Record On Incidence And Intensity Of *Estigmena Chinensis* Hope. (Coleoptera: Chrysomelidae) On Natural Bamboo Stand

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ABSTRACT
Bamboo is a robust, relatively fast-growing, environmentally sustainable material used worldwide for centuries. It has the potential to be an extremely pleasing and a value alternative to more traditional materials like timber, as seen by numerous visually stunning modern structures. Approximately 212 insect pest species have been identified attacking bamboo, causing damage from seed to completed product. For the first time, *Estigmena chinensis* was seen destroying seven green-standing bamboo species in natural stands, including *Gigantochloa manggog, Thyrsostachyus oliver, Bambusa balcooa, Schizostachyum dullooa, Dendrocalamus hamiltoni, Gigantochloa atroviolacea, and Bambusa polymorpha*. Maximum attack incidence was observed in *T. oliver* (56.18%) in 2017 and minimum in G. atroviolacea (20.75%) in 2020. The maximum and minimum intensity of the attack was recorded in *B. balcooa* (3.16%) in 2018 and *T. oliveri* (1.08%) in 2017, respectively.

KEYWORDS: *Estigmena Chinensis*, Coleoptera, Chrysomelidae, Incidence, Intensity.

1. INTRODUCTION

Bamboo, sometimes known as "green gold," is a woody, fast-growing species in the Poaceae family, which includes 1250 species divided into 75 genera. Bamboos play a significant role in India's forest economy and cultural communities [1]. It grows natively in all subtropical and temperate zones, as well as in the tropics. In India, 212 insect species belonging to the insect orders Homoptera, Lepidoptera, Isoptera, Thysanoptera, and Coleoptera attacking bamboos, which have been classified as nursery pests (5) defoliators (48), sapsuckers (90), termites (13) and culm and shoot borers (12) borer of felled and dried bamboos (44). *Estigmena chinensis* Hope (Coleoptera: Chrysomelidae) is a major pest of green-standing bamboo that causes significant damage and economic loss [2]. Several food plants had been found devasted [3-5]. A brief overview of its life history, but there were many features that had not been investigated before [6-8]. To reduce the attack of *E. chinensis*, proposed that the affected culms of bamboos should be separated from the healthy ones and exposed to the sun [6,7]. In the western sub-Himalayas, the ecology and biology of *E. chinensis* on bamboo were studied [9]. Females of the beetle are larger than males, indicating sexual dimorphism. *Myocalandra exarata Boheman* (Coleoptera: Curculionidae) larvae are secondary borers of green living bamboos such as *Dendrocalamus strictus* and *B. polymorpha* that E. chinensis have damaged and other pests [10].

2. METHOD(S)

A survey was conducted at the Forest Research Institute in Dehradun to investigate the incidence and intensity of attack in several species of bamboo in natural stands - plantations of Thano, Timli, Jhajra, and Bamboo-setum. Damage caused by *E. chinensis* was surveyed for three years, i.e., 2017, 2018, and 2020 and observations of intensity and incidence of borer attacks were recorded. The overall number of culms and the number of fresh culms in each clump were counted. The number of attacked culms from new culms in all selected clumps was counted. The following formula was used to compute the percent of the incidence of attack:

$$\text{Percentage incidence of borer attack} = \frac{\text{No. of attacked culms}}{\text{Total No. of new culms in the clump}} \text{X } 100$$

The total number of borer exit holes in each new attacked culm was counted to determine the intensity of the borer attack. The attack intensity was classified as follows based on the number of exit holes per attacked culm:

- Low intensity of attack if the average number of borer holes per attacked culms is 1.0 -2.0.
- Moderate intensity of attack if the average number of borer holes per attacked culm is 2.0 -3.0.
- If the average number of borer holes per attacked culm exceeds 3.0, the intensity of attack is high.

3. RESULTS AND DISCUSSION

3.1. FEEDING PATTERN

The newly hatched larvae do not bore instantly but feed between the culms sheath and the culms surface for a while. Later on, they burrow both up and down into the internode tunnel, and as the larvae grow, the larval gallery expands, and fine/coarse wood dust is discharged. During the first several months of growing, the most damage is done. Bamboo culms were bent and congested due to the heavy infestation, which even killed the culms.

