Theme: ENVIRONMENT- 1.2. Commercial plantation and Management: Pests and diseases

First Record of Green Standing Bamboo Borer (*Estigmena chinensis* Hope.): Its Biology, Epidemiology and Management in India

K.P. Singh and Indu Singh
Entomology Division, Forest Research Institute
Indian Council of Forestry Research and Education
E-mail: singhkp@icfre.org

Abstract

Estigmena chinensis Hope. (Coleoptera: Chrysomelidae) was observed feeding on green standing bamboo in Dehradun, Uttarakhand, India. This is the first report of the occurrence of *E. chinensis* on eight species of green standing bamboo in India. Eight species of green standing bamboo were studied, out of which, three bamboo species *viz. Bambusa nutans, B. tulda* and *Dendrocalamus asper* were categorized under high category of incidence with an average per cent of 44.40, 22.50 and 30.27 respectively. Similarly, one bamboo species *Dendrocalamus calostachys* was categorized under moderate category with an average incidence of 17.30 %. In low category, four bamboo species *viz. Dendrocalamus giganteus, Dendrocalamus longisphathus, Bambusa multiplex and B. striata,* have an average per cent incidence of 3.08, 3.34, 5.79 and 4.70 respectively.

The emergence of beetles occurred before the onset of monsoon. Longevity of female and male was 5.8 ±0.20 and 5.1 ±0.23 days, respectively. The female of *E. chinensis* laid eggs in groups of 2, 3 or 4 during mid July to third week of August, on the internodes of leaf axils of bamboo covering with masticated fragments of leaves and a sticky secretion. Beetles fed voraciously on the tender leaves of bamboo and its larvae on the culm sheaths and the internodes. Each gravid female lays 18.6 ±0.79 eggs. The incubation period is 24.2 ±0.71 days. The colour of larva was translucent white. The larval period was 13.75±0.56 days.

Qualitative observation reveled that systemic insecticides performed better as compare to contact insecticides. Evidently, it is derived that dimethoate 0.04% concentration was found the most effective for the control of *E. chinensis* damaging *Dendrocalamus strictus* in natural stand.

Key words: *Estigmena chinensis,* Coleoptera, Chrysomelidae, Bamboo, Epidemiology

Introduction

Bamboos are woody grass like fast growing species belonging to order Gramineae of family Poaceae and subfamily Bambusoidea. All 75 genera and 1250 species of bamboo are woody and fast growing. According to Dransfield (1992), bamboo grow above the sea level in tropics to 4000 meters in temperate region. They are distributed largely in the tropics and naturally in all subtropical and temperate zones except in Europe. In India, there are 125 indigenous as well as exotic species of bamboo belonging to 23 genera. The acreage under bamboo forests is 10.03 million ha, roughly 12.8% of the total forest area of India. They are found in all the states of the country except Jammu and Kashmir. Bamboo plays an important role in the forest economy and the cultural feature of India (Soderstrom and Ellis 1988). Bamboo has versatile uses, as paper pulp resource, scaffoldings, food during famine and seasonal scarcity, agricultural implements, building material, fishing rods, weaving material, parquet manufacture and as water conduits. Bamboo is also becoming increasingly popular in the horticultural industry as a house plant (Rao et al. 1990). Banslochan and Tabasheer is a silicaceous deposit occurring in the joints in the hollow stem of a number of species of bamboo and are reported to have many medicinal properties (Shukla and Das 1981). It can be used for the treatment of asthma, cough, paralytic complaints and other debilitating diseases.

Insect pests are one of the major constraints affecting production and productivity of bamboo by causing considerable damage from growing stages to finished products. Bamboos are recorded to have been damaged by 212 insect species at various stages and render them of no commercial value. They have been categorised as culm and shoot borers (12), felled and dried bamboo borers (44), defoliators (48), Nursery pests (5), termites (13) and sap suckers (90) belonging to insect orders Coleoptera, Lepidoptera, Isoptera, Homoptera and Thysanoptera. The borer complex of bamboo is most important as they extensively damage the developing clumps and culms, and reduce yields and marketability. The bamboo borer *i.e. Estigmena chinensis* was observed feeding for the first time on eight green standing bamboo species. Characteristics of the pest, epidemiology and management are described.

