THE PREVENTION OF BORER ATTACKS ON HOOP PINE LOGS.

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SUMMARY.

Five species of Platypodidae and two species of Scolytidae were responsible for damage to felled hoop pine logs confined to the rain-forest in the Killarney district during periods of wet weather. Platypus froggatti, the largest and most destructive species, is host specific and dominates attacks on logs near cut-over areas. The other species are polyphagous and the smaller ones dominate in virgin areas. All are strongly and positively chemotropic and attacks become intensified in a few days after or during rain. The adults commence and continue the tunnel systems which are mostly across the grain and can extend deeply into the logs.

Replicated log protection experiments were conducted, mostly with K55 standard creosote, on a total of 127 logs involving 44,563 super. feet of timber. All non-creosote treatments reduced the intensity of borer attacks but were significantly inferior to creosote. Materials mixed with creosote did not add to its value. Creosote at the rate of one gallon to 140 square feet of log surface gave virtually complete protection for 10 weeks.

INTRODUCTION.

In Queensland rain-forests serious damage by shothole and pinhole borers may be experienced when logs are not quickly transported from foci of borer infestation to local mills or railheads. Increased attention to tracks and roads in the forest and the construction of all-weather access roads have helped considerably in reducing the risk of borer attacks, and co-ordination between cutters and haulers hastens the removal of the logs soon after felling.

In some districts, however, weather, topographic and other local factors do not readily permit the quick transference of logs from the forest. Borer attacks then prevent the full economic utilization of the timber. This was the problem with hoop pine (*Araucaria cunninghamii* Ait.) logs in the Killarney district some years ago, and an investigation of chemical means of log protection was commenced in 1939 and continued for several years.

REVIEW OF LITERATURE ON LOG PROTECTION.

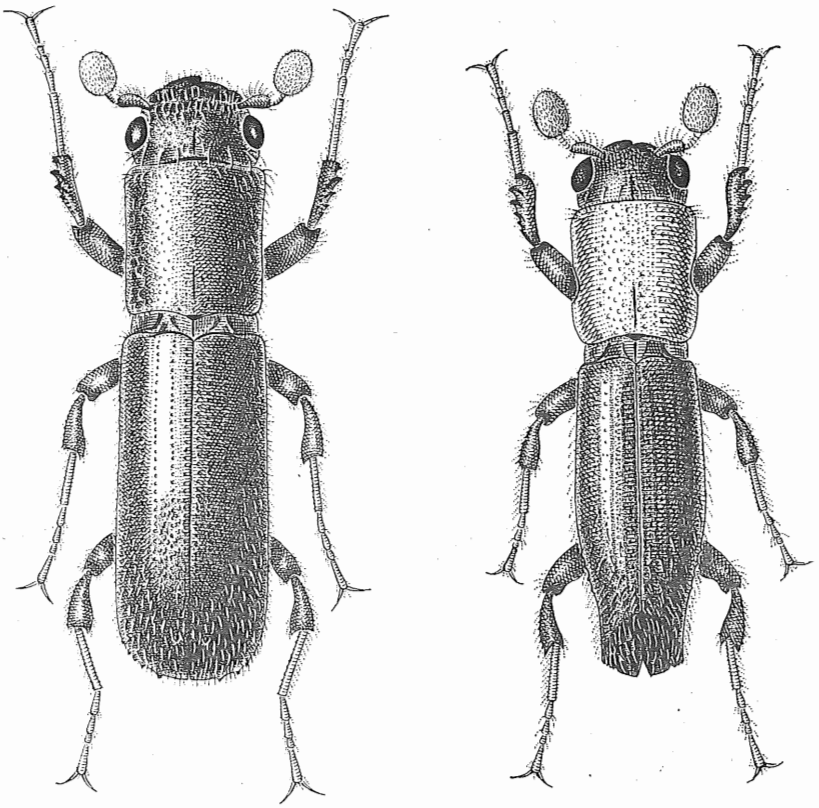
Few detailed investigations into the protection of logs from shothole and pinhole borers have been reported. The earliest authoritative account was by Craighead (1922) in America, and Smith (1935) later discussed non-chemical means for a specific problem in North Queensland. Since the present