3.2. INCIDENCE AND INTENSITY OF ATTACK (Figures 1-7)

The table shows seven bamboo species' attack intensity and incidence across three years (2017, 2018, and 2020). In 2017, three clumps of *Giagatochloa manggong* were chosen to study the intensity and incidence of attacks. The first clump had a total of 101 culms, 27 of which were fresh culms, and 07 culms that the borer had damaged with 13 borer holes. In the second clump, there were 97 culms, 29 of which were fresh culms and 09 culms damaged by the borer, with 16 borer holes. The third clump had a total of 88 culms, 25 of which were fresh culms and 11 culms that were damaged by the borer, with seven borer holes. The incidence of attack was 25.92, 31.03, and 44.00 percent, respectively, resulting in 33.65 percent of the average attack. The number of borer holes per culms was 2.08, considered 'Moderate.' The total number of culms in the first clump in 2018 was 128, with 11 new culms and 04 culms damaged by the borer, with 07 borer holes. In the second clump, there were 127 culms in total, 13 of which were fresh culms and 06 culms that were damaged by the borer, with ten borer holes. The third clump had a total of 113 culms, 10 of which were fresh culms and 02, which were damaged by the borer, with 08 borer holes. The incidence of attack was 36.36, 46.15, and 20.00 percent, respectively, resulting in 34.17 percent of the average attack. The number of borer holes per culm was 2.08, considered 'Moderate.' The total number of culms in the first clump in 2020 was 154, with 08 new culms and 02 culms damaged by the borer, with 04 borer holes. In the second clump, there were 152 culms in total, 11 of which were fresh culms and 04 of which were damaged by the borer, with 08 borer holes. The third clump had 144 culms, 20 of which were fresh culms and 05 of which were damaged by the borer, with 11 borer holes. Borer attack was 25.00, 36.36, and 25.00 percent, respectively, resulting in 28.88 percent of the average attack. The number of borer holes per culm was 2.09, which was classified as 'Moderate.'

The attack intensity and incidence were studied in 2017 among 03 clumps of *Thyrsostachyus oliveri.* There were 154 culms in the first clump, 21 of which were fresh culms, and 14 were damaged by the borer, with 15 borer holes. In the second clump, there were 46 culms, 19 of which were new, and 09 culms that were damaged by the borer, with ten borer holes. The third clump had a total of 49 culms, 22 of which were fresh culms and 12 of which were damaged by the borer, with 13 borer holes. The incidence of attack was 66.66 percent, 47.37 percent, and 54.54 percent, respectively, resulting in 56.19 percent of the average attack. The number of borer holes per culm was 1.08, putting it in the 'Low' category. In 2018, there were 78 culms in the first clump, 12 of which were fresh culms and 07 culms that were damaged by the borer, with 08 borer holes. In the second clump, there were 68 culms, 10 of which were fresh culms, and 05 culms, which were damaged by the borer, with 07 borer holes. In the third clump, there were 71 culms, 15 of which were fresh culms, and 08 culms, which were damaged by the borer, with ten borer holes. The incidence of attack was 58.33, 50.00, and 53.33 percent, respectively, resulting in 53.89 percent of the average attack. The number of borer holes per culm was 1.25, putting it in the 'Low' category. In the first clump in 2020, there were 112 total culms, 14 of which were fresh culms and 06, which were damaged by the borer, with 08 borer holes. In the second clump, there were 97 culms, 18 fresh culms and ten damaged by the borer, with 13 borer holes. In the third clump, there were a total of 99 culms, 21 of which were fresh culms and 11 culms that were damaged by the borer, with 12 borer holes. The incidence of attack was 42.86 percent, 55.55 percent, and 52.38 percent, respectively, resulting in 50.26 percent of the average attack. The number of borer holes per culm was 1.22, which fell into the 'Low' category.

