THE APPEARANCE OF ADULT SHOT-HOLE BORERS *(XYLEBORUS FORNICATUS* EICH) OUTSIDE THEIR GALLERIES UNDER NATURAL CONDITIONS

E. Judenko

The numerous investigations into shot-hole borer hitherto carried out in this country have not considered the behaviour of adult beetles outside their galleries. This is an important observation because a knowledge of the activities of the beetles outside the bush is very essential in the search for practical measures of control to prevent the same beetles attacking the tea bush.

All bark-beetles (*Scolytidae*) approximating the size and appearance of the shot-hole borer of tea collected during the investigation were sent to Professor K. E. Schedl, a Senior Entomologist of the Federal Forestry Research Institute of Austria, for identification. The data presented in this article relate only to the species *Xyleborus fornicatus* Eich, as determined by Professor Schedl.

Appearance of adult beetles outside their galleries on tea bushes

The aims of the experiments carried out on estates in Sabaragamuwa were:

1. to ascertain the influence of rainfall and the age of tea from pruning on the number of beetles which appear on tea bushes,

2. to study the behaviour of the beetles on the lower parts (frame) of the tea bush,

and 3. to determine the proportion of males to females outside their galleries.

Two methods were adopted to obtain this information; the first, by shaking off the beetles from the bush, and the second, by the application of sticky bands around branches.

Experiments with the "Shaking off" method

The method adopted here was to shake off or disturb the beetles from the branches till they dropped into special receptacles made of tin and placed underneath the bushes. The branches were shaken by striking them with a wooden hammer or mallet covered with a pad of cloth to avoid injury to the bush (Fig. 1 in Plate I). The receptacles or containers were of 3 different sizes so that they fitted round bushes of various sizes (Fig. 2 in Plate I). When the "shaking off" was completed the contents of the receptacles were emptied into linen bags which in turn were removed to the laboratory for a careful examination. All bark-beetles (Scolytidae) of the size of adult shot-hole borers of tea were collected and preserved in alcohol.

25 bushes were shaken or disturbed on each occasion. Results of the experiment carried out on one of the estates, *viz.* Denawaka Group, are summarized in table 1.

Table 1. *Denawaka Group, Denawaka Division, Field No.* 4; *planted in* 1930. *Elevation* 800 *ft.*

Date	Number of adults shaken off			Age of tea from pruning in months	Monthly rainfall in ins.
	Males	Females	Total		
26- 1-56	2	2	4	0	5.84
24- 2-56	0	3	3	1	5.46
23- 3-56	0	1	1	2	12.54
25- 4-56	0	3	3	3	17.78
28- 5-56	0	6	6	4	8.89
28- 6-56	0	1	1	5	21.93
26- 7-56	0	2	2	6	2.17
24- 8-56	0	8	8	7	12.86
29-10-56	0	2	2	9	10.72
17-12-56	0	4	4	11	5.89
25- 2-57	0	2	2	13	9.96
22- 3-57	0	2	2	14	8.57
30- 4-57	0	2	2	15	8.77
22- 5-57	0	3	3	16	11.77
24- 6-57	0	3	3	17	16.44
30- 7-57	0	5	5	18	13.74

Experiments with Sticky Bands

The "bands" consisted of strips of white flexible cardboard 3½ inches wide; they were fastened with the aid of drawing pins round branches of an average girth of ½ inch. This is illustrated in fig. 3 of Plate 2. The bands were greased with the tanglefoot known as 'Ostico' and produced by Messrs. Plant Protection Ltd.

The investigation was carried out at 7 centres. While the experimental bushes on each of the 6 estates carried one sticky band per bush, the 7th experiment on field No. 5 Millawitiya, had 100 sticky bands distributed on 17 bushes. (Fig. 4 of plate 2 illustrates one such bush). The bands were on the average a little over a foot from ground level in the case of the abovementioned 6 estates and ½ ft. in the case of field No. 5, Millawitiya. They were examined at regular intervals when all trapped bark-beetles which resembled shot-hole borer in size and appearance were collected with the aid of needles, cleaned with xylol and preserved in alcohol for future examination. Fresh 'Ostico' was applied to all bands after examination. When any band disappeared it was replaced immediately. Table 2 is typical of the results obtained at one centre in the case of the abovementioned 6 estates, and the record of observations made at Millawitiya Estate field No. 5 are shown in Table 3.

