Incidence, intensity of attack and control of the Bamboo borer, *Phloeobious crassicollis* Jord.

K.P. Singh
Entomology Division, Forest Research Institute
(Indian Council of Forestry Research and Education)
Dehradun-248006, India
E-mail: singhkp@icfre.org

Abstract:

Bamboos belong to grasses family Poaceae, sub family Bambusoideae, and have immense importance to the economy of South-East-Asia. They are widely distributed all over the world comprising 75 genera and 1250 species. A total of 212 insect species causing damage to bamboos right from seeds to nurseries to plantations were categorized as nursery pests (5), defoliators (48), sap suckers (90), culm and shoot borers (12), termites (13) and borers of felled and dried bamboo (44). *Phloeobious crassicollis* Jord. is a major borer, which attacks green standing bamboo species of *Bambusa bambos, B. nutans, B. polymorpha*, *B. tulda, B. vulgaris, B. wamin*, *Dendrocalamus giganteus, D. strictus, D. calostachyus* and *Gigantochloa atroviolacea*. *Bambusa wamin* was found heavily infested (44.27%) followed by *Bambusa bambos* (31.22%)*, B. polymorpha* (30.18%)*, Dendrocalamus strictus* (28.61%) (high intensity of attack); *B. vulgaris* (20.25%), *D. calostachyus* (19.90%), *B. nutans* (17.94%) *D. giganteus* (17.66%) (moderate intensity of attack); *B. tulda* (1.65%) and *Gigantochloa atrovolacea* (1.07%) (low intensity of attack). Among high intensity attack, statistically higher damagewas in *Bambusa wamin,* while damage in other three subsequent species was statistically at par. Chemical control experiments were carried out using three systemic (dimethoate, monocrotophos and imidacloprid) and four-contact insecticides (deltamethrin, cypermethrin, chlorpyriphos and endosulphan) at 0.01, 0.02 and 0.04% concentrations. It was concluded that chlorpyriphos (0.04%) provided 75.00% control of borers followed by 65.12 and 65.00% with the application of endosulphan (0.04%) and Imidacloprid (0.04%) respectively. Monocrotophos, deltamethrin, dimethoate and cypermethrin were found not very effective as they can control the attack ≤ 50 %.

Keywords: *Phloeobius crassicollis,* Incidence, Intensity, Anthribidae, Coleoptera

Introduction

Bamboos belong to subfamily Bambusoideae of family Poaceae, and all 75 genera and 1250 species of bamboo are woody and fast growing (Soderstrom and Ellis, 1987).They are distributed in tropics and subtropics as well as temperate zones. Bamboo is a cultural feature of South-east Asia and is termed as "bamboo culture", "green gold" etc. Bamboos have 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. Bamboos , an important paper pulp source in India and China (Maheshwari and Satpathy, 1990; Zhen-Xing *et.al,* 1988), are highly susceptible to insect damage, being attacked by 212 insect species belonging to orders Coleoptera, Homoptera, Isoptera, Lepidoptera and Thysanoptera (Beeson, 1941). Life cycle of bamboo stem beetle *Estigmena chinensis* Hope. was studied (Roonwal, 1977). A brief note on bamboo borer *Cyrtotrachelus longimanus* Fab. was given by Chen, 1928. Detailed study of insect pest of bamboo and their control was carried out by Singh and Bhandari, 1988. Out of these, *Phloeobious crassicollis* Jord. is reported as a major borer

(Fig 1 to 5) of bamboo (Singh, 2014). Earlier it was reported that this borer attacked on the dried bamboo after felling but no work has so far been carried out on incidences and intensity of attack by *P. crassicollis* on green standing bamboo species and its chemical control. Therefore, an attempt was made to carry out survey on incidence and intensity of attack by *P. crassicollis* and study its control by using chemical insecticides. The findings are reported in this paper.