In 2017, 03 clumps of *Bambusa balcooa* were chosen to study the attack intensity and incidence. There were 115 culms in the first clump, 42 of which were fresh culms and 18 culms of which were damaged by the borer, with 58 borer holes. A total of 102 culms were detected in the second clump, 46 of which were fresh culms and 21 culms that were damaged by the borer, with 61 borer holes. There were 105 culms in the third clump, 39 of which were fresh culms and 16 culms of which were damaged by the borer, with 49 borer holes. Incidence of attack occurred at 42.85, 45.65, and 41.02 percent, with an average attack of 43.17 percent. The number of borer holes per culm was 3.05, putting it in the 'High' category. In 2018, there were 159

culms in the first clump, 38 of which were fresh culms and 15 culms that were damaged by the borer, with 51 borer holes. There were 151 culms in the second clump, 45 of which were fresh culms and 16 culms of which were damaged by the borer, with 43 borer holes. In the third clump, there were a total of 148 culms, 48 of which were fresh culms and 19 culms that were damaged by the borer, with 64 borer holes. The incidence of attack was 39.47, 35.55, and 39.58 percent, respectively, resulting in 38.20 percent of the average attack. The number of borer holes per culm was 3.16, putting it in the 'High' category. The total number of culms in the first clump in 2020 was 206, with 29 new culms and 16 damaged by the borer, with 53 borer holes. In the second clump, there were 212 culms, 32 of which were fresh culms and 14 of which were damaged by the borer, with 42 borer holes. In the third clump, there were 209 culms, 36 of which were fresh culms and 16 of which were damaged by the borer, with 48 borer holes. Borer attack incidence was 55.17 percent, 43.75 percent, and 44.44 percent, respectively, resulting in 47.79 percent of the average attack. The number of borer holes per culm was 3.11, putting it in the 'High' category.

03 clumps of *Scohizostachyum dullooa* were chosen in 2017 to study attack intensity and incidence. The overall number of culms in the first clump was 42, with 28 fresh culms and 11 culms that had been damaged by the borer, with 15 borer holes. The total number of culms in the second clump was 18, with 07 fresh culms and 02 culms that had been damaged by the borer, with 05 borer holes. In the third clump, there were 25 culms, 12 of which were fresh culms, and 04 culms, which were damaged by the borer, with 06 borer holes. Borer attack incidence was 39.28, 28.57, and 33.33 percent, respectively, resulting in 33.73 percent of the average attack. The number of borer holes per culm was 1.53, which fell into the 'Low' category. In 2018, there were 73 culms in the first clump, 29 of which were fresh culms and 09 culms that had been damaged by the borer, with 12 borer holes. In the second clump, there were a total of 28 culms, with 08 being fresh culms and 03 culms that had been damaged by the borer, with 05 borer holes. The third clump had a total of 44 culms, 13 of which were fresh culms and 04 of which were damaged by the borer, with 09 borer holes. Borer attack incidence was 31.03, 37.50, and 30.77 percent, respectively, resulting in 33.10 percent of the average attack. The number of borer holes per culm was 1.62, putting it in the 'Low' category. The total number of culms in the first clump in 2020 was 112, with 26 new culms and 12 culms having been damaged by the borer, with 14 borer holes. The total number of culms in the second clump was 52, with 09 fresh culms and 01 culm damaged by the borer, with 03 borer holes. In the third clump, there were 72 culms, 12 of which were fresh, and 03 culms that had been damaged by the borer, with 05 borer holes. Borer attack incidence was 46.15, 11.11, and 25.00 percent, respectively, resulting in 27.42 percent of the average attack. The number of borer holes per culm was 1.37, which fell into the 'Low' category.

