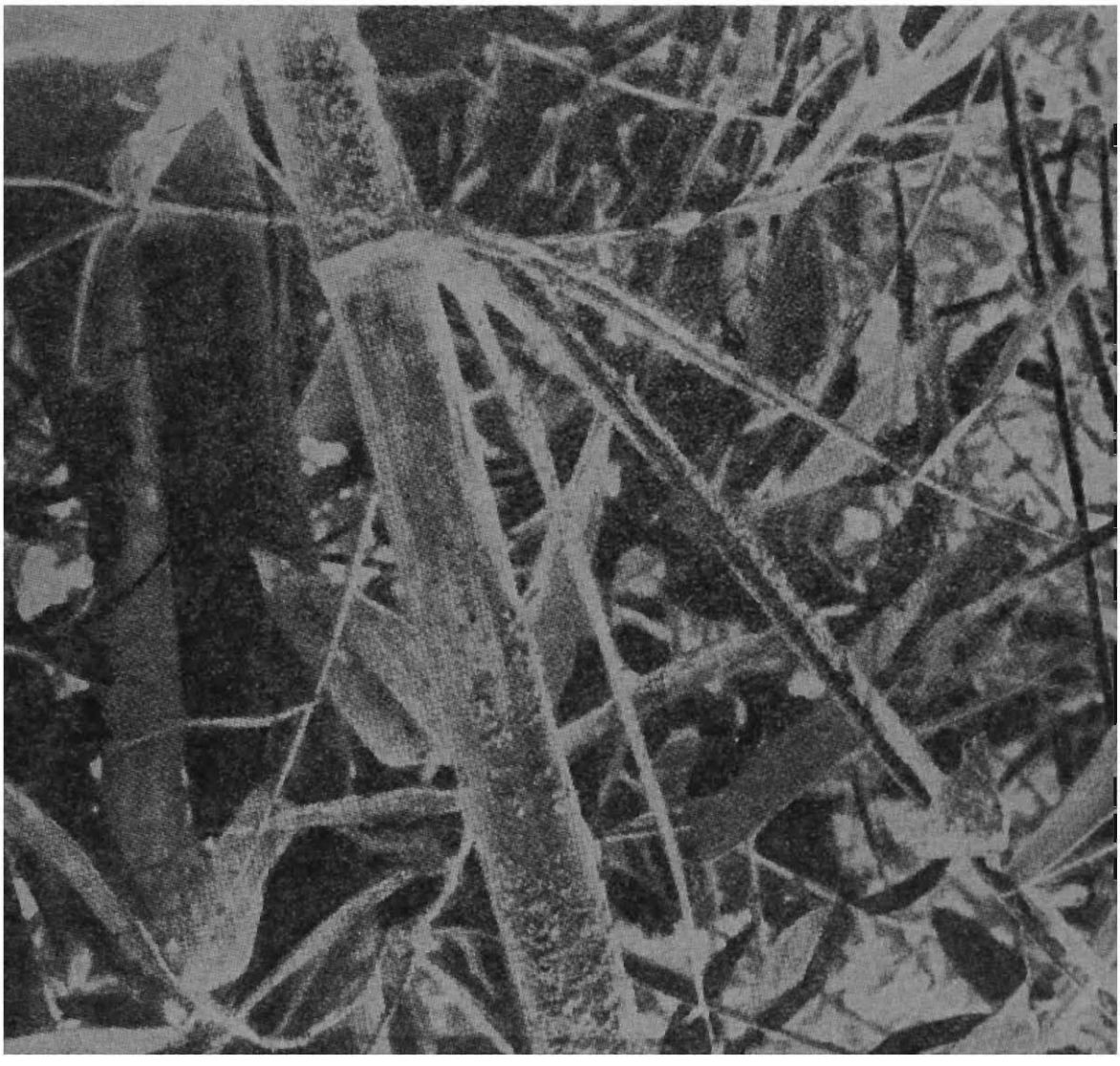
PART II—NYMPHAL TAXONOMY

Material and Methods

Apterous viviparous females were cultured in laboratory on potted plants. Newly emerged nymphs were taken out from the plant and placed on fresh potted plants for their attaining second, third, fourth

instar nymph and the adult stages. Ten nymphs of each instar and adults of apterae were kept in 70% alcohol and were processed for the preparation of permanent slides.