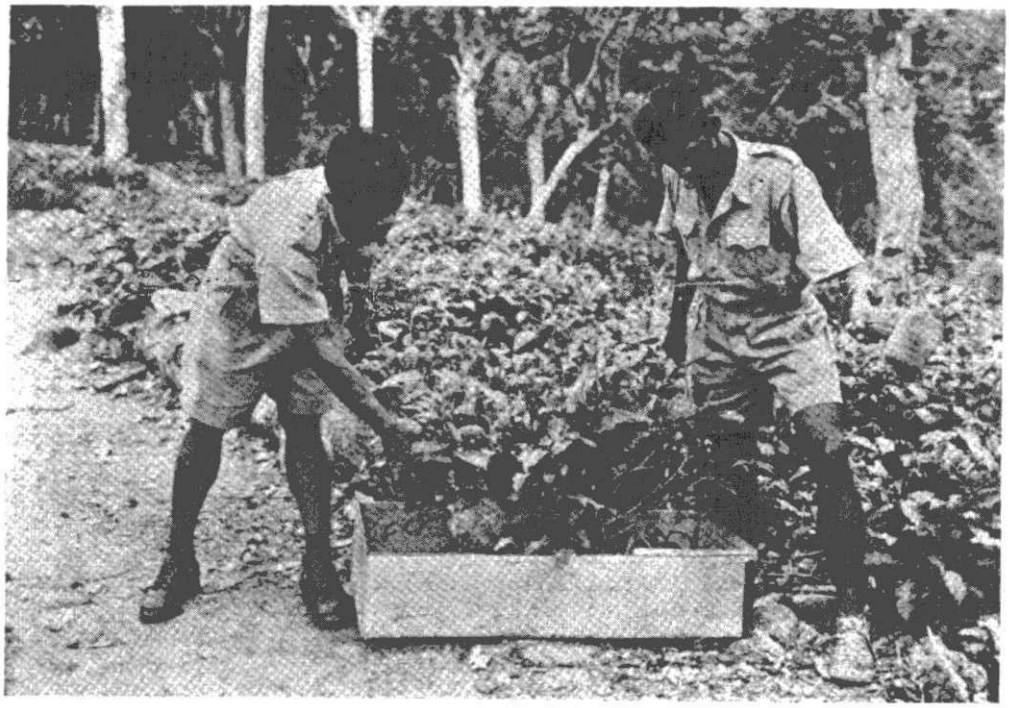

Fig. 1.

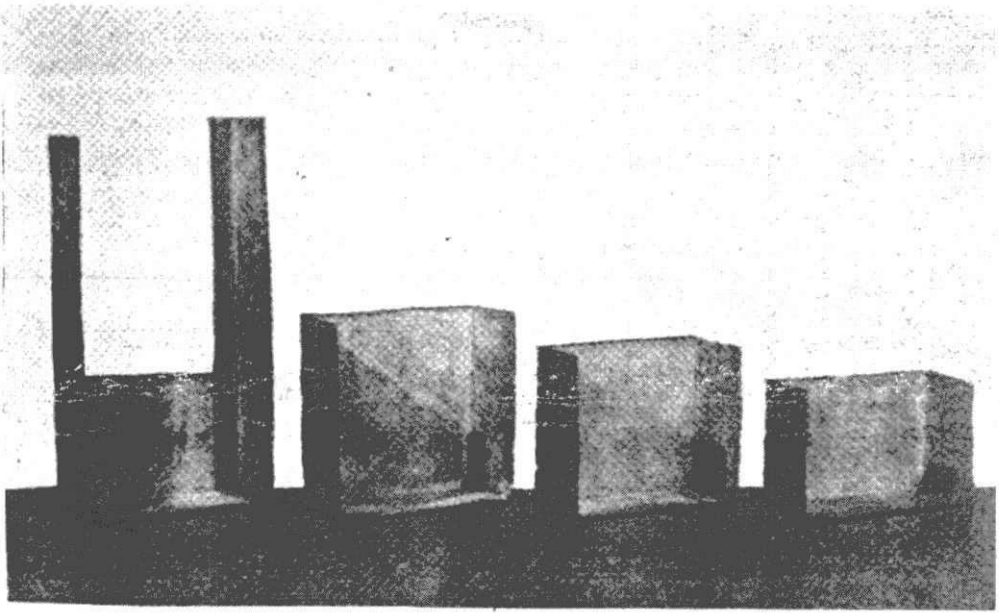

Fig. 2.