Materials and Methods:
The details of the materials and methods are given hereunder:

1. Intensive survey was carried out to examine incidence and intensity of attack of bamboo borer, *P. crassicollis* in different bamboo species in natural stand at Barkala and Sahansara beats, Sahakumbari Range, Shiwalik Forest Division, Saharanpur, Uttar Pradesh and Bamboo-satum, Forest Research Institute, Dehradun, Uttarakhand, India. The assessment of incidences and intensity of attack by borer was calculated by analyzing total number of clumps in the field and number of culms in each clump. Total numbers of attacked culms were counted in the clumps and the percent incidence of attack was calculated

2. Similarly, intensity of insect attack was assessed on the basis of total number of borer holes in each attacked culm. If the number of borer holes per attacked culm was one, it was considered as low, if two, it was considered as moderate and if more than two, then considered as high.

3. Control of *P. crassicollis* on green *Bambusa bambos* was tested using systemic insecticides.. Under this trial in May 2008, 10 treatments with three replications were used for which 30 clumps were marked. The insecticides used were dimethoate, monocrotophos and imidacloprid at 0.01, 0.02 and 0.04 per cent concentration applied through internodal injections. Two boreholes were made on the internodes of each culm with the help of an auger (Fig 6). Each insecticide (80-100 ml) of different concentrations was injected into the holes of culm with the help of syringe (Fig 7). Before applying insecticides, pretreatment observations were recorded. Total numbers of culms were counted in each clump, total of borer-attacked culms and numbers of borer holes in each culm were also recorded.. Post- treatment observations were recorded after one year of applications. Another experiment using contact insecticides in *Bambusa bambos* at Barkala beat, Shakumbari range, Shiwalik Forest Division, Saharanpur, (Uttar Pradesh) was laid down. Under the trial 13 treatments with three replications were used for which 39 clumps were marked. The insecticides used were deltamethrin, cypermethrin, chlorpyriphos and endosulphan at 0.01, 0.02 and 0.04 per cent concentrations. Observations on incidence and intensity of attack were recorded before applying the insecticides. Post-treatment observations were recorded after one year. The percentage of control of borer attack was calculated.

Results and discussion:

Data of incidence and intensity of attack on ten bamboo species have been recorded and presented in Table 1. Culms of *Bambusa wamin* were examined, and observed that 38.67 mean numbers of culms were found attacked with 124 borer holes in Bamboo-satum of FRI, Dehradun, Uttarakahnd, India. The mean per cent incidence of borer attack was 44.27% and the intensity of attack put under 'High' category (Fig. 8). In Barkala beat 41 mean number of culms were found attacked by the borer out of 131.33 mean number of culms studied with 91.33 mean number of holes. The percentage of incidence of attack was 31.22 % and borer holes in proportion with the culm was more than 2, therefore, it was kept in 'High' category of intensity of attack (Fig. 9). In Bamboo-satum FRI 376.67 culms of *Bambusa polymorpha* were inspected. Out of these 113.67 culms were observed attacked by the borer showing 254 borer holes. The incidence of attack was 30.18% and intensity of attack in

relation to attacked culms and number of borer holes was treated as 'High'. (Fig 10). *Dendrocalamus strictus* was inspected in Bamboo-satum FRI, 263.33 culms were examined, out of which 75.33 culms were found attacked by the borer showing 178 borer holes. The incidence of borer attack was 28.61% and the intensity of attack was 'High' (Fig. 11).

Table 1. Incidence and intensity of attack on different bamboo species by *P. crassicollis*

Locality	Bamboo species	Mean no. of culms	Incidence of attack		Mean no. of holes	Intensity of attack category
			Mean no. of attacked	Mean % of incidence		
Species having high incidence and intensity of attack						
Bamboo Satum FRI	*Bambusa wamin*	87.33	38.67	44.27[a] ± 1.15	124.00	High
Barkala Beat (Shakumbhari Range)	*Bambusa bambos*	131.33	41.00	31.22[b] ± 0.46	91.33	High
Bamboo Satum FRI	*Bambusa polymorpha*	376.67	113.67	30.18[b] ± 1.63	254.00	High
Bamboo Satum FRI	*Dendrocalamus strictus*	263.33	75.33	28.61[b] ± 2.59	178.00	High
Species having moderate incidence and intensity of attack						
Bamboo Satum FRI	*Bambusa vulgaris (Yellow Bans)*	242.00	49.00	20.25[a] ± 0.967	65.67	Moderate
Bamboo Satum FRI	*Dendrocalamus calostachyus*	132.33	26.33	19.90[ab] ± 1.901	34.67	Moderate
Bamboo Satum FRI	*Bambusa nutans*	152.33	27.33	17.94[bc] ± 0.219	38.33	Moderate
Bamboo Satum FRI	*Dendrocalamus giganteus*	228.33	40.33	17.66[c] ± 0.490	75.00	Moderate
Species having low incidence and intensity of attack						
Bamboo Satum FRI	*Bambusa tulda*	242.33	4.00	1.65 ± 0.411	2.33	Low
Bamboo Satum FRI	*Gigantochloa atroviolacea (Kala Bans)*	342.33	3.67	1.07 ± 0.113	1.67	Low