Thirteen characters of taxonomic importance were examined for each nymphal instar and the adult. Morphometric measurements were carried out and all the measurements were converted into millimetre (mm).



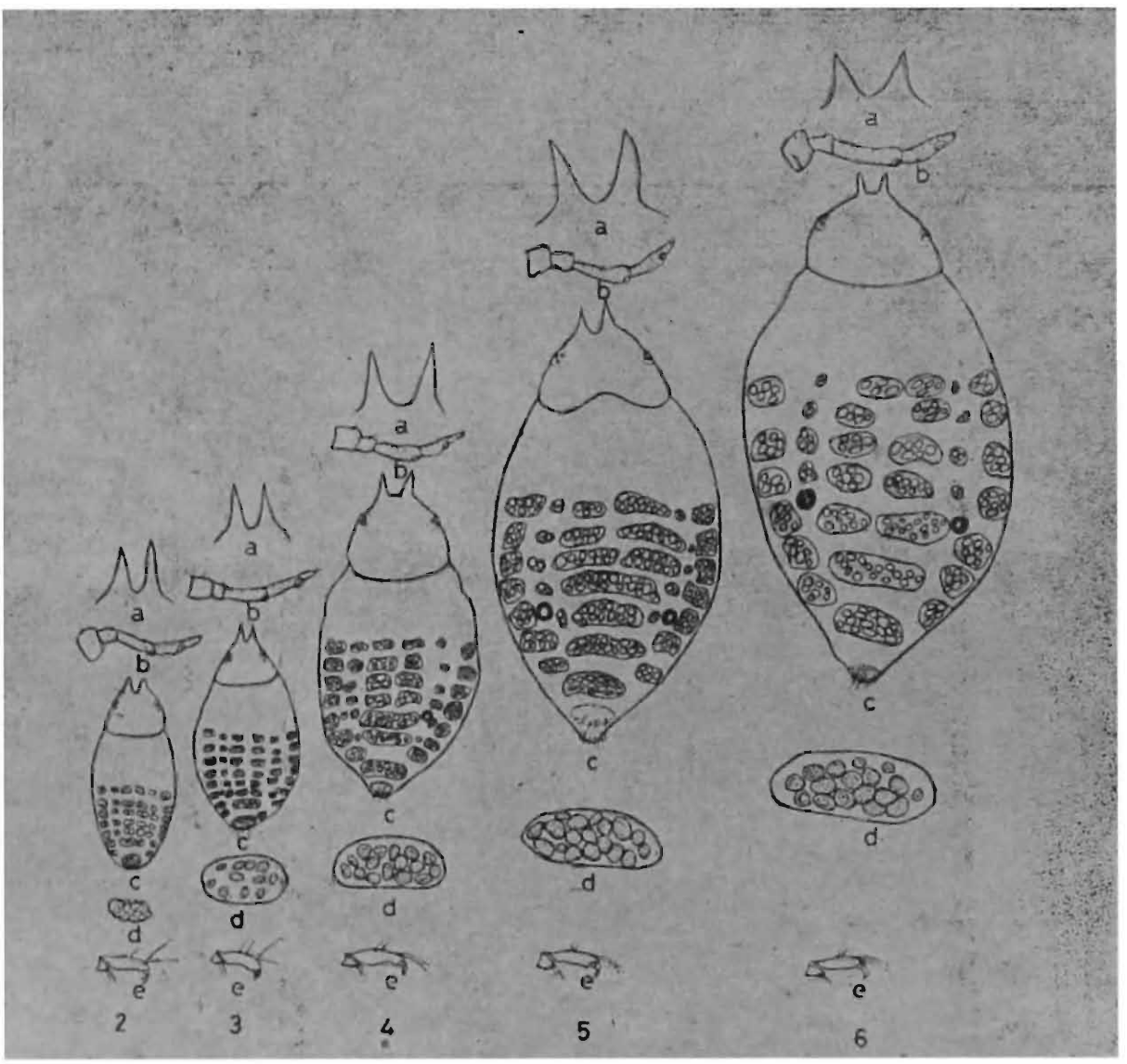
Text-fig. 1. A colony of *C. silvestrii* on *Bambusa arundinacea* infesting stem and branchlets

RESUTS AND DISCUSSION

First instar nymph : (Text-fig. 2a-e)

Body 0.81-0.90 mm long and 0.40-0.45 mm as maximum width. Head and prothorax fused. Frontal horns somewhat pointed at the apex and widest at the base, 0.07-10 mm long, placed on each side of the mid-dorsal region. Eyes 3- faceted, triommatidia prominent.