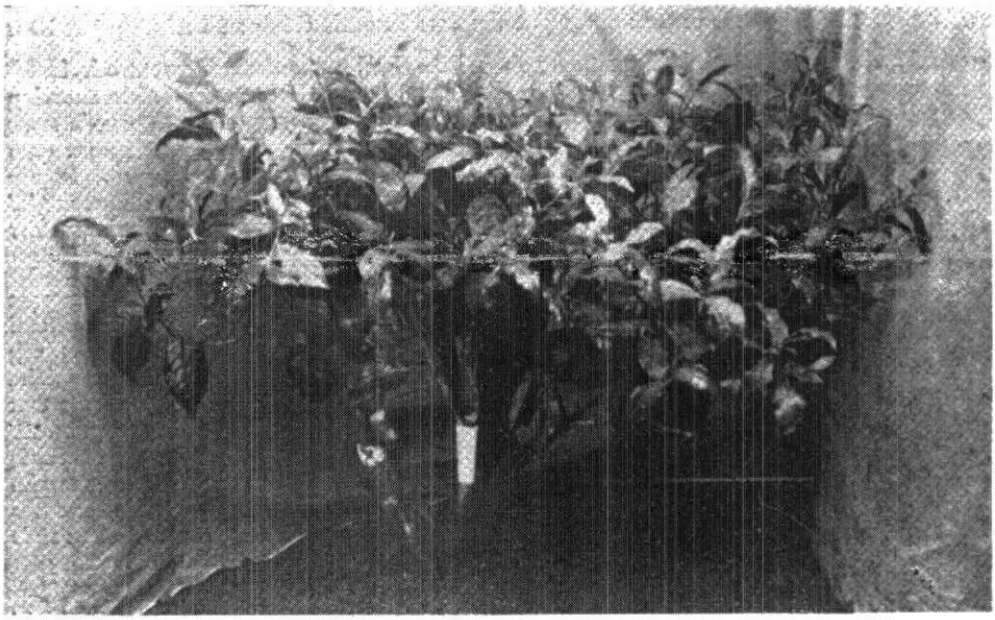

Fig 3.

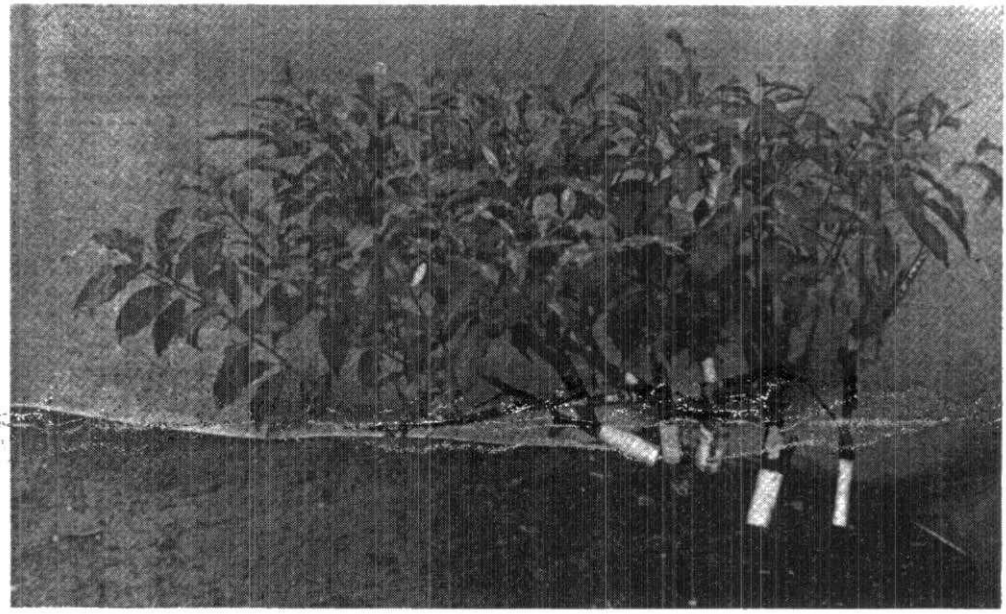

Fig. 4.