Same alphabets represent statistically at par group ± Standard Deviation

Per cent attack of high intensity attack species of bamboo was statistically analyzed by one way ANOVA and observed that per cent attack of the borer in *B. wamin* species was statistically significant (Variance ratio, F= 57.232, p = < 0.05) with all other three species *viz. B. bambos* (mean difference 13.065*), *B. polymorpha* (mean difference 14.330*) and *D. strictus* (mean difference 15.563*). It indicates that this borer was creating maximum damage in *B. wamin* while damage in other three species is statistically not significant.

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Bambusa vulgaris, *Dendrocalamus calostachyus*, *Bambusa nutans* and *Dendrocalamus giganteus* were observed moderately attacked by the borer and their mean per cent of incidence was 20.25, 19.90, 17.94 and 17.66 respectively. 242 culms of *Bambusa vulgaris,* 132 culms of *Dendrocalamus calostachyus*, 152.33 culms of *Bambusa nutans* and 228.33 culms of *Dendrocalamus giganteus* were studied and observed that 49.00, 26.33, 27.33 and 40.33 culms were found attacked by the borer respectively (Fig. 12 – 15).

Per cent borer attack of moderate intensity attack 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= 4.496, p = < 0.05). Borer attack in B. *vulgaris* was significantly different with *B. nutans* (mean difference 2.340*), *D. giganteus* (mean difference 2.586*) while per cent borer attack in *D. calostachyus was* significantly different with *D. giganteus* (mean difference 2.293*).

Damage from borer attack in *D. calostachyus* was statistically at par with the damage in *B. vulgaris* and in *B. nutans.* Damage from borer attack in *B. nutans* was statistically at par with the damage in *D. calostachyus* and *D. giganteus. Bambusa tulda* and *Gigantochloa atroviolacea* growing in Bamboo-satum of Forest Research Institute, Dehradun were observed having low incidence and intensity of attack by the borer. 242.33 culms of *Bambusa tulda* and 342.33 culms of *Gigantochloa atroviolacea* were studied and observed that only 4 and 3.67 number of culms with 1.65 and 1.07 per cent incidence were attacked by the borer respectively (Fig. 16 & 17).

Control of borer:

On the basis of pre and post-treatment observations (Table 2) 0.01% concentration of dimethoate applied (T1) showed that the mean number of borer attack remained 13.82% against the pre-treatment mean per cent attack of 19.51. The borer control was 29.17%. Dimethoate 0.02% (T2), the pre-treatment borer attack was 12.35 % and post-treatment observation showed that the mean percentage of attack was reduced to 18.52 and the control of borer attack was 33.33. Application of 0.04% of dimethoate, the attack came down from 17.21 % to 10.66 % and borer control was 38.10%. By using monocrotophos 0.01% (T4), the pre-treatment percentage of attack was 18.65 and post-treatment observations showed that the attack reduced to 12.00 %. The borer control was 35.71%. Pre-treatment observations of monocrotophos 0.02% (T5), borer attack was 17.32% and after applying of insecticide, borer attack reduced to 11.02 %. The per cent of borer control was 36.36. Monocrotophos 0.04% (T6) at the time of pre-treatment observation, the borer attack was 21.62% but after applying insecticide, the percentage of borer attack lowered to 12.61. The overall borer control was high as 41.67%. Imidacloprid 0.01% (T7), before applying insecticide the percentage of borer attack was 22.55 % and after application of insecticide, the borer attack was reduced to 12.75. The per cent of borer control was 43.48. By applying imidacloprid 0.02% (T8), pre- treatment observation showed that the borer attack was 17.97 % but after applying the insecticide, borer attack was lowered to 8.50 %. The borer control was 52.17%. Similarly, in T9, when imidacloprid 0.04% was applied and the borer attack on pre-treatment observation was 14.93% while after applying the insecticide, the percentage of borer attack was reduced to 5.22%. The percentage of borer control was 65.00%. The post-treatment observations revealed that imidacloprid 0.04% concentration was proven the best and controlled 65.00% borer attack followed by monocrotophos 41.67% and dimethoate 38.10%. In control treatment (T10), the pre treatment observations showed that the percentage of borer attack was 19.28 whereas in post-treatment observation it was 22.29 %. The respective per cent of borer attack increased was 15.63%.