investigation was commenced, Christian (1939) in America has given results obtained with many chemicals, mostly of organic origin. Hogan (1944) dealt with the protection of fire damaged timber in Victoria but did not give details of chemical treatments. Ambrosia beetles were included in an account of log treatments carried out by Holmes (1947) in Ceylon. More recently, experiments have been conducted by Browne (1949) in Malaya, by Kinghorn and Webb (1950) in Canada, and by Taylor and Hadlington (1950) and Hadlington (1951) in Australia.

In addition to the above several workers in America (Whittens, 1942; Wallace, 1943; Becker, 1946; and Connola, Collins and Hagman, 1947) have conducted experiments on various Scolytid bark beetles which are relevant to a discussion on log protection.

THE ECONOMIC IMPORTANCE OF BORER DAMAGE.

The ramifying tunnels of shothole and pinhole borers do not result in mass tissue destruction and unless numerous do not always affect the structural



A B

Fig. 1.

A, *Platypus froggatti* Samps. ♂ (× 11); B, *Platypus australis* Chap. ♂ (× 13); [*Drawings by William Manley.*

strength of the wood. However, the appearance of borer holes on hoop pine logs almost invariably causes degrading, and in extreme instances may reduce ply logs to case timber quality. In addition to decreasing the limited number of logs available for plywood manufacture, there is considerable monetary loss in value of the logs themselves and the timber cut from them. The importance of the damage is accentuated by the fact that the natural resources of this excellent timber are quickly approaching exhaustion. Consequently, the prevention of loss by borers is of considerable importance not only in reducing the monetary loss but also in making the greatest possible use of the remaining limited supplies.

BORER SPECIES IMPLICATED.

Many insects may be associated with felled hoop pine logs and a complete study would no doubt show a succession of attacks. However, recognition is here given to seven species damaging logs in the forest during the first few months after felling. These are *Platypus froggatti* Samps., *Platypus australis*

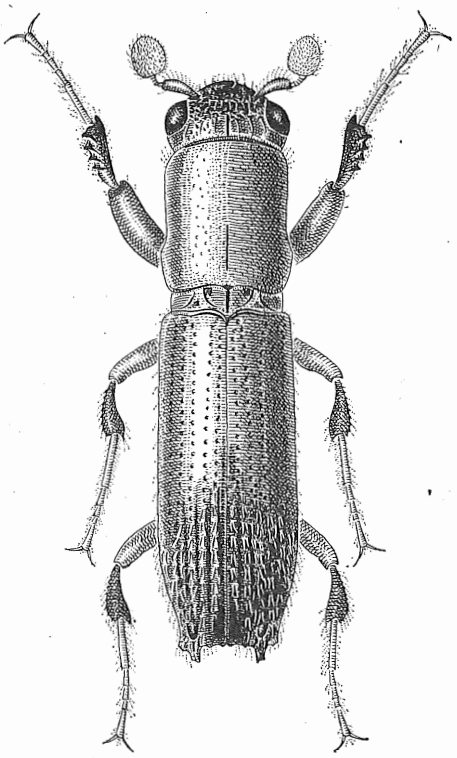


Fig. 2.