Antennae 4-segmented, 0.22-0.25 mm long, p.t. 0.5× base of last antennal segment ; primary rhinaria round, somewhat protuberant, finely ciliated. Ultimate rostral segment short and blunt, 0.08-0.10 mm long ;

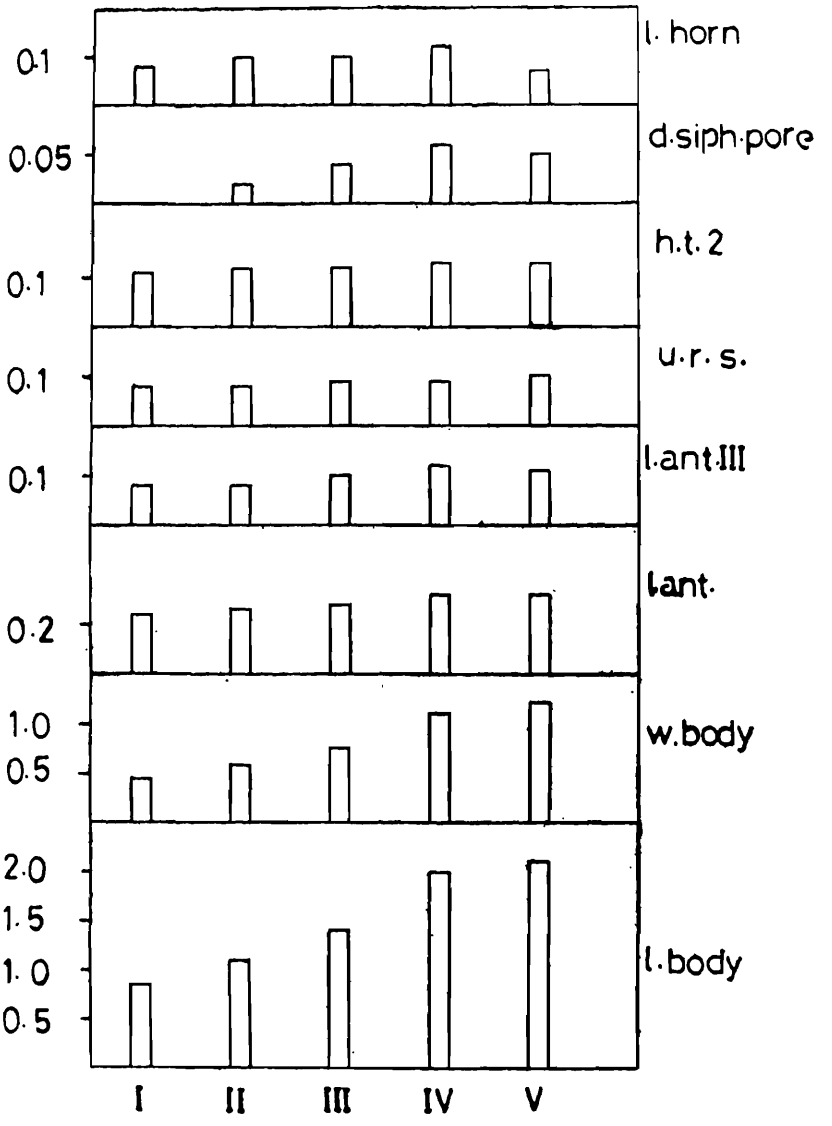


Text-fig. 2-6. First, second, third, fourth instar nymphs and adult of *C. silvestrii*—Apterous viviparous female

a—Antenna
b—Frontal horns
c—Body
d—Wax plate on tergite VIII
e—Hind tarsi

without any secondary hairs. Legs stout ; forefemora stouter ; h.t.2 0.11-0.12 mm long ; first tarsi with 2 long hairs on each leg ; dorso-apical hairs long, two in number, with funnel shaped apices. Abdomen pale and membranous. Siphunculi absent. Cauda broadly rounded. Wax glands distributed throughout the body, on cephalothorax these arranged in groups of 3-4 wax cells ; on thoracic and abdominal

segments in groups of 1-5. These are distributed segmentally along spinal, pleural and marginal rows ; those on segment 6 without spinal and pleural wax glands and the segment 8 with only spino-pleural wax glands ; all these wax glands consist of 2-7 wax cells grouped together except on the posterior abdominal segments where wax cells are indistinguishable.