In 2017, 03 *Dendrocalamus hamiltoni* clumps were chosen to study the attack of intensity and incidence. The total number of culms in the first clump was 21, with 09 new culms and 03 culms damaged by the borer, with 11 borer holes. In the second clump, there were 29 culms, 11 of which were fresh culms, and 02 culms which were damaged by the borer, with 07 borer holes. The third clump had a total of 30 culms, 12 of which were fresh culms and 05 culms that had been damaged by the borer, with ten borer holes. The incidence of attack was 33.33 percent, 18.18 percent, and 41.67 percent, respectively, resulting in 31.06 percent of the average attack. The number of borer holes per culm was 2.80, which fell into the 'Moderate.' The total number of culms in the first clump in 2018 was 33, with 08 fresh culms and 02 culms that had been damaged by the borer, with 05 borer holes. In the second clump, there were 25 culms, 11 of which were fresh culms, and 03 culms, which were damaged by the borer, with 07 borer holes. In the third clump, there were 28 culms, 05 of which were fresh culms and 03 culms that were damaged by the borer, with 11 borer holes. The incidence of attack was 25.00, 27.27, and 60.00 percent, respectively, resulting in 37.42 percent of the average attack. The number of borer holes per culm was 2.87, which fell into the category 'Moderate.' The total number of culms in the first clump in 2020 was 56, with 09 new culms and 04 culms damaged by the borer, with 12 borer holes. The total number of culms in the second clump was 62, with 08 new culms and 03 culms damaged by the borer, with 08 borer holes. The total number of culms in the third clump was 74, with 06 fresh culms and 03 borer holes damaged by the borer, with 08 borer holes. The incidence of attack was 44.44, 37.50, and 50.00 percent, respectively, resulting in 43.98 percent of the average attack. The number of borer holes per culm was 2.80, categorized as 'Moderate.'

03 clumps of *Gigantochloa atroviolacea* were chosen in 2017 to attack intensity and incidence. The first clump had a total of 58 culms, 12 of which were fresh culms and 03 culms, of which were damaged by the borer, with 05 borer holes. The total number of culms in the second clump was 62, with 08 fresh culms and 04, which were damaged by the borer, with 09 borer holes. In the third clump, there were 54 culms, 11 of which were fresh culms, and 04 culms which were damaged by the borer, with ten borer holes. The incidence of attack was 25.00, 50.00, and 36.36 percent, respectively, resulting in 37.12 percent of the average attack. The average number of borer holes per culm was 2.18, categorized as 'Moderate.' In 2018, there were 64 culms in the first clump, 11 of which were fresh culms and 02 culms that were damaged by the borer, with 06 borer holes. The total number of culms in the second clump was 78, with 05 being fresh culms and 01 culms, of which were damaged by the borer, with 04 borer holes. The total number of culms in the third clump was 92, with 09 being fresh culms and 04 culms, of which were damaged by the borer, with 06 borer holes. The incidence of attack was 18.18, 20.00, and 44.44 percent, respectively, resulting in 27.54 percent of the average attack. The average number of borer holes per culm was 2.28, categorized as 'Moderate.' In the first clump in 2020, there were 91 total culms, 15 of which were fresh culms and 04 culms, which were damaged by the borer,

with 09 borer holes. The total number of culms in the second clump was 98, with 08 fresh culms and 01 culms damaged by the borer, with 03 borer holes. The third clump had a total of 106 culms, 13 of which were fresh culms and 03 culms, which were damaged by the borer, with 07 borer holes. The attack incidence was 26.67, 12.50, and 23.08 percent, respectively, resulting in 20.75 percent of the average attack. The number of borer holes per culm was 2.37, which was classified as 'Moderate.'