Table 2. Chemical control using systemic insecticides against *P. crassicollis* (Anthribidae: Coleoptera) at Sahansara beat (Shakumbari range, Saharanpur U.P, India)

Insecticides used	Dosages %	Treatment	Mean No. of culms	Pre treatment observation in 2008		Post treatment observation in 2009		Average % borer control
				Mean No. of attacked culms	Mean Initial % of attack	Mean No. of attacked culms	Mean Remained % of	
Dimethoate 30EC	0.01	T1	41.00	8.00	19.51	5.67	13.82	29.17[a] ± 8.1228
	0.02	T2	27.00	5.00	18.52	3.33	12.35	33.33[a] ± 7.5049
	0.04	T3	40.67	7.00	17.21	4.33	10.66	38.10[a] ± 4.7591
Monocrotophos 50EC	0.01	T4	25.00	4.67	18.67	3.00	12.00	35.71[a] ± 8.6631
	0.02	T5	42.33	7.33	17.32	4.67	11.02	36.36[a] ± 3.3641
	0.04	T6	37.00	8.00	21.62	4.67	12.61	41.67[ab] ± 2.5750
Imidacloprid 17.8 SL	0.01	T7	34.00	7.67	22.55	4.33	12.75	43.48[ab] ± 0.7958
	0.02	T8	42.67	7.67	17.97	3.67	8.50	52.17[bc] ± 11.564
	0.04	T9	44.67	6.67	14.93	2.33	5.22	65.00[c] ± 3.8798
Control	-	T10	55.33	10.67	19.28	12.33	22.29	15.63[d]* ± 13.217

*Same alphabets represent statistically at par group; *Borer attack was increased in control treatment*

The observations of systemic insecticides were tested statistically by one - way ANOVA against the per cent borer control. Results of experiments revealed that treatments were significantly different (Variance ratio, F = 62.573; p = < 0.05) (Table3). All the dosages of different systemic insecticides *viz.* dimethoate, monocrotophos and imidacloprid were giving statistically significant differences for borer control against the non treatment (control). Within the insecticides, per cent borer control by applying imidacloprid 0.01 % was statistically different by applying dimethoate 0.01 % and imidacloprid 0.04 % (Table 2). Per cent borer control by applying imidacloprid 0.04 % was statistically different by applying all the dosages of different systemic insecticides except imidacloprid 0.02 %. Different dosages of same insecticide were statistically non significant differences on the per cent borer attack except for imidacloprid insecticide where 0.01% dosages was providing significant differences on per cent borer attack with 0.04 % dosages.

Table 3. Statistically significant mean differences on the basis of CD (LSD)

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Sl. No.	Insecticide dosages	Mean Difference	P value
1	Imidacloprid 0.01 % Vs Dimethoate 0.01 %	12.9233*	0.048
2	Imidacloprid 0.02 % Vs Dimethoate 0.01 %	20.9433*	0.003
3	Imidacloprid 0.02 % Vs Dimethoate 0.04 %	15.8133*	0.018
4	Imidacloprid 0.04 % Vs Dimethoate 0.01 %	33.6766*	0.000
6	Imidacloprid 0.04 % Vs Dimethoate 0.02 %	31.6466*	0.000
8	Imidacloprid 0.04 % Vs Dimethoate 0.04 %	26.5166*	0.000
9	Imidacloprid 0.04% Vs Monocrotophos 0.01 %	29.4566*	0.000
10	Imidacloprid 0.04 % Vs Monocrotophos 0.02 %	27.8866*	0.000
11	Imidacloprid 0.04 % Vs Monocrotophos 0.04 %	22.9633*	0.001
12	Imidacloprid 0.04 % Vs Imidacloprid 0.01	20.7533*	0.003