Table 2. *Hedgefield Estate. Field No.* 5, *planted in* 1924-1928. *Elevation* 800 *ft.* 25 *experimental bushes with one sticky band on each of the bushes. Average distance from the surface of the soil to the bases of sticky bands* 1 *ft.* 2*ins.* (*max.* 2 *ft. min.* 2 *ins.*).

Period when sticky bands were exposed	Length of period in days	Number of adults trapped			Age of tea from pruning in months	Rainfall in ins.
		Males	Females	Total		
21.2-21.3. 1956	29	0	4	4	20-21	9.39
21.3-20.4	30	0	1	1	21-22	3.48
20.4-21.5	31	0	10	10	22-23	20.16
21.5-25.6	35	0	2	2	23- 0	28.71
25.6-23.7	28	0	1	1	0- 1	1.87
23.7-21.8	29	0	2	2	1- 2	8.48
21.8-27.9	37	0	0	0	2- 3	25.89
27.9-22.10	25	0	2	2	3- 4	18.92
22.10-11.12	50	0	3	3	4- 6	24.63
11-12-56-15.1.57	35	0	2	2	6- 7	4.91
15.1-18.2	34	0	1	1	7- 8	3.39
18.2-18.3	28	0	1	1	8- 9	10.62
18.3-26.4	39	0	2	2	9-10	20.79
26.4-20.5	24	0	1	1	10-11	5.10
20.5-20.6	31	0	5	5	11-12	29.53
20.6-22.7	32	0	2	2	12-13	17.78
22.7-26.8	35	0	1	1	13-14	8.64
26.8-23.9	28	1	0	1	14-15	5.75
23.9-22.10	29	0	1	1	15-16	8.64

Table 3. *Millawitiya Estate: Field No.* 5, *planted in about* 1930. *Elevation* 300 *ft.* 100 *sticky bands on* 17 *experimental bushes. Average distance between the soil surface and the bases of the sticky bands* 6 *ins.* (*max.* 11 *ins.; min.* 1 *inch*).

Period when sticky bands were exposed	Length of period in days	Number of adults trapped			Age of tea from pruning in months	Rainfall during the period in ins.
		Males	Females	Total		
6.10-8.11.56	33	0	1	1	14-15	12.49
8.11-5.12	27	0	2	3	15-16	17.63
5.12.56-7.1.57	33	0	1	1	16-17	4.54
7.1-11.2	35	0	2	2	17-18	6.40
11.2-13.3	30	0	3	3	18-19	9.44
13.3-6.4	24	0	2	2	19-20	4.25

Conclusions

Conclusions drawn from experiments carried out by the "shaking off" method and with "sticky bands," indicate that:

1. there is no correlation between the number of beetles trapped, the amount of rainfall and the age of tea after pruning,
2. female beetles appear more often than males outside galleries,
3. some beetles appear outside their galleries on the lower parts of the bush.

Appearance of Beetles in the Air

The second phase of the investigation consisted of a series of experiments relating to the appearance of beetles in the air. They were designed to ascertain whether the beetles are distributed by air, and if so, the heights and distances they could reach and whether such movements were influenced by rainfall and/or the age of the tea from pruning.

"Sticky traps" as described by Fulton and Chamberlain (1931, p. 758) were used in the investigation. An individual trap consisted of a wooden frame 5′ × 3½′ over which a sheet of galvanized hardware cloth (No. 8) is stretched. Only the cloth is greased, and the sticky surface then measures 4′ 8″ × 3′ 2″. The illustration (fig. 5 in Plate III) shows four such traps placed one on top of the other.

Laboratory experiments had earlier demonstrated that if the mesh of the galvanized hardware cloth was *blocked* with grease, the cloth trapped more beetles than if only the wire was greased. But on the other hand, if all the meshes in the trap were blocked with grease, the air would be obstructed and deflected. Consequently only parts of the cloth, in the shape of squares, were blocked with grease. These squares, eight in number in each frame are seen in figure 5. The rest of the wire mesh was only lightly greased so as to allow currents of air to pass through.