Text-fig. 7. Histogram showing differential gradient in some characters of nymphal instars and adult of *C. silvestri*—Apterous viviparous female.

Second instar nymph : (Text-fig. 3a-e) :

Body 0.93-1.30 mm long and 0.50-0.67 mm wide in the middle of abdomen. Frontal horns 0.09-0.11 mm long. Antennae 4-segmented ; 0.26 0.27 mm long ; p.t. about 0.5× base of last antennal segment. Ultimate rostral segment 0.08-0.09 mm long. Fore femora slightly stouter than mid and hind femora ; h.t. 20.10-0.12 mm long. Siphunculi present, ring like, placed on a pigmented cone ; diameter of siphuncular pore 0.02-0.03 mm. Cauda rounded, bearing 6-7 hairs.

Wax glands present throughout the body, in cephalothorax this consisted of 5-6 wax cells and on thorax and abdomen it consisted of 11-19 wax cells placed close together, the maximum number being on tergite 8 ; all the wax cells are distinguishable. Other characters as in first instar nymphs.

Third instar nymph : (Text-fig. 4a-e) :

Body 1.28-1.49 mm long and 0.68-0.80 mm as maximum width. Frontal horns 0.10-0.11 mm long. Antenna 4-segmented, 0.26-0.27 mm long ; p.t. 0.62×base of last antennal segment. Ultimate rostral segment 0.08-0.09 mm long. Legs stout ; first tarsi with 3 hairs on each leg ; h.t. 2 0.11-0.13 mm long. Diameter of siphuncular pore 0.03-0.04 mm. Subanal plate undivided. Cauda transversely round. Wax glands present throughout the body ; in cephalothorax each gland consisted of 7-9 cells and those on thorax and abdomen, it consisted of 11-12 wax cells, the maximum number being present in the wax gland on 8th tergite. Other characters as in nymphs of first and second instars.

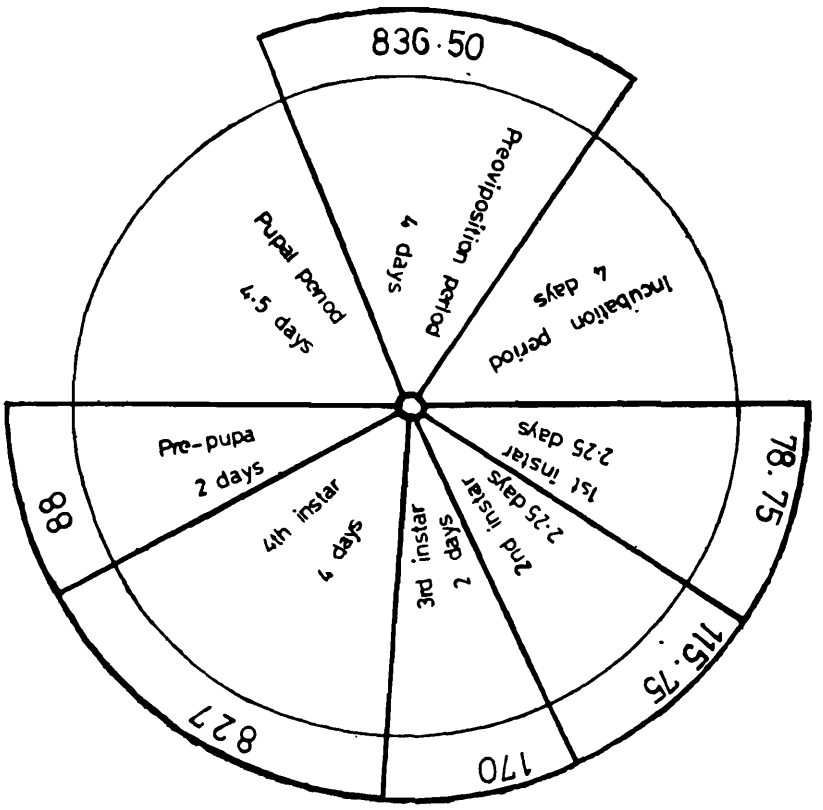
Fourth instar nymph : (Text-fig. 5a-e) :