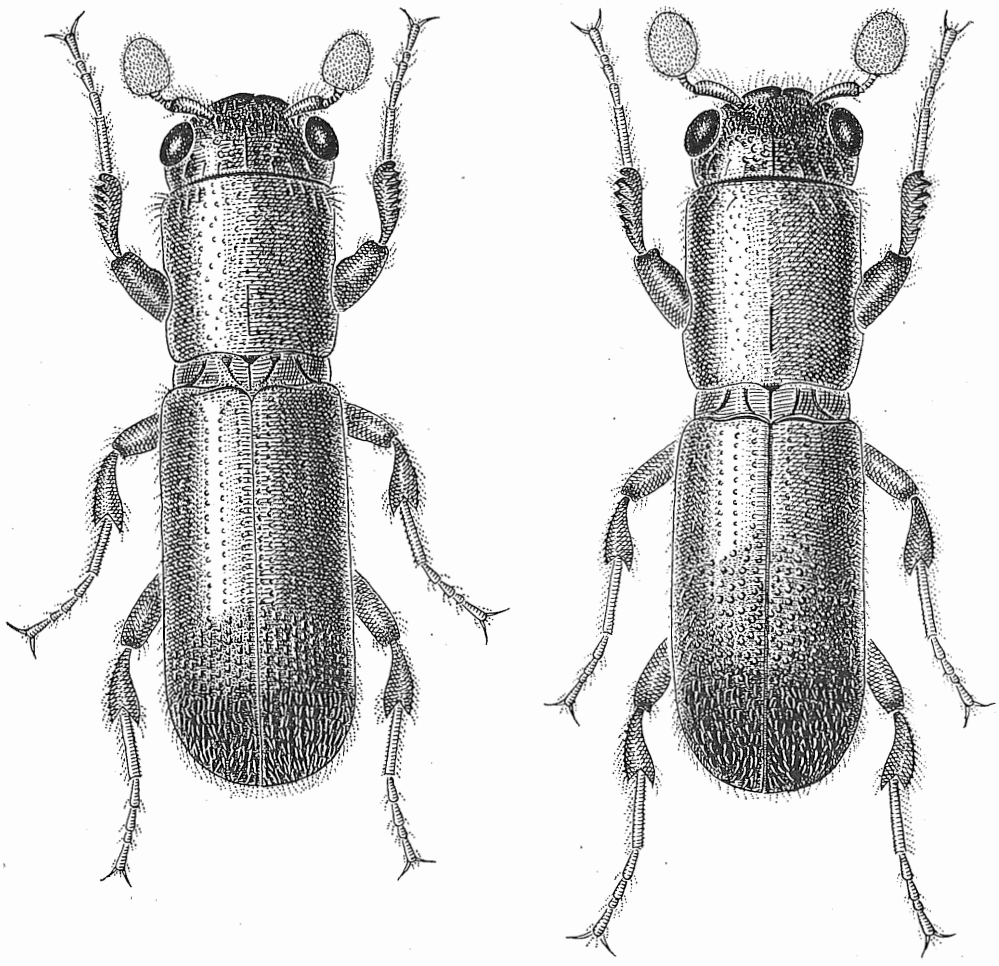
Crossotarsus omnivorus Lea ♂ (× 19).

[*Drawing by William Manley.*

Chap., *Crossotarsus omnivorus* Lea, *Platypus semigranosus* Samps. and *Platypus subgranosus* Schedl (family Platypodidae); and *Xyleborus perforans* Woll. and *Xyleborus eucalypticus* Schedl (family Scolytidae).

The presence of *P. subgranosus* in addition to *P. semigranosus* and of two separate species of *Xyleborus* was not established until after the field observations had been completed. Consequently the two species in each case are combined in subsequent discussions.

Adults of the five Platypodid species have the same general elongate shape and brown colour. Both males and females are more or less cylindrical, but each species exhibits sexual dimorphism. The difference is barely noticeable