The traps were erected between bamboo poles while the lower trap was supported on two bricks (not visible in fig. 5). To prevent the migration of the beetles from the soil surface the bricks and the bases of the bamboo poles were greased with 'Ostico'. As in the case of the sticky bands 'Ostico' was used for the sticky traps as well. From time to time the traps were cleaned with the aid of xylol and fresh 'Ostico' was applied. The investigation was conducted on 3 estates. Traps were examined at regular intervals when all bark-beetles of the size of *X. fornicatus* were collected, cleaned with xylol and transferred to alcohol for purposes of preservation. A feature of all the collections made was that only female beetles were trapped. This corroborates an observation by Fisher and others (1953, p. 383) that males of the genus *Xyleborus* are incapable of flight

The record of observations made at Millawitiya Estate are shown in table 4.

Table 4. *Record of flight at Millawitiya Estate. Field No.* 6, *planted ab.* 1930 *Elevation* 300 *ft. Height of the bushes just before pruning – ab.* 3 *ft.*

Period	Length of periods in days	Number of females trapped. (Figures in brackets refer to the height of the sticky traps above ground level)					Rainfall in inches	Age of tea from pruning in months
		No. 1 (5″–3′ 7″)	No. 2 (3′11″–7′ 1″)	No. 3 (7′ 5″–10′ 7″)	No. 4 (10″11″–14′ 1″)	Total		
8.5–22.5.56	15	2	1	1	0	4	5.94	22
22.5–6.6	15	0	0	1	0	1	3.78	22-23
6.6–20.6	14	1	0	1	0	2	13.71	23
20.6–3.7	13	1	1	1	1	4	6.27	23-0
3.7–16.7	13	1	1	6	0	8	1.29	0
16.7–31.7	15	12	3	2	0	17	0.69	0
31.7–14.8	14	0	2	1	1	4	4.37	1
14.8–29.8	15	2	3	1	0	6	7.15	1
29.8–11.9	13	0	1	0	1	2	11.15	1-2
11.9–24.9	13	0	2	0	0	2	3.18	2
24.9–9.10	15	4	1	6	0	11	15.21	2-3
9.10–23.10	14	6	4	1	1	12	5.31	3
23.10–7–11	15	2	1	1	0	4	6.00	3-4
7.11–19.11	12	0	2	0	0	2	8.09	4
19.11–5.12	16	3	0	1	0	4	10.72	4-5
5.12–19.12	14	17	0	0	0	17	1.93	5
19.12.56–2.1.57	14	0	0	0	0	0	2.63	5-6
2.1–15.1	13	0	0	0	0	0	4.14	6
15.1–29.1	14	0	0	0	0	0	0.76	6
29.1–12.2	14	0	0	0	0	0	1.30	6-7
12.2–26.2	14	1	1	0	0	2	7.45	7
26.2–12.3	14	1	7	0	2	10	1.99	7-8
12.3–26.3	14	0	0	0	0	0	2.82	8
26.3–8.4	13	2	2	2	5	11	2.13	8-9
8.4–23.4	15	9	8	5	13	35	7.11	9
23.4–8.5	15	1	1	0	1	3	2.38	9-10
Total	366	65 39%	47 28%	30 18%	25 15%	167		