Material and Methods

Study Site:

This study was conducted at Dehradun Forest Division, Uttarakhand, (30.3165° N, 78.0322° E), India.

Rearing:

The infested bamboo culms caged in wooden glass cages of size 60x60x90 cm. Chimney cages were also used to observe the different biological features of borer. The metallic zinc cages were also used for rearing the adult. Some culms were split to examine the moulting of larvae and its growth increment. Freshly emerged male and female beetles, one pair each were kept together in chimney cage to record the mating behavior, duration and longevity. Morphometrics observations were also recorded. The numbers of eggs laid by single female were counted. The site of eggs laid, their colour and incubation period was also recorded. Every month some infested bamboo billets were taken out, split and examined for larvae (Fig.1). The colour, body length, breadth, head length, breadth, larval period and feeding patterns were recorded. The infested bamboo culms were split and examined the presence of pupae during the end of August to the end of September.

Biology:

During the course of study, the incubation, larval, pupal period, longevity of male and female adult and total life cycle of borer was recorded. Biology of the borer has been studied in the laboratory and field. Morphometric measurements of different stages were taken with the help of stereo-scopic microscope. Every month, few bamboo billets were split to examine feeding pattern of larvae.

Epidemiology:

Intensive surveys were conducted in natural stands of bamboo plantations to observe and record the epidemiology (incidence and intensity) of the borer. To assess the incidence of attack, three clumps of each bamboo species was selected and every clump of the plantation plot were scored visually on the basis of per cent incidence (number of attacked culms) damaged. They were categorized as high (>20% attacked culms), moderate (10-20% attacked culms) and low (<10% attacked culms) damaged categories. Further, to assess more empirically the extent of damage to culms, the number of holes in each attacked culm was recorded to calculate the intensity of attack.

Management:

Field trial for the control of bamboo borer:

Study on *E. chinensis* on green standing *Dendrocalamus strictus* in natural stand were undertaken in Dehradun Forest Division, Uttarakhand, India. Three systemic insecticides *viz*. dimethoate, monocrotophos and imidachloprid at 0.01, 0.02 and 0.04 per cent concentration with three replications were applied as internodal injections. Three clumps were selected for each treatment of 0.01, 0.02 and 0.04 %. Two boreholes were made on the internodes of each culm with the help of an auger. 80-100 ml of each insecticide with the specific concentrations was put into the holes of culm by a syringe. Another field experiment was laid by using contact insecticide. The insecticides used were deltamethrin, cypermethrin, and chloropyriphos at 0.01, 0.02 and 0.04 per cent concentration in three replications. Pre-treatment observation of incidence and intensity of attack was recorded before applying the insecticides. Post-treatment observations were taken after one year. The control of borer attack was calculated by using the formula as under:

$$\text{\% of borer attack controlled} = 100 - \frac{\text{\% of attack on Post-treatment observation}}{\text{\% of attack on Pre-treatment observation}} \times 100$$

Results

An infestation of the borer, identified as *E.chinensis* Hope. (Coleoptera: Chrysomelidae) on green standing bamboo was observed. The larvae fed initially between the culms sheath and the soft surface of the culms and the later voraciously on the internodes (Fig.2). Eventually, the larval galleries were enlarged and fine wood dust was ejected, resulting into the bending and congestion of bamboos. The damage was done during the first few months of growth, second year and older culms being rarely attacked (Fig. 3). After emergence, the beetles eat the tender leaves of bamboo at the top. Heavy feeding on leaves retards the growth (Fig. 4). They also eat the tissue of bamboo inside the galleries.