A B

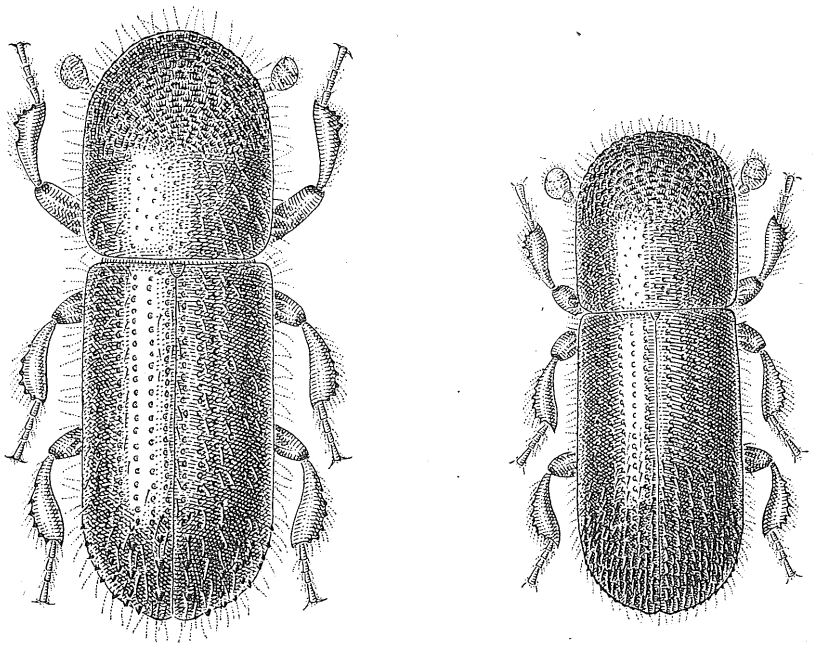
Fig. 3.

A, *Platypus subgranosus* Schedl. ♀ (× 25); B, *Platypus semigranosus* Samps. ♂ (× 25);

[*Drawings by William Manley.*

in *P. froggatti* (Figure 1, A), the male being distinguished by a small blunt terminal process on each elytron. In *P. australis* (Figure 1, B) the elytra of the male are constricted appreciably to a pronounced apical declivity. In the male *C. omnivorus* (Figure 2) there is slight constriction of the elytra; each terminates in a spine and is without the pronounced apical declivity. *P. semigranosus* and *P. subgranosus* (Figure 3, B and A) are similar except that in the latter the apical third of the elytra is granose while the former has the apical half coarsely granose. The females of all species are separated, apart from size differences, only on slight differences in apical elytral characters. Measurements of length and width of each species are as follows:—

Species.		Length. mm.	Width. mm.
P. froggatti ..	♂ and ♀	6·75–7·0 ..	1·9–2·1
P. australis	♂	5·0 –5·5 ..	1·2–1·4
	♀	5·25–5·75 ..	1·3–1·5
C. omnivorus	♂	3·75–4·0 ..	1·0–1·25
	♀	4·0 –4·25 ..	1·0–1·2
P. semigranosus ..	♂	3·5 –3·75 ..	1·0–1·2
	♀	3·75–4·0 ..	1·0
P. subgranosus ..	♂	3·5 –3·75 ..	1·0–1·2
	♀	3·75–4·0 ..	1·0



A B

Fig. 4.

A, *Xyleborus perforans* Woll. (× 32); B, *Xyleborus eucalypticus* Schedl (× 35).

[*Drawings by William Manley.*

The two species of *Xyleborus* (Figure 4, A and B) have the same cylindrical shape and brown colour. Macroscopically the only difference is in size and even that may be unreliable. The sexes are not readily distinguished. Measurements of length and width of each species are as follows:—

Species.	Mean Length. mm.	Mean Width. mm.
X. perforans	2·4 ..	0·8
X. eucalypticus	1·8 ..	0·65

HABITS OF THE BORERS.

Adults of the several species may be free living in the forest during moist humid weather, and are active on the wing during the daytime. All are strongly and positively chemotropic and under suitable conditions are attracted to logs on the day of felling, though normally a few days elapse before attacks become concentrated.