In 2017, 03 clumps of *Bambusa polymorpha* were chosen to study the attack of intensity and incidence by *E. chinensis*. In the first clump, there were 83 culms, 12 of which were fresh culms, and 03 culms, which were damaged by the borer, with 06 borer holes. In the second clump, there were 92 culms, 16 of which were fresh culms, and 04 culms, which were damaged by the borer, with 09 borer holes. In the third clump, there were 103 culms, 21 of which were fresh culms, and 07 culms, which were damaged by the borer, with 12 borer holes. The incidence of attack was 25.00, 25.00, and 33.33 percent, respectively, resulting in 27.78 percent of the average attack. The number of borer holes per culm was 1.85, which fell into the 'Low' category. The total number of culms in the first clump in 2018 was 109, of which 10 were new culms and 02 culms that were damaged by the borer, with 03 borer holes. In the second clump, there were 118 culms, 13 of which were fresh culms and 04 of which were damaged by the borer, with 07 borer holes. The third clump had 141 culms, 18 of which were fresh culms and 04 of which were damaged by the borer, with 09 borer holes. The incidence of attack was 20.00, 30.77, and 22.22 percent, respectively, resulting in 24.33 percent of the average attack. The number of borer holes per culm was 1.90, putting it in the 'Low' category. In the first clump in 2020, there were a total of 128, of which 14 were fresh culms and 05 culms that were damaged by the borer, with ten borer holes. The total number of culms in the second clump was 142, with 12 new culms and 04 culms, which were damaged by the borer, with 09 borer holes. The overall number of culms in the third clump was 175, with 17 new culms and 06 culms damaged by the borer, with 09 borer holes. The incidence of attack was 5.71, 33.33 and 35.29 percent, respectively, resulting in 34.78 percent of the average attack. The number of borer holes per culm was 1.90, putting it in the 'Low' category.

Phloeobius crassicollis (Anthribidae: Coleoptera) were observed damaging three bamboo species for the first time, namely *Bambusa* bamboos*, Bambusa tulda*, and *Dendrocalamus* strictus [11]. The frequency and severity of *P. crassicollis* attacked in ten bamboo species. *Bambusa wamin* was the most heavily attacked species, 44.26 percent, subsequently *Bambusa* bamboos 31.21 percent, *Bambusa polymorpha* 29.93 percent, *Dendrocalamus strictus* 28.70 percent, *Bambusa vulgaris* 20.27 percent, *D. calostachyus* 19.98 percent, *Bambusa nutans* 17.93 percent, *D. giganteus* 17.69 percent, *Bambusa tulda* 1.06 percent [12]. Statistical analysis of the percent attack of *Phloeobius crassicollis* on bamboo species revealed that this borer caused the most damage to *Bambusa wamin*.

4. CONCLUSION

E. chinensis was found to damage seven green-standing bamboo species in natural stands for the first time, including *G. manggog, T. oliveri, B. balcooa, S. dullooa, G. atroviolacea, D. hamiltoni*, and *B. polymorpha*. In 2017, 2018, and 2020, the incidence of attack on *G. manggog* was 33.65, 34.17, and 28.78 percent, respectively, while the intensity of the attack was 2.07, 2.08, and 2.09 percent. In 2017, 2018, and 2020, the incidence of attack on *T. oliveri* was 56.19, 53.89, and 50.26 percent, respectively, while the intensity of the attack was 1.08, 1.25, and 1.22 percent. In 2017, 2018, and 2020, the incidence of attack on *B. balcooa* was 43.17, 38.20, and 47.79 percent, respectively, with an intensity of attack of 3.05, 3.16, and 3.11 percent. In 2017, 2018, and 2020, the incidence of attack on *S. dullooa* was 33.73, 33.10, and 27.42 percent, respectively, while the intensity of the attack was 1.53, 1.62, and 1.37 percent. In 2017, 2018, and 2020, the incidence of attacks on *D. hamiltoni* was 31.06, 37.42, and 43.98 percent, respectively, while the intensity of the attack was 2.80, 2.87, and 2.80 percent. In 2017, 2018, and 2020, the incidence of attack on *G. atroviolacea* was 37.12, 27.54, and 20.75 percent, respectively, while the intensity of the attack was 2.18, 2.28, and 2.37 percent. In 2017, 2018, and 2020, the incidence of attack on *B. polymorpha* was 27.78, 24.33, and 34.78 percent, respectively, while the intensity of the attack was 1.85, 1.9, and 1.9 percent. Only one bamboo species, *B. balcooa*, was found to have a high-intensity attack rate. In contrast, three others, *G. manggog, D. hamiltoni,* and *G. atroviolacea*, were found to have a moderate attack level. The low intensity of the attack was assigned to *T. oliveri, S. dullooa*, and *B. polymorpha.*

AUTHOR CONTRIBUTIONS

Both authors contributed equally to this study.

CONFLICT OF INTEREST

None.