Biology

Adult:

The emergence of beetles occurred before the onset of monsoon. The beetle was an elongated and parallel sided with blunt and moderate stout and 11-segmented antennae (Fig.5). Beetle shows sexual dimorphism. The mean body length and width of female beetle was 14.34 ±0.48 mm and 3.75 ±0.08 mm and in male it was 10.91 ±0.30 mm and 3.41 ±0.06 mm, respectively. The mean head length and head width of female beetle was 1.79 ±0.03 mm and 1.85 ±0.02 mm, where as in case of male beetle it was 0.69 ±0.04 mm and 0.62 ±0.42 mm, respectively. The pre-oviposition and oviposition period was 2.20±0.25 and 1.20±0.13 days respectively. Longevity of female and male was 5.8 ±0.20 and 5.1 ±0.23 days, respectively.

Eggs:

The female of *E. chinensis* laid eggs in groups of 2, 3 or 4 during mid July to third week of August, on the internodes and leaf axils of bamboo covering with masticated fragments of leaves and a sticky secretion which hardens on the contact with air (Fig 6).The egg was elongate with rounded end and the egg chorion was colour less and transparent. Each gravid female beetle laid 18.6 ±0.79 eggs. The mean length was 1.16±0.41 mm and breadth was 0.84 ±0.02 mm. The incubation period was 24.2 ±0.71 days.

Table 1.Biology and Morphometric observations of *E. chinensis*

Biology								
Egg	Larva	Pupa		Adult longevity				
Incubation period (days)	Larval period (days)	Pre-pupal (days)	Pupal period (days)	Pre-oviposition period (days)	Ovi-position period (days)	Adult longevity (days)		Total life period (days)
						♀	♂	
24.2 ± 0.71	64.70 ±0.58	7.50 ±0.22	9.50 ±0.17	2.20 ±0.25	1.20 ±0.13	5.80 ±0.20	5.10 ±0.23	98.40 ±1.46

Morphometric observations					
Stages		Body length (mm)	Body width (mm)	Head length (mm)	Head width (mm)
Egg		1.16±0.41	0.84±0.02	-	-
Larva		14.71 ±0.50	2.88 ±0.10	0.85 ±0.02	1.27 ±0.03
Pupa		13.53 ±0.25	Thorax 3.50±0.21 Abdomen 4.47±0.15	-	-
Adult	Female	14.34 ±0.48	3.75 ±0.08	1.79 ±0.30	1.85 ±0.02
	Male	10.91 ±0.30	3.41 ±0.06	0.69 ±0.04	0.62 ±0.42

Larva:

The colour of larva was translucent white, head, antennae; pronotum and anal shield smoky brown, eyes and tips of claws was black (Fig.7). The mean length and width of mature larvae was 14.71 ±0.50 mm and 2.88 ±0.10 mm, where as the mean head length and width was 0.85 ±0.02 mm and 1.27 ±0.03 mm, respectively. The larval period was 64.70±0.58 days.

Pupa:

The colour of pupa was yellowish brown and spindle-shaped (Fig.8). The mean length of pupa was 13.53 ±0.25 mm and the mean width of thorax and abdomen was 3.50 ±0.25 mm and 4.47±0.15 mm respectively. The pupal period was 9.50±0.17 days (Table 1). Total life cycle was completed in 98.40±1.46 days.

Attacked bamboo species:

Bamboo borer, *E. chinensis* is a major borer of green standing bamboo. Eight species of green standing bamboo *viz. Dendrocalamus longispathus, D. giganteus, D. asper, D. calostachyus, Bambusa wamin, B. tulda, B. multiplex* and *B. striata,* for the first time were found attacked by the borer. Epidemiology (incidence and intensity of attack) on these bamboo species were also recorded (Fig.9-16).

Epidemiology:

Epidemiology (incidence and intensity) of eight bamboo species have been recorded and presented in Table 2.