** Mean difference is significant at the 0.05 level*

Some of the contact insecticides were tested in the concentration of 0.01, 0.02 and 0.04 % doses and on the basis of pre and post treatment observations presented in Table 4, it evident from the data that when deltamethrin 0.01% was applied the borer attack remained 14.29 % against the pretreatment borer attack of 19.48%. The mean percentage of borer control was 26.67. Deltamethrin 0.02% (T2), reduced the pre-treatment borer attack of 21.43 % to 14.29%, which showed borer control of 33.33%.When 0.04 % dose was tried, the pre-treatment borer attack was 21.79% which was decreased to 11.54 % after application. The mean percentage of borer control was 47.48 after applying insecticide. Cypermethrin 0.01% (T4) reduced the borer attack to 13.33 % against the pre-treatment borer damage of 18.67 %. The mean borer control was 28.57 %. Cypermethrin 0.02% (T5) reduced the borer damage to 11.59 % against the pre-treatment damage of 17.39 %. The mean percentage of borer control was 33.33%. Cypermethrin 0.04% (T6) reduced the borer attack to 9.46 % against the pre-treatment borer attack of 18.92 %. The resultant borer control was 50.00%. In T7, chlorpyriphos (0.01%) decreased the borer damage to 8.22% against the pre-treatment borer attack of 15.07 %. The mean percentage of borer control was 45.45%. In T8, chlorpyriphos 0.02% reduced the borer damage to 4.21 % against the pre-treatment borer damage of 14.74 %, with overall average borer control of 71.43%. In T9, chlorpyriphos 0.04% reduced the borer attack to 4.11 % against the pre-treatment borer attack of 16.44 % having an average borer control of 75.00%. In T10, endosulphan 0.01% reduced the borer attack to 7.89 % against the pre-treatment borer damage of 14.91 % with an average borer control of 47.06%. In T11, Endosulphan 0.02% reduced the borer attack to 5.88 % against the pre-treatment borer damage of 16.47 % having an average borer control of 64.29%. Similarly, in T12 endosulphan 0.04% reduced the borer damage to 5.54 % against the pre-treatment borer damage of 15.88 % with an average borer control of 65.12%.

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Table 4. Chemical control using Contact insecticides against *Phloeobius crassicollis* (Anthribidae: Coleoptera) at Barkala beat (Shakumbari Range, Saharanpur U.P)

Insecticide	Dosages %	Treatment	Mean No. of culms	Pre treatment observation		Post treatment observation		Average % control
				Mean No. of attacked culms	Mean Initial% of attack	Mean No. of attacked culms	Mean Remained % of	
Deltamethrin	0.01	T1	25.67	5.00	19.48	3.67	14.29	26.67[a] ± 4.8093
	0.02	T2	28.00	6.00	21.43	4.00	14.29	33.33[a] ± 7.5056
	0.04	T3	26.00	5.67	21.79	3.00	11.54	47.48[a] ± 9.6244
Cypermethrin	0.01	T4	25.00	4.67	18.67	3.33	13.33	28.57[a] ± 7.6874
	0.02	T5	23.00	4.00	17.39	2.67	11.59	33.33[a] ± 0.0288
	0.04	T6	24.67	4.67	18.92	2.33	9.46	50.00[a] ± 11.558
Chlorpyriphos 50 E.C	0.01	T7	24.33	3.67	15.07	2.00	8.22	45.45[a] ± 17.647
	0.02	T8	31.67	4.67	14.74	1.33	4.21	71.43[b] ± 3.8567
	0.04	T9	24.33	4.00	16.44	1.00	4.11	75.00[b] ± 2.7523
Endosulphan 35 EC	0.01	T10	38.00	5.67	14.91	3.00	7.89	47.06[a] ± 9.6388
	0.02	T11	28.33	4.67	16.47	1.67	5.88	64.29[b] ± 12.714
	0.04	T12	42.00	6.67	15.88	2.33	5.54	65.12[b] ± 4.8093
Control	-	T13	32.33	5.00	16.46	6.00	18.56	20.00*[c] ± 17.351