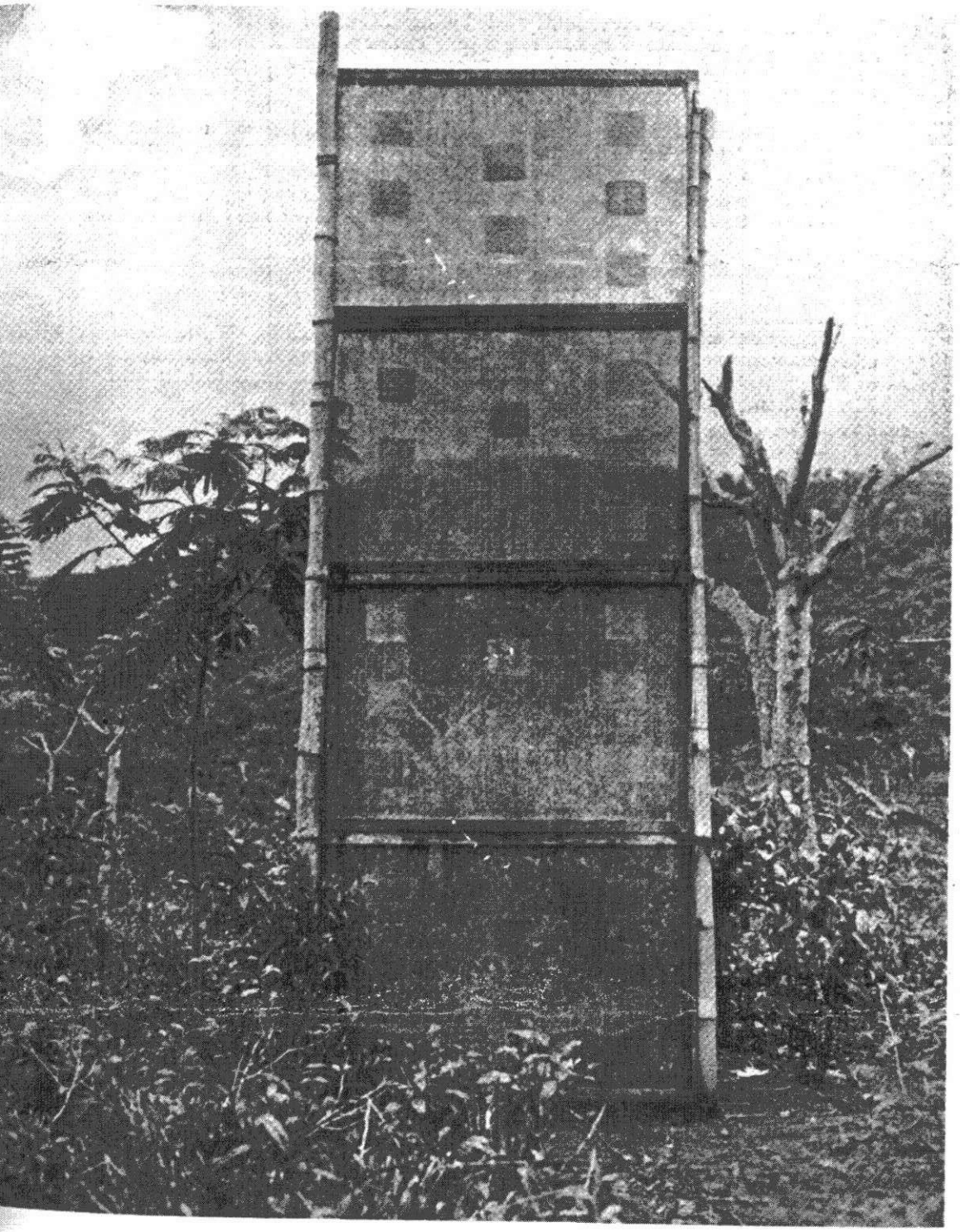

Fig. 5.

Conclusions.

1. Female beetles are distributed by air at up to about 11-14 feet and this indicates they can reach new clearings from a neighbouring tea field infested with shot-hole borer.

2. The majority of female beetles fly above the level of tea bushes and this demonstrates their ability to reach not only adjoining tea bushes but also bushes placed further away.

3. There does not appear to be any obvious correlation between the number of beetles captured, the amount of rainfall and the age of the tea from pruning.

Acknowledgments

The writer expresses his thanks to Professor K. E. Schedl for the identification of a great variety of beetles without which this report could not have been published; to Superintendents of estates for facilities afforded for the experiments; and to Mr. C. Shanmugam, his assistant, for help in the investigations.

References

1. Fisher, R. G., Thompson, G. H., and Webb, W. E. Ambrosia beetles in Forest and Sawmill. Forestry Abstracts (1953) Vol. 14. pp. 381-389.

2. Fulton, F. A., and Chamberlin, J. C. A new automatic trap for the study of insect dispersion and flight associations. Journal of Economic Entomology (1931) Vol. 24. pp. 757-761.