Table 2. Epidemiology in different bamboo species by *Estigmena chinensis* (Coleoptera: Chrysomelidae)

Bamboo species	Avg. incidence of attack (%)	Avg. No of holes /culm	Intensity of Attack
Bambusa multiplex	$5.79^{e} \pm 1.14$	0.68	Low
Bambusa nutans	$44.40^{a} \pm 3.67$	2.08	High
Bambusa tulda	$22.50^{c} \pm 3.67$	2.25	High
Dendrocalamus calostachys	$17.30^{d} \pm 1.60$	1.25	Moderate
Dendrocalamus giganteus	$3.08^{e} \pm 0.32$	0.65	Low
Dendrocalamus longisphathus	$3.34^{e} \pm 0.91$	0.72	Low
Bambusa striata	$4.70^{e} \pm 1.21$	0.73	Low
Dendrocalamus asper	$30.27^{b} \pm 1.86$	2.13	High

*If the average number of borer holes per attacked culm is below one – Low
*If the average number of borer holes per attacked culm is between one and two – Moderate
*If the average number of borer holes per attacked culm is more than two - High

Same alphabets indicate statistically at par groups
± Standard Deviation

Each year, 3 clumps of each of the eight species were examined to find out the per cent incidence of attack and its intensity. *Bambusa multiplex* was kept under the “low” category with an average incidence of 5.79% and average number of holes per culm being 0.68. *Bambusa nutans* was kept under the “High” category with an average per cent incidence of 44.40 and average number of holes per culm being 2.08. *Bambusa tulda* was kept under the “High” category with an average incidence of 22.50% and average number of holes per culm being 2.25. *Dendrocalamus calostachys* was kept under the “Moderate” category with an average incidence of 17.30% and average number of holes per culm being 1.25. *D. giganteus* was kept under the “Low” category with an average incidence of 3.08% and average number of holes per culm being 0.65. *D. longisphathus* was kept under the “Low” category with an average incidence of 3.34% and average number of holes per culm being 0.72. *B. striata* was kept under the “Low” category with an average incidence of 4.70% and average number of holes per culm being 0.73. *D. asper* was kept under the “High” category with an average incidence of 30.27% and average number of holes per culm being 2.13.

Per cent attack of intensity on different species of bamboo was statistically analyzed by one way ANOVA and observed that per cent attack of the borer in all the species was statistically significant (Variance ratio, F= 235.789, p = < 0.05). Borer attack in *Bambusa nutans, Dendrocalamus asper, Bambusa tulda* and *Dendrocalamus calostachyus* was significantly different with each other as well as all other species of bamboo under this study. Per cent damage from borer attack in *Bambusa multiplex, Dendrocalamus giganteus, Dendrocalamus longisphathus* and *Bambusa striata* was statistically at par.

Management:

Using contact insecticides:

An experiment using contact insecticides was laid down in *Dendroclamus strictus* for the control of *E. chinensis*. It was observed that at the time of pre-treatment observation, the average borer attack in *D.strictus* was 21.72%, after applying deltamethrine 0.01%, it reduced to 17.02%, which showed an average borer control of 21.55%. Dose of deltamethrin 0.02% lowered the pre-treatment average borer attack of 30. 26 to 23.80%, which showed an average borer control of 22.23%.
Use of deltamethrin @ 0.04% the pre-treatment average borer attack was 29.95% which was decreased to 21.36%. The average borer control was 28.53%.

Cypermethrin 0.01% concentration reduced the average borer attack to 20.97 against the pre-treatment average borer damage of 27.68.The average borer control was 22.48. Cypermethrin 0.02% reduced the borer damage to 22.97% against the pre-treatment damage of 29.93%.The average percentage control was 23.14%. Cypermethrin 0.04% reduced the borer attack to 21.40against the pre-treatment observations of 29.8466%. The resultant borer control was 27.78% (table 3).

Chlorpyriphos 0.01% decreased the borer damage to 19.97% against the pre-treatment borer attack of 26.02%.The resultant respective control was 19.97% with an average control of 21.72%.
Chlorpyriphos 0.02% lowered the borer damage to 22.53% against the pre-treatment borer damage of 33.09%.The overall control was 31.73%. Similarly, chlorpyriphos 0.04% reduced the borer attack to 18.18 % against the pre-treatment borer attack of 27.40%. The overall control was 33.92%.