*Same alphabets represent statistically at par group; *Borer attack was increased in control treatment*

In control treatment (T13), the pre observations showed that the percentage of borer attack was 16.46 %, whereas in post treatment observation it was 18.56% and the borer attack increased was with an average of 20.00%. On the qualitative observations, it was concluded that out of the contact insecticides chlorpyriphos 0.04% yielded significant effect (75.00%) for the control of bamboo borer *P. crassicollis*

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followed by endosulphan 0.04%, which controlled 65.12% of borer attack. cypermethrin and deltamethrin were found least effective (Table-4).

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 = 19.852; p = < 0.05). All the dosages of different systemic insecticides *viz.* deltamethrin, cypermethrin, chlorpyriphos and endosulphan were giving statistically significant differences for borer control against the control where no insecticide was used. Within the insecticides, percent bore control by applying chlorpyriphos 0.04 % were statistically different by applying all contact insecticides except chlorpyriphos 0.02 %, endosulphan 0.02 % and endosulphan 0.04 %. Per cent borer control by applying endosulphan 0.04 % were statistically different by applying all the dosages of different contact insecticides except chlorpyriphos 0.02 %, chlorpyriphos 0.04 % and endosulphan 0.02 %. It was observed in case of all contact insecticides that dosages having 0.01 % concentration were very less effective on borer control as compared to 0.04 per cent dosages. Therefore, within same insecticide differences in per cent control of borer attack were statistically significant in the treatments using 0.01 % and 0.04 % concentrations.

Conclusion:

Phloeobious crassicollis Jord. is a major borer, which attacks green standing bamboo species of *bamboos. Bambusa wamin, Bambusa bambos, Bambusa polymorpha and Dendrocalamus strictus* were found highly attacked by the borer with 44.27 %, 31.22 %, 30.18 % and 28.61 % incidence respectively. *Bambusa vulgaris*, *Dendrocalamus calostachyus*, *Bambusa nutans* and *Dendrocalamus giganteus* were observed moderately attacked by the borer and their per cent incidence was 20.25, 19.90, 17.94 and 17.66 respectively. *Bambusa tulda* and *Gigantochloa atroviolacea* were found under low category of borer attack with 1.65% and 1.07% respectively. Different systemic insecticides were tested to control the attack of this borer and observed that imidacloprid (0.04 % dose) was the best followed by monocrotophos and dimethoate. On the qualitative observations, it was concluded that out of the contact insecticides chlorpyriphos 0.04% yielded significant effect (75.00%) for the control of bamboo borer- *P. crassicollis* followed by endosulphan 0.04%, which controlled 65.12% of borer attack. Cypermethrin and deltamethrin were found least effective

Fig 1 - 7: Showing; 1. Female; 2. Male; 3. Larvae; 4. Pupa of *P. crassicollis;* 5. Feeding by larvae; 6. Drilling hole in bamboo culm; 7. Applying insecticide through injection.

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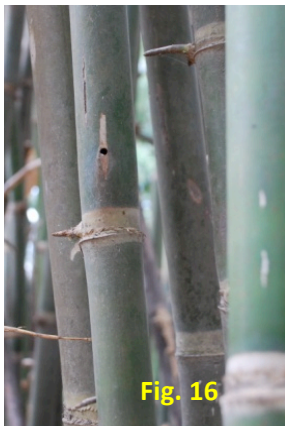

Fig 8 -17: Showing attacked bamboo species by *P. crassicollis;* 8, *Bambusa wamin;* 9. *B. bambos;* 10*, B. polymorpha*; 11. *Dendrocalamus strictus;* 12. *B. valgaris;* 13. *D. calostachyus;* 14. *B. nutans;* 15. *D. giganteus;* 16. *B. tulda;* 17. *Gigantochloa atroviolacea.*

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