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Table: Incidence and intensity of attack on different bamboos by *Estigmena chinensis.*

Locality	Bamboo species	Year	No. of total clumps	No. of total culms	No. of total new culms	No. of attacked culms	% incidence of attack	Average % incidence of attack	Total No. of holes	Avg. No. of holes/ attacked culm	Intensity of attack
Bamboo setum, FRI	*Giagatochloa manggong*	2017	01 01 01	101 97 88	27 29 25	07 09 11	25.92 31.03 44.00	33.65	19 21 18	2.07	Moderate
		2018	01 01 01	128 127 113	11 13 10	04 06 02	36.36 46.15 20.00	34.17	07 10 08	2.08	Moderate
		2020	01 01 01	154 152 144	08 11 20	02 04 05	25.00 36.36 25.00	28.78	04 08 11	2.09	Moderate
Bamboo setum,	*Thyrsostachyus oliveri*	2017	01 01 01	54 46 49	21 19 22	14 09 12	66.66 47.37 54.54	56.19	15 10 13	1.08	Low
		2018	01 01 01	78 68 71	12 10 15	07 05 08	58.33 50.00 53.33	53.89	08 07 10	1.25	Low
		2020	01 01 01	112 97 99	14 18 21	06 10 11	42.86 55.55 52.38	50.26	08 13 12	1.22	Low
Bamboo setum, FRI	*Bambusa balcooa*	2017	01 01 01	115 102 105	42 46 39	18 21 16	42.85 45.65 41.02	43.17	58 61 49	3.05	High
		2018	01 01 01	159 151 148	38 45 48	15 16 19	39.47 35.55 39.58	38.20	51 43 64	3.16	High

		2020	01 01 01	206 212 209	29 32 36	16 14 16	55.17 43.75 44.44	47.79	53 42 48	3.11	High
Bamboo setum, FRI	*Scohizostachyum dullooa*	2017	01 01 01	42 18 25	28 07 12	11 02 04	39.28 28.57 33.33	33.73	15 05 06	1.53	Low
		2018	01 01 01	73 28 44	29 08 13	09 03 04	31.03 37.50 30.77	33.10	12 05 09	1.62	Low
		2020	01 01 01	112 52 72	26 09 12	12 01 03	46.15 11.11 25.00	27.42	14 03 05	1.37	Low
Bamboo setum, FRI	*Dendrocalamus hamiltoni*	2017	01 01 01	21 29 30	09 11 12	03 02 05	33.33 18.18 41.67	31.06	11 07 10	2.80	Moderate
		2018	01 01 01	33 25 28	08 11 05	02 03 03	25.00 27.27 60.00	37.42	05 07 11	2.87	Moderate
		2020	01 01 01	56 62 74	09 08 06	04 03 03	44.44 37.50 50.00	43.98	12 08 08	2.80	Moderate
Bamboo setum, FRI	*Gigantochloa atroviolacea*	2017	01 01 01	58 62 54	12 08 11	03 04 04	25.00 50.00 36.36	37.12	05 09 10	2.18	Moderate
		2018	01 01 01	64 78 92	11 05 09	02 01 04	18.18 20.00 44.44	27.54	06 04 06	2.28	Moderate
		2020	01 01 01	91 98 106	15 08 13	04 01 03	26.67 12.50 23.08	20.75	09 03 07	2.37	Moderate
Bamboo setum, FRI	*Bambusa polymorpha*	2017	01 01 01	83 92 103	12 16 21	03 04 07	25.00 25.00 33.33	27.78	06 09 12	1.85	Low
		2018	01 01 01	109 118 141	10 13 18	02 04 04	20.00 30.77 22.22	24.33	03 07 09	1.90	Low
		2020	01 01 01	128 142 175	14 12 17	05 04 06	35.71 33.33 35.29	34.78	10 09 09	1.90	Low

Figures on next page…

Figures: 1. *Gigantochloa manggog*, 2. *Thyrsostachyus oliveri,* 3. *Bambusa balcooa,* 4. *Schizostachyum dullooa*, 5. *Bambusa hamiltoni*, 6.*Gigantochloa atroviolacea,* 7. *Bambusa polymorpha*.