In control treatment, the level of borer attack was increased to 39.90% against the pre-treatment observation of borer attack 25.05%. The overall borer damage increased to 61.13%. On the qualitative observation records of these contact insecticides, it was observed that chlorpyriphos 0.04% and 0.02% yielded 33.92 and 31.73% control of bamboo borer, *E. chinensis* respectively followed by deltamethrin 0.04%, which controlled 28.53% of borer attack while cypermethrin was found least effective (Table-3).

Table.3. Chemical control using Contact insecticides against *E. chinensis* (Coleoptera: Chrysomelidae)

Insecticides	Doses (%)	Pre treatment observation	Post treatment observation	Average % of control
		Avg. of attack (%)	Avg. remaining of attack (%)	
Deltamethrin	0.01	21.72	17.02	$21.55^{a} \pm 3.40$
	0.02	30.26	23.80	$22.23^{a} \pm 4.82$
	0.04	29.95	21.36	$28.53^{a} \pm 4.29$
Cypermethrin	0.01	27.68	20.97	$22.48^{a} \pm 12.81$
	0.02	29.93	22.97	$23.14^{a} \pm 1.59$
	0.04	29.84	21.40	$27.78^{a} \pm 4.82$
Chloropyriphos 50 E.C	0.01	26.02	19.97	$21.72^{a} \pm 6.15$
	0.02	33.09	22.53	$31.73^{a} \pm 2.75$
	0.04	27.40	18.18	$33.92^{a} \pm 4.27$
* Control	-	25.05	39.90	$61.13^{b} \pm 9.62$

*In control treatment the percentage of borer attack is increased
Same alphabets indicate statistically at par groups

± *Standard Deviation*

The observations of contact insecticides were tested statistically by one - way ANOVA against the per cent borer control, results revealed that treatments were significantly different (Variance ratio, F = 58.351; p = < 0.05) (Table 3). All the doses of different contact insecticides *viz.* Deltamethrin, Cypermethrin and Chlorpyriphos were giving statistically significant differences for borer control against the control where no insecticide was used. Within the insecticides, per cent bore control by applying Chlorpyriphos 0.04 % was statistically different by applying all contact insecticides except Chlorpyriphos 0.02 %, Cypermethrin 0.04 % and Deltamethrin 0.04 %. All the doses applied of different insecticides were statistically significantly different with control, which indicated that used insecticides have effect on the control of the attack of the borer.

Using Systemic insecticides

Another experiment using three systemic insecticides *viz*. dimethoate, monocrotophos and imidachloprid was laid down in *Dendroclamus strictus* for the control of bamboo borer, *E.chinensis* in natural stand and detailed data is presented in Table 4.

Dimethoate 0.01%, the pre-treatment percentage of attack was 24.49. The post-treatment observations showed that the average borer attack reduced to 09.63%. The overall control was 60.20%. The average borer attack was 23.80% in pre treatment observations. After applying dimethoate 0.02%, the percentage of attack reduced to 09.40. The overall control was 60.29%. In dimethoate 0.04% at the time of pre-treatment observation, the borer attack was 39.21%. After applying insecticide, the percentage of borer attack lowered to 13.55. The overall percentage control was 65.28%.

Monocrotophos 0.01% showed that the borer attack remained 09.32% against the pre treatment attack of 19.45% and the overall respective control was 52.39%. Monocrotophos 0.02%, the pre-treatment borer attack was 18.58%. The post-treatment observation showed that the percentage of attack was reduced to 07.45. The overall control was 59.81%. Similarly, the pre-treatment incidence of attack was 33.96% while after applying 0.04% of monocrotophos, the attack comes down to 12.35%. The overall control was 63.57%.

Before applying insecticide the average percentage of borer attack was 25.74. After applying imidacloprid 0.01%, the attack was reduced to 13.82%, and the overall control was 46.34%. Pre-treatment observation showed the percentage of the borer attack was 23.76, after applying imidaclorpid 0.02% the borer attack was lowered to 12.51%. The overall percentage control was 47.62%. Similarly, imidaclorpid 0.04% was applied and the borer attack on pre-treatment observation was recorded 29.66%. After applying the insecticide, the borer attack was reduced to 14.33%. The overall percentage of borer control was 51.12%. Regarding the control treatment, the pre and post treatment observations, the average percent attack was 29.66% and 14.33% respectively. The overall percent of borer attack was increased to 48.86 % (Table 4).