All species except *P. froggatti* are polyphagous and can readily penetrate the bark of most hosts. *P. froggatti* is restricted to hoop pine and enters only exposed wood. However, on barked hoop pine logs each species can commence boring in any position (Figure 5), though preference is shown for surface depressions, cracks, and the angle between wood and adhering bark fragments (Figure 6). Most species can penetrate to a depth greater than their own length in 24 hours.

In all species the adults initiate and continue boring the tunnel system. The Platypodids tunnel mostly across the grain. Entrance is normally perpendicular to the log surface but later the tunnels may change in direction and also become branched. Hoop pine sapwood is several inches thick (Figure 7), allowing scope for extensive tunnel exploitation in this tissue alone, but beetles can penetrate deeper into the log (Figure 8, B). Tunnels of *P. froggatti* have been traced across the grain for 15 inches from the surface, and along the grain for 37 inches.

The Xyleborid tunnels are also mostly across the grain but tend to be more devious and branched than those of the Platypodids. While change in direction is common a few inches from the surface, they also can penetrate well into the log.

Tunnels of both Platypodids and Xyleborids are accompanied by borer "dust," consisting of fine shreds of chewed-off wood. This is pushed back along the tunnel and eventually to the exterior so as to provide unimpeded movement by the beetles and their progeny throughout the tunnel system. With each species except *P. froggatti* the material is slightly compressed and projects as a "thread" from the entrance, sometimes for more than an inch, before falling to the ground (Figure 5 and Figure 6, A). With *P. froggatti* the dust often falls without forming a thread. Because of the greater