Body 1.87-2.11 mm long and 1.04-1.26 mm as maximum width. Frontal horns 0.10-0.13 mm long. Antenna 4-, sometimes indistinctly 5-segmented, 0.30-0.34 mm long ; p.t. 0.4×base of last antennal segment. Ultimate rostral segment somewhat narrow at the apex ; 0.09-0.10 mm long. Legs stout ; first tarsal segments with 3 hairs ; h.t. 2 0.11-0.14 mm long. Diameter of siphuncular pore 0.04-0.07 mm. Subanal plate bilobed. Cauda knobbed. Wax glands sclerotized, distributed all over the body ; in cephalothorax each gland consisted of 7-9 cells and those on thorax and abdomen it consisted of 9-17 cells. Other characters as in nymphs of other instars.

Adult : (Text-fig. 6a-e) :

Body 2.03-2.20 mm long and 1.12-1.31 mm as wide in the middle of abdomen. Frontal horns bluntish, bearing a few minute hairs, 0.06-0.08 mm long. Antennae 4- or 5- segmented ; about 0.30-0.34 mm long ; p.t. about 0.5× base of last antennal segment ; primary rhinaria round, somewhat protuberant and finely ciliated. Ultimate rostral segment bluntish, 0.10 mm long, about 0.40-0.60×h.t. 2 and without any secondary hairs. Legs deep brown, first tarsal segments with 3 hairs ; h.t. 2 0.13-0.4 mm long. Diameter of siphuncular pore 0.05 mm. Cauda with a basal constriction, knobbed. Subanal plate

bilobed. Abdomen pale but pigmented around wax gland cells, in cephalothorax wax glands consisted of 7-9 wax cells and those on thorax and abdomen, it consisted of 12-16 cells. Other characters as in nymphs.



Text-fig. 8. Diagramatic representation of Life cycle of *Anisolemnia dilatata* and mean feeding capacity at different stages.

In general, most of the characters exhibited a gradual increase in length from first instar to adult stages (Text-fig. 7). Depending on the degree of differences, three categories of the characters can be made as under :

i. Characters with minimum difference

ii. Characters with maximum difference

iii. Characters with variable difference

i. *Characters with minimum differences* :

Second segments of hind tarsi, ultimate rostral segment and base of antennal segment III exhibited minimum degree of differences in between the developmental stages. The little existing differences (Table 1), however, seem to be overlapping in a narrow range. These characters are comparatively stable in nature.

ii. *Characters with maximum differences* :

Length of body, width of body and diameter of siphuncular pore exhibited maximum degree of difference. All the three characters

TABLE 1. Morphometric data of some important character of different developmental stages of *Ceratovacuna silvestrii* (Takahashi)

Characters	First Instar			Second Instar			Third Instar			Fourth Instar			Adult		
	Range in mm Min	Max	Mean value (mm)	Range in mm Min	Max	Mean value (mm)	Range in mm Min	Max	Mean value (mm)	Range in mm Min	Max	Mean value (mm)	Range in mm Min	Max	Mean value (mm)
L. Body	0.81	0.90	0.85	0.93	1.30	1.11	1.28	1.49	1.39	1.87	2.11	1.97	2.03	2.20	2.12
W. Body	0.40	0.45	0.43	0.50	0.67	0.57	0.68	0.80	0.74	1.04	1.26	1.10	1.12	1.31	1.22
L. Ant.	0.22	0.25	0.24	0.24	0.27	0.25	0.26	0.27	0.27	0.30	0.34	0.32	0.30	0.34	0.32
L. Ant. III	0.07	0.08	0.08	0.06	0.10	0.08	0.09	0.10	0.10	0.11	0.13	0.12	0.10	0.12	0.11
Base III	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03
U. r. s.	0.08	0.10	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.09	0.10	0.09	0.10	0.10	0.10
h. t. 2	0.11	0.12	0.11	0.10	0.12	0.12	0.11	0.13	0.12	0.11	0.14	0.13	0.13	0.14	0.13
D. Siph.	—	—	—	0.02	0.03	0.02	0.03	0.04	0.04	0.04	0.07	0.06	0.05	0.05	0.05
L. Horn	0.07	0.10	0.08	0.09	0.11	0.10	0.10	0.11	0.10	0.10	0.13	0.12	0.06	0.08	0.07
No. of wax gland cells															
Cephalothorax	3	4	3.5	5	6	5.5	7	9	8	7	9	8	7	9	8
Tergite V	not distinguishable			11	16	14	11	19	14	9	15	13	12	16	14
Tergite VIII	not distinguishable			13	19	16	15	22	17	12	17	14	12	16	14
F. T. C.	2,2,2	2,2,2,	2,2,2	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3

exhibited persistent differences in between the developmental stages and seldom overlap. These characters seems to be of significant taxonomic value.