On the qualitative observation records of these systemic insecticides, it was observed that dimethoate 0.04% and 0.02% yielded significant effect (65.28 and 60.29%) for the control of bamboo borer- *E. chinensis*. In case of monocrotophos 0.04% and 0.02% provided 63.57 and 59.81% of borer control. Imidacloprid was observed least effective amongst the systemic insecticides and yielded 51.12 and 47.62% of borer control at 0.04 and 0.02% concentration. It is also observed that systemic insecticides performed better as compare to contact insecticide. Evidently, it is derived that dimethoate 0.04% concentration was found the most effective for the control of *E. chinensis* damaging *Dendrocalamus strictus* in natural stand.

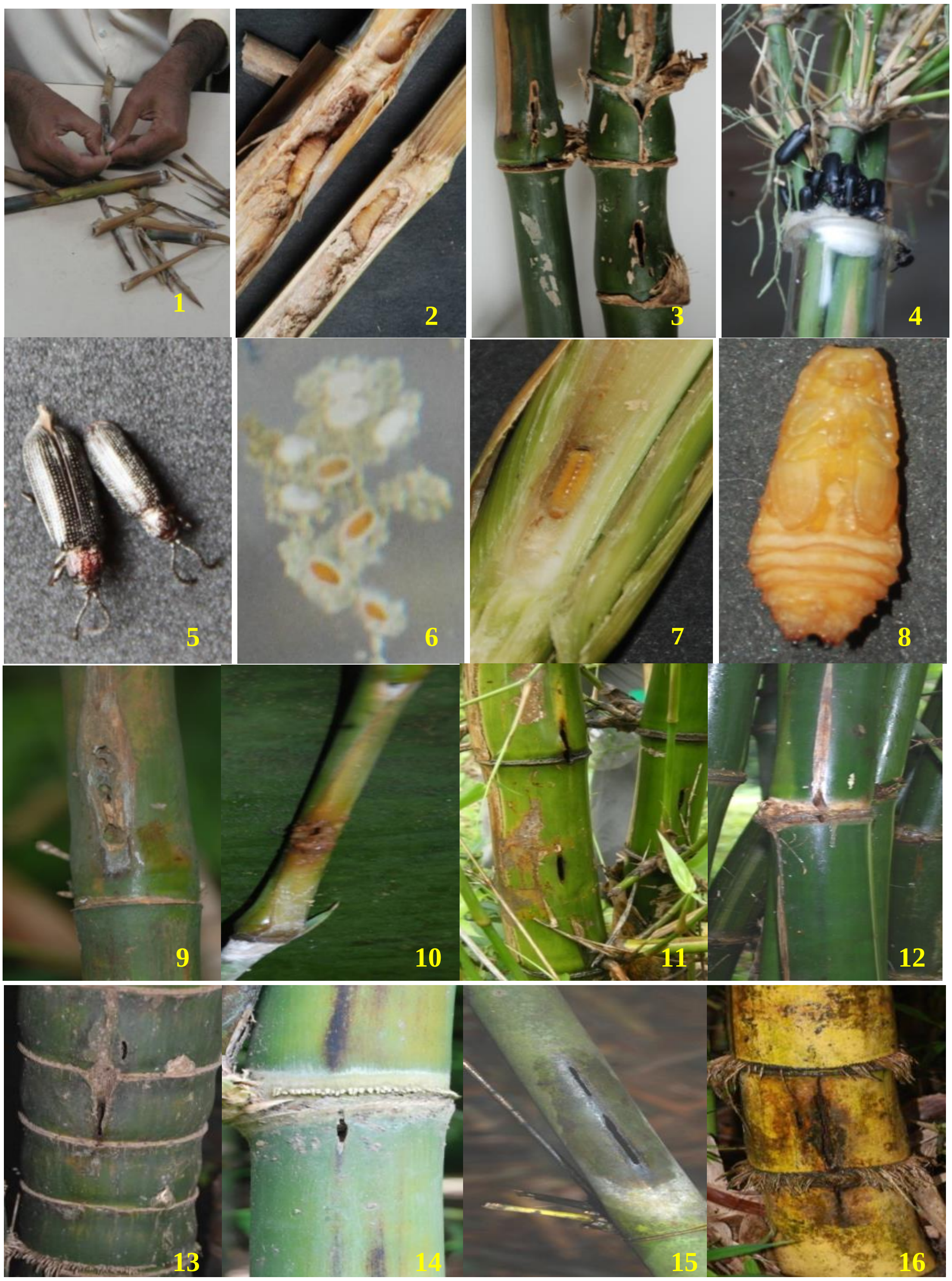

Fig. 1-8 showing; 1. Splitting of culms for larvae and pupae; 2. Damage caused by larvae 3. Bending and congestion of bamboo due to borer attack; 4. Adult feeding; 5. Female & male; 6. Eggs; 7. Larva; 8. Pupa; Fig. 9-16 showing attacked bamboo species of 9. *Dendrocalamus longispathus,* 10. *D. giganteus,* 11. *D. asper,* 12. *D. calostachyus,* 13. *Bambusa wamin,* 14. *B.tulda,* 15. *B. multiplex* and 16. *B. striata*

Table.4. Chemical control using systemic insecticides against *E. chinensis* (Coleoptera: Chrysomelidae)

Insecticides	Doses %	Pre treatment observation	Post treatment observation	Average % of control
		% of attack	% of attack	
Dimethoate	0.01	24.49	09.63	$60.20^{a} \pm 4.94$
	0.02	23.80	09.40	$60.29^{a} \pm 2.10$
	0.04	39.21	13.55	$65.28^{a} \pm 2.41$
Monocrotophos	0.01	19.45	09.32	$52.39^{b} \pm 4.11$
	0.02	18.58	07.45	$59.81^{a} \pm 6.01$
	0.04	33.96	12.35	$63.57^{a} \pm 2.71$
Imidacloprid	0.01	25.74	13.82	$46.34^{b} \pm 3.57$
	0.02	23.76	12.51	$47.62^{b} \pm 4.11$
	0.04	29.66	14.33	$51.12^{b} \pm 1.93$
* Control	-	21.37	31.81	$48.86^{c} \pm 1.90$

*In control treatment the percentage of borer attack is increased
Same alphabets indicate statistically at par groups