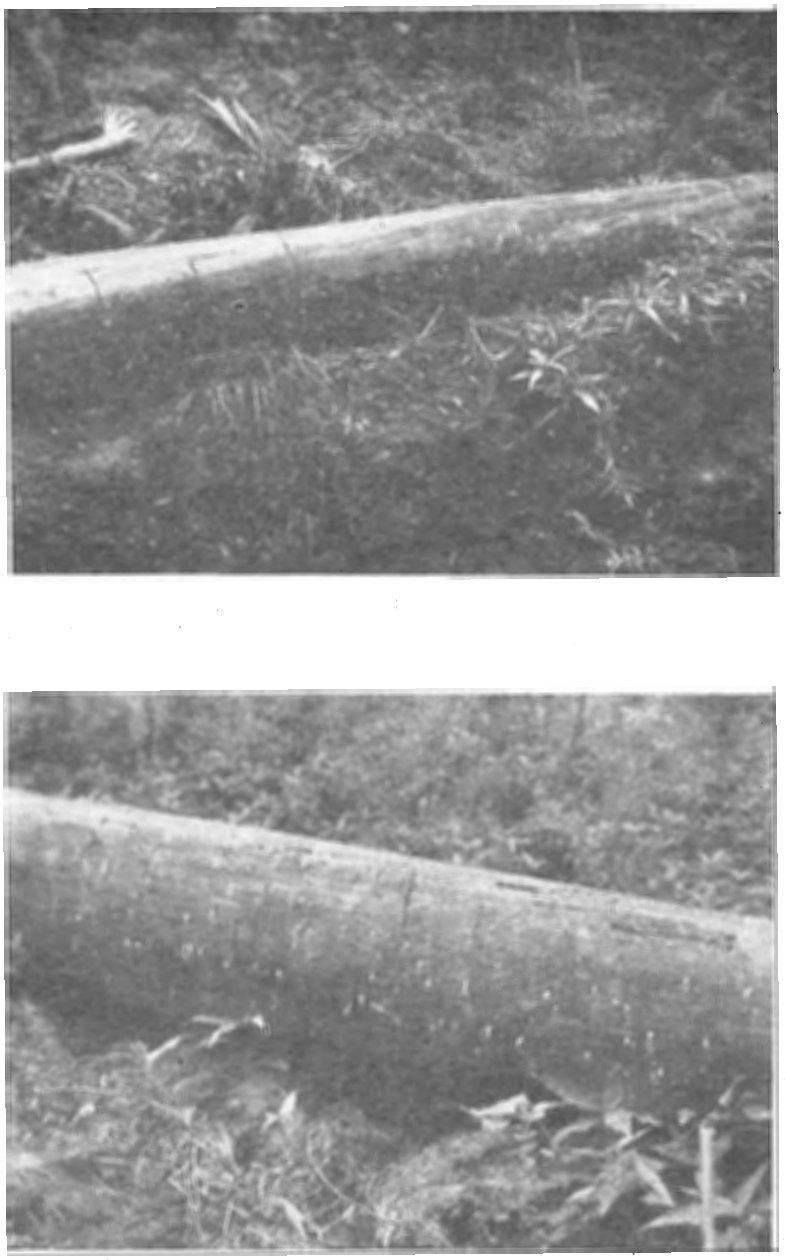


Fig. 5.

Borer Attacks on Hoop Pine Logs, Indicated by ''Threads'' from Tunnel Entrances.

A

B

Fig. 6.

A, ''Threads'' from Borer Attacks on the Sides and Under Surfaces of a Log; and B, Borer ''Dust'' of *Platypus froggatti* in an Angle between Bark and Wood.

amount of wood chewed away by this species, a large amount of dust accumulates below the entrance (Figure 8). The threads and accumulated dust provide obvious evidence of attacks.

Fungal growth, on which the larvae feed, lines the tunnel walls and sometimes may cause tunnel blockages. This material is at first of a greyish colour but later turns black, giving the characteristic shot-burn appearance to the tunnel walls, while mycelial penetration stains the adjacent wood a bluish colour.

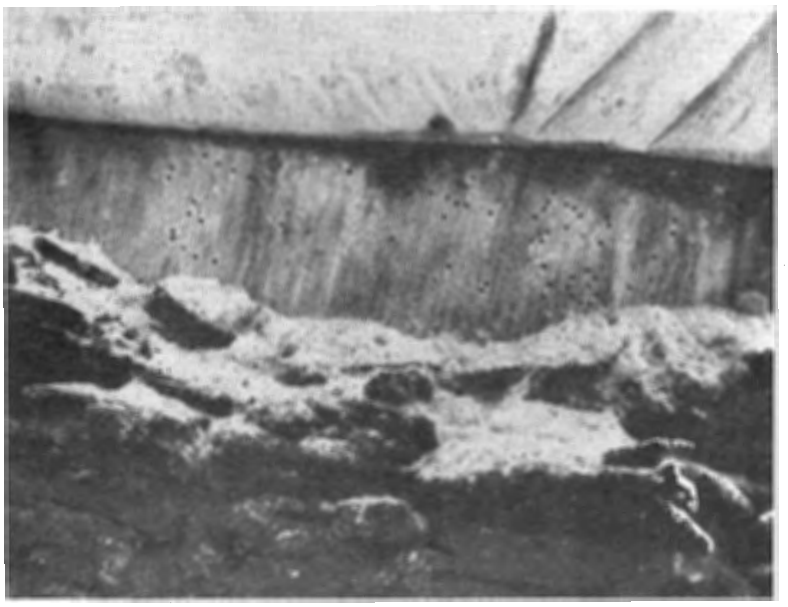
BREEDING SOURCES.

Breeding in virgin areas is restricted to decadent trees, suppressed branches and various injuries and is less with *P. froggatti* than with the other species.

Where logging operations are in progress suitable host material is provided in abundance. This includes hoop pine and many other tree species

Fig. 7.

End of a Hoop Pine Log, Indicating Width of Sapwood.



A

B

Fig. 8.

A, Borer "Dust" from Tunnels of *Platypus froggatti*; and B, Transverse Section of Log, showing Tunnels of *Platypus froggatti*.

smashed or bruised by the falling pine trees (Figure 9). Breeding is thus favoured and gains impetus, so in a year or two from the commencement of logging the beetle population becomes high.