iii. *Characters with variable differences* :

All other characters fall in this category. In these characters the degree of differences was very variable in different stages (Table 1), sometimes overlapping and sometimes widely different.

An interesting point that emerged from this study is that the degree of differences in most of the characters from fourth instar to adult was lowest while in some other characters there was no difference (Table 1 & Text-fig. 7).

Key to the identification of NYMPHS AND ADULT :

(Apterous viviparous morph)

i.	Body without siphunculi ; F. T. C. 2, 2, 3 ; maximum length of body 0.90 mm ...	*First instar nymph*
	Body with siphunculi, F. T. C. 3, 3, 3. ...	... (ii)
ii.	Cephalothorax with each wax gland consisting of 5-6 wax gland cells ; body 0.93-1.30 mm and 0.50-0.67 mm wide ...	*Second instar nymph*
	Cephalothorax with each wax gland consisting of 7-9 wax gland cells ; body never less than long 1.28 mm long ...	... (iii)
iii.	Cauda rounded ; subanal plate undivided ; body and antenna 1.28-1.49 mm and 0.26-0.27 mm long respectively ; maximum diameter of siphuncular pore 0.04 mm ...	*Third instar nymph*
	Cauda knobbed, subanal plate bilobed ; body and antenna never less than 1.87 and 0.30 mm long ...	... (iv)
iv.	Frontal horns 0.10-0.13 mm long ; body 1.87-2.11 mm long ...	*Fourth instar nymph*
	Frontal horns 0.06-0.08 mm long ; body 2.03-2.20 mm long ...	*Adult apterae viviparae*

PART III : LIFE CYCLE STUDY OF *ANISOLEMNIA DILATATA* (Fab.)

MATERIALS AND METHODS

Adult beetles of both sexes were brought to the laboratory along with their aphid prey and allowed for mating and oviposition in dry

paired petridishes. The eggs were taken out and placed one each in 4 pairs of petridishes simultaneously. After the hatching of larva, counted number of sufficient aphids were supplied to each growing larva at an interval of 24 hours. This practice was continued till pupation. After the emergence of the adult beetles, aphid supply was resumed but could be maintained till the first oviposition only. Thereafter non-availability of aphids on bamboo plant became a limiting factor in further study. Observations were done in respect of daily feeding rate and duration of different developmental stages. The study was conducted from 6.3.1982 to 4.4.1982.

Results

DEVELOPMENTAL STUDY : (Table-2)

i. *Eggs* : The eggs were laid in batches, each batch consisting of 20-28 eggs arranged vertically in 2-3 longitudinal rows. The egg was yellow in colour and ovoid in shape. It remained attached to the surface of leaf or branchlet at its basal end.

TABLE 2. Developmental period of *Anisolemnia dilatata*

DEVELOPMENTAL STAGES	DURATION (DAYS) Replications				MEAN (DAYS)
	I	II	III	IV	
INCUBATION PERIOD	4	4	4	4	4
FIRST INSTAR	1	3	3	2	2.25
SECOND INSTAR	3	1	2	3	2.25
THIRD INSTAR	2	2	2	2	2
FOURTH INSTAR	4	4.5	4	3.5	4
PRE-PUPA	1.5	1.5	1.5	2	1.87
PUPA	4.5	4.5	4.5	4.5	4.5
TOTAL	20	20.5	21	21	20.625=21

ii. *Incubation period* : All the eggs hatched into first instar larvae on the 4th day within a difference of about 30 minutes.

iii. *First instar larvae* : Black in colour ; duration 1-3 days, average 2.25 days ; initially fed on the egg case and gradually switched to aphid feeding ; slowly moved from one place to other in search of aphids ; fed on early instar nymphs only and avoided contact with older nymphs and the adults.