± *Standard Deviation*

When the treatments using systemic insecticides were tested statistically by one - way ANOVA against the per cent borer control, results revealed that treatments were significantly different (Variance ratio, F = 260.681; p = < 0.05) (Table 4). All the doses of different systemic insecticides *viz.* Dimethoate, Monocrotophos and Imidacloprid were giving statistically significant differences for borer control against the control where no insecticide was used. Within the insecticides, per cent bore control by applying Imidacloprid 0.01, 0.02 and 0.04 % were statistically different by applying Dimethoate 0.01, 0.02 and 0.04 % and 0.02 and 0.04 % dose of Monocrotophos. Per cent bore control by applying Monocrotophos 0.01 % were statistically different by applying all the doses of Dimethoate. All the different doses of Imidacloprid insecticide were statistically significant differences on the per cent borer attack for Dimethate insecticide for 0.01, 0.02 and 0.04% dose.

Discussion

The species, *E. chinensis* was first reported by Cotes (1896) and later in 1941, Stebbing gave a sketchy account and Beeson in 1941 gave a brief account of its life history, but many aspects remain unstudied. Roonwal (1977) studied the ecology and biology of *E. chinensis* Hope. on bamboos in the western sub-Himalayas. He reported that the beetle shows sexual dimorphism and has a habit of 'death simulation' when disturbed. Host plants of *E. chinensis* and the damage it caused have been referred to by Beeson (1919) and Chatterjee and Bhasin (1936). Singh and Bhandari, 1988 reported that the larvae of *Myocalandraexarata* Boheman (Coleoptera: Curculionidae) are the secondary borers of green living bamboos, like *Bambusa polymorpha* and *Dendrocalamus strictus* that have been damaged by *E. chinensis*. Similar type of work was carried out by Singh (2014) on *Phloeobius crassicollis* Jord. this was found feeding on ten bamboo species in India for the first time.