Fig. 9.
Damage to Stand and Canopy by Felling Operations.

Logging of hoop pine gives particular impetus to the breeding of *P. froggatti*. As attacks by the other borers are normally spread over many hosts it may be expected that *P. froggatti* will dominate in attacks on hoop pine logs felled in or adjacent to cut-over areas. In virgin areas, on the other hand, where breeding of *P. froggatti* is restricted, the other borer species should dominate.

SEASONAL ACTIVITY.

While detailed quantitative investigations on beetle populations and activity have not been made, experience has shown that there are definite seasonal variations. Both cold weather and dry weather are unfavourable. The

former directly limits activity and logs felled during the winter months are not attacked. Dry weather in the warmer months restricts the period or radius of chemotropic attraction or tends to confine the beetles within the original host tissue and attacks on fresh logs are negligible. Isolated storm rains in early summer stimulate activity for short periods. However, with the onset of more frequent rain in summer or early autumn moist conditions obtain for several months. The chemotropic attraction then is great; further, the beetles are either directly or indirectly stimulated to emerge from old host tissues and seek new ones. Consequently there is continuous activity amongst a large free-living borer population and logs felled in this period may be subjected to heavy attacks.

CONDITIONS IN THE EXPERIMENTAL AREA.

The experimental area was located on State Forest Reserve 399, Parish of Emu Vale, 25 miles east of Warwick. This reserve extends over a large area of precipitous country on the western watershed of the Great Dividing Range, covering the sources of the Condamine River and many of its tributaries. Numerous ravines and valleys extend well into the range and the intervening spurs lead back to mountain peaks over 4,000 feet high. Rainfall is comparatively high and is estimated to be double the recorded annual average of 28 inches at Killarney, on the foothills of the western slope.

The more readily accessible timber in the lower reaches of the valleys had previously been cut. Access to the timber being harvested was by zigzagging tracks along the watercourses. Logging operations, especially haulage, were therefore intimately related to climatic conditions.

At the time of this investigation, hoop pine was the only species being harvested. Logs felled near the beds of the valleys were barked and remained at the stump until snigged to forest ramps. The commercial boles of trees felled on the higher slopes were "shot" into the valleys after barking, and there cut into log lengths (Figure 10) before being snigged to the ramps.

Logging operations were of necessity carried out mostly in limited periods determined by rainfall. In spite of difficulties, operations continued reasonably well for eight or nine months of the year. During the remaining months, usually in late summer and early autumn, persistent rain frequently made the forest inaccessible. Consequently it was usual to increase logging operations prior to this period so as to provide a reserve of logs for continuous milling operations during the wet weather.

The onset of the wet season is irregular and unpredictable, and when it commenced early large quantities of logs remained sometimes for many months on the forest floor, or on ramps. Borer attacks then became concentrated on the logs, more particularly on those near previously logged areas.

The essential part of the investigations, therefore, was to devise a means of protection for the logs against borer attacks especially applicable to those likely to be confined to the forest during wet weather.

Fig. 10.

Boles Cut into Logs after being "Shot" into the Valley during Logging Operations in the Cryptocarya Creek Area.

Fig. 11.

Experimental Logs in the Crypt:carya Creek Area strewn along the Valley.

CONTROL EXPERIMENTS.

Trial Sites.

Control experiments were established on two sites, in the Menura Creek and Cryptocarya Creek areas. The Menura Creek site was on comparatively even ground adjacent to a cut-over area. Because of proximity to water and snigging tracks, the logs were treated where they fell. The Cryptocarya Creek site was part of a virgin stand. After the boles were "shot" and cut, the logs, strewn along the bed of the valley, were treated there (Figure 11).

Log Material.

As far as was possible, small mill logs were used. These allowed sufficient surface area without involving a large volume in the event of wastage occurring. A few were of ply quality, but most were graded "logs" and "tops." In all, 33 trees were felled, providing 127 logs which gave 44,563 super. feet of timber and 11,697 square feet of log surface.