iv. *Second instar larvae* : Black colour with yellowish bands on thorax and abdomen ; duration 1-3 days, average 2.25 days ;

wholly dependent on aphids for food, found actively moving in search of aphids ; fed mostly on early instar nymphs and rarely on third and fourth instar nymphs.

v. *Third instar larvae* : Colour similar to second instar ; duration 2 days in all the cases ; actively feeding on aphids ; vigorously moved from one leaf to another in search of aphids ; fed on all the stages of nymphs but fewer adults only.

vi. *Fourth instar larvae* : Colour similar to second and third instars but more prominent ; duration 3.5-4.5 days, average 4 days ; found very actively feeding on aphids ; fed on aphids of all stages with preference for older nymphs and adults.

vii. *Pre-Pupa* : Colour of the larvae become more yellowish ; mobility reduced and body started downward bending, slowly fed on aphids ; toward the end of this stage prepupa attached to a point by its posterior end ; duration 1.5-2 days.

viii. *Pupa* : Yellowish in colour with black spots on the dorsal side ; externally no visible activity ; duration 4.5 days in all the cases.

ix. *Imago* : The adult beetle emerged from the puparium rupturing postero-dorsal side. Dorsal cuticle yellow in colour with blackish spots. Soon it started wandering around the petri dish. Given the aphids, beetle slowly fed on them. The feeding activity gradually increased.

x. *Oviposition* : Beetles of opposite sexes were allowed to mate in order to get the eggs. First oviposition took place on the 4th day. Thereafter the study was discontinued for want of aphids. Starving beetles did not oviposit and died in 5-7 days.

xi. *Total developmental period* : From the date of oviposition to the emergence of adult beetle developmental period varied in a narrow range of 20-21 days. However, it was interesting to note that the duration of first and second instars was very variable in four replications but when the two stages are considered together, the variation gap was limited to one day only (Table 2).

FEEDING STAGES AND THEIR CAPACITY : (Table 3 & 4)

First instar larvae : In the first few hours immediately after hatching, the larvae fed on the egg cases and did not move. After about 6-8 hours, slight movement was noticed and they started touching the aphids. After several such attempts, first aphid was caught hold of and larva chewed on it very slowly. However, the following day, larva

moved more actively and would choose the youngest nymphs for feeding. First instar larva consumed 21-54 aphids per day. Mean consumption was 78-75 aphids per larva.

TABLE 3. Rate of daily feeding in the life cycle of *Anisolemnia dilatata*

Date	Age of larvae (days)	No. of aphid consumed per day Replications 1	2	3	4	average
14.3.82	0	till the larvae fed in the egg case				0
15.3.82	1	25	30	32	21	27
16.3.82	2	42	43	45	30	40
17.3.82	3	54	54	35	57	50
18.3.82	4	45	44	55	50	48.5
19.3.82	5	59	60	60	56	59
20.3.82	6	45	67	74	75	62.25
21.3.82	7	198	145	150	150	148.25
22.3.82	8	155	157	160	159	157.25
23.3.82	9	165	200	200	195	190
24.3.82	10	190	250	250	260	237.5
25.3.82	11	170	225	200	250	211.25
26.3.82	12	0	90	0	92	45.5
30.3.82	13-16	Pupal condition				
31.3.82	17	120	Pupal condition			120
1.4.82	18	180	104	110	90	121
2.4.82	19	200	180	176	180	184
3.4.82	20	240	293	280	273	271.5
4.4.82	21	220	260	230	220	230

TABLE 4. Mean of feeding by different stages in the life cycle of *Anisolemnia dilatata*

FEEDING STAGES	AVERAGE duration (days)	Average no. of aphid consumed per day REPLICATIONS I	II	III	IV	Mean
FIRST INSTAR	2.25	25	127	112	51	78.75
SECOND INSTAR	2.25	141	44	115	163	115.75
THIRD INSTAR	2	104	127	224	225	170
FOURTH INSTAR	4	658	977	810	864	827
PRE-PUPA	2	170	90	0	92	88
ADULT	upto 4-5	960	837	796	753	836.50
Total	16-17.5	2058	2202	2058	2148	2116.00

Second instar larvae : In the transition period of moulting from first instar to second instar, the larva was rather motionless and did not feed on aphids. After ecdysis, larvae started feeding on aphids

first slowly and then more actively. This instar also avoided contact with older nymphs and the adults but consumed aphids more vigorously. Seond instar larvae consumed 42-60 aphids per day and mean consumption was 117.75 aphids per larva.