References:

Beeson, C.F.C. 1919. The food- plants of Indian forest insects. Part-III. *Indian Forester*, 45 (6), 312-323.

Beeson, C.F.C. 1941. *The Ecology and Control of the Forest Insects of India* and *Neighboring Countries.* Vasant Press, Dehra Dun. Reprinted Govt. of India Publication. 1007 pp.

Chatterjee, N.C. ; Bhasin, G.D. 1936. Entomological investigations on the spike disease of sandal, (27) Crysomelidae (Col.). *Indian Forest Rec. (ent.)*, 1 (13), 243-318.

Cotes, E.C. 1896. Miscellaneous notes from the Entomological section. *Indian Mus. Notes, Calcutta*, 3 (5), 80-81.

Dransfield, S. 1992.The bamboos of Sabah. *Sabah Forest Report*, No. 14. Malaysia.

Rao, I.V.R.; Yusoff, A.M.; Rao, A.M.; Shastry, C.B. 1990. Propagation of bamboo and rotten through tissue culture. IDRC, Canada.

Roonwal, M.L. 1977. Field ecology and biology of bamboo beetle, *Estigmena chinencis* Hope (Coleoptera: Chrysomelidae) in the Western sub Himalayas. *J. Ent. Res*., 1 (2), 168-175.

Shukla, U.; Das, D. 1981. On occurrence of some medicinal grasses in Eastern India. *Indian J. For*. 4, 273-279.

Singh, K.P. 2014. *Phloeobiu s crassicollis* Jord. (Anthribidae: Coleoptera)- A Serious Borer of Green Standing Bamboo Species. *Ann. For*., 22 (2), 244-248.

Singh, P.; Bhandari, R.S. 1988. Pests of bamboos and their control in India, *Indian For*., 114, 670-783.

Soderstrom, T.R., Ellis, R.P. 1988. The woody bamboos (Poaceae: Bambuseae) of Shrilanka: A morphological and anatomical study. *Smithsonian Contribution* No. 72.

Stebbing, E.P. 1941. *Indian Forest Insects of Economic Importance, Coleoptera*. Secretary of State for India. London. 648pp.

<table>
<tr><td colspan="3">Suggestions by the reviewer (Dr. Eric HEISEL)</td></tr>
<tr><td>1.</td><td>The size of the larvae is quite important. It would have been interested to test higher concentration of insecticide</td><td>We have tested the lower and higher concentrations of different insecticides against the larvae of E. chinensis. Optimum mortality was observed at 0.04% concentration of insecticide.</td></tr>
<tr><td>2.</td><td>Insecticides are dangerous. I would have appreciated to see a table with their hazard and their approval in the main countries in the Word.</td><td>The classification of insecticide is done according to LD_{50} values of World Health Organization (2009).

{LD_{50}: A common measure of acute toxicity is the lethal dose (LD_{50}) or lethal concentration (LC_{50}) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. LD_{50} is generally expressed as the dose in milligrams (mg) of chemical per kilogram (kg) of body weight.}

INDEX. Classification of active pesticide ingredients I a = Extremely hazardous; I b = Highly hazardous; II = Moderately hazardous; III = slightly hazardous; U = Unlikely to present acute hazard in normal use; FM = Fumigant, not classified; O = Obsolete as pesticide, not classified

<table>
<tr><th>Common name of insecticide</th><th>Class</th></tr>
<tr><td>Dimethoate</td><td>II</td></tr>
<tr><td>Monocrotophos</td><td>I b</td></tr>
<tr><td>Imidacloprid</td><td>II</td></tr>
<tr><td>Deltamethrin</td><td>U</td></tr>
<tr><td>Cypermethrin</td><td>II</td></tr>
<tr><td>Chlorpyriphos</td><td>II</td></tr>
</table></td></tr>
</table>