Third instar larvae : This instar devoured 59-573 aphids per day, the rate being 59-75 aphids on the first day after second moulting and 145-593 on the last day before third moulting. The average feeding rate ranged between 104-284 aphids per larva.

Fourth instar larvae : The larvae of this instar fed preferably on older nymphs and adults. This instar was more motile and fed very vigorously on aphids. This instar larvae consumed 145-260 aphids per day and mean consumption was 658-977 aphids per larva. In separate petridishes when this instar was provided with nymphs of first, second and third instar in one set and fourth and adult stages in another set, the larval feeding exceeded significantly in the second set.

Pre-pupa : In this stage feeding was interrupted by brief periods of rests. In this stage feeding depended more on aphids coming in close contact rather than moving about for the prey. Average feeding rate varied between 90-170 aphids per pre-pupa.

Adult : After emergence from the puparium, imago did not feed on aphids for sometime. In this period it moved randomly trying to negotiate in the surrounding environment. It soon started feeding on aphids first at a slower rate but subsequently much faster. The feeding capacity increased gradually from 90-170 aphids in the first 24 hours to 240-310 aphids in a day just preceding oviposition. Pre-oviposition feeding rate on an average varied between 543-740 aphids. The adult beetles equally fed on all stages of the aphids.

Total feeding : During the developmental periods from first instar to pre-pupal stages food capacity varied between 1098-1295 aphids. Considering pre-oviposition period of four days in addition to it, the food capacity extended to 2058-2202 aphids per beetle (Table 4).

DISCUSSION

Before this study, *Anisolemnia dilatata* was known to be a predator of *Pseudoregma bucktoni*, also a hormaphidine aphid infesting bamboo plants (Behura, 1963). This predatory beetle was not found among aphids of other plants present near the bamboo clusters where it occurred. Also, this beetle did not occur on any of the twentytwo

aphid species which were collected during the same period from different parts of Agartala and surrounding areas. The association of this beetle with the bamboo aphids appears to be specific.

This beetle species can eat more aphids than many other predatory species of aphids. In most cases of beetle predators of aphids, the total feeding usually does not exceed 700 aphids per beetle and rarely beyond 700 aphids. But in the present study, *A. dilatata* has been found to consume upto 2202 aphids uptil first oviposition period and perhaps more than 3000 aphids during the entire life of a beetle. The enormous feeding potentiality of this species can be utilised in the control of certain aphid species which are of economic importance and before this can be achieved, a much more detailed study of biology and ecology of the predatory species is required.

Summary

Ceratovacuna silvestrii (Takahashi) is chiefly a bamboo infesting aphid known from India, Japan and Taiwan. In India this species occurs widely in northeast India. This paper, however, reports this species for the first time from Tripura. So far, the information on this aphid has been very scanty. In this paper for the first time this aphid has been studied through its field observations, nymphal taxonomy and biology of a dominating predatory beetle *Anisolemnia dilatata*.

Field observations during the period of November 1981-August 1982 has revealed that this species immigrates on bamboo plant during the end of November and builds up its maximum population during January-February. Population decline occurs in March and emigration takes place in April-June. Both immigration and emigration take place through the wind dispersal of early instar nymphs. Parasites and predators of this aphid comprised 1 species of hymenopteran parasite and 4 species of predators. The predators included 1 species of Syrphidae (Diptera), 1 species of homerobiidae (Neuroptera) and 2 species of Coccinellidae (Coleoptera). Of these, *Anisolemnia dilatata*, a coccinellid species has been found to be the dominating predator.

Nymphal taxonomy has helped in the understanding of differences in different stages of this aphid. The least differences occured between fourth instar nymph and the adult.

Life cycle study of *Anisolemnia dilatata* has revealed that this beetle completes its development within 20-21 days. First oviposition occurs on the fourth day. The total feeding before the pre-oviposition period was 1098-1395 aphids and after pre-oviposition period, it was 2058-2202

aphids. Maximum feeding occurred during the fourth instar larval period and minimum feeding occurred during the pre-pupal period (Text-fig. 8).

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