Chemicals Used.

Since the borer species encountered do not consume wood particles, the materials selected were designed to act mainly as repellants and deterrents. They were applied as solutions soon after felling and barking of the logs.

With the work of Craighead (1922) as a guide, interest was centred on creosote. This was used alone and with diluents and other chemicals as indicated by the results of prior laboratory mixing tests. The diluents and some other non-creosote materials were included as treatments for comparative purposes. The various materials used are detailed later.

Methods and Rates of Application.

All treatments, except when applied as bands, were made with a knapsack spray pump, the logs being rolled to ensure a cover on all surfaces. An arbitrary rate of one gallon to 125-150 square feet of log surface was chosen as providing a liberal application and was adopted as the standard for this investigation. In practice this rate was reached when the solution commenced to run and drip from the log. The treatments were randomized and most had five replications.

Assessment of Protection.

Assessment of log protection was determined from a count of all borer entrance holes appearing on the logs after treatment. At the same time the borer species operating on each log were noted and an estimate made of relative abundance. (See Appendix 1.) For comparative purposes the following ratings were used to evaluate borer attacks.

No attack—no borer holes.
Slight attack—1 to 5 holes per 100 sq. ft. of log surface.
Light attack—6 to 20 holes per 100 sq. ft. of log surface.
Moderate attack—21 to 50 holes per 100 sq. ft. of log surface.
Heavy attack—more than 50 holes per 100 sq. ft. of log surface.

This is a severe rating. It was chosen partly because the borers can make extensive tunnel systems within the log. The main reasons, however, were to impose a high degree of protection and to obtain a critical division between treatments without using an unmanageable number of replicates.

The position of attack on the logs was determined by dividing the circumference into five sectors, as follows:—"a," the under surface; "e," the upper surface; "b," "c" and "d," the intervening side surfaces. (Discussion given in Appendix 2.)

FIRST EXPERIMENT.

Menura Creek Site.

Felling on the Menura Creek site commenced on January 11 and extended to the next day. Ten trees provided the 33 logs used. This involved a total of 9,472 super. feet of timber and 2,785 square feet of log surface; the logs therefore averaged 287·0 super. feet and 84·4 square feet of surface area. Treatments were applied mainly on the day of felling, and not later than the following day. Details of log dimensions and dates of felling are given in Table 1.

Table 1.

DATA ON LOGS AND TREATMENTS ON THE MENURA CREEK SITE.

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 1—Creosote Emulsion.									
3 ..	16	58	280	80·8	3	11–1–39	11–1–39		
5 ..	16	46	176	63·6	2	11–1–39	11–1–39		
10 ..	14	61	271	75·2	1	12–1–39	12–1–39	3	140
14 ..	15	74	428	98·8	1	12–1–39	12–1–39		
19 ..	22	53	322	100·2	3	12–1–39	12–1–39		
Total	..	..	1,477	418·6	..	..	..	..	..
Mean	16·6	58·4	295·4	83·7	..	..	..	..	..
Treatment 2—Creosote and Kerosene.									
8 ..	20	45	211	77·3	2	11–1–39	11–1–39		
12 ..	19	50	247	81·8	3	11–1–39	11–1–39		
16 ..	20	62	400	107·3	3	12–1–39	12–1–39	3	151
21 ..	16	68	385	95·7	1	12–1–39	12–1–39		
25 ..	16	65	352	91·2	2	12–1–39	12–1–39		
Total	..	..	1,595	453·3	..	..	..	..	..
Mean	18·2	58·0	319·0	90·7	..	..	..	..	..
Treatment 3—Creosote and "Lignasan."									
2 ..	16	65	352	91·2	2	11–1–39	11–1–39		
4 ..	15	54	228	70·6	1	11–1–39	11–1–39		
9 ..	19	38	143	55·2	3	11–1–39	12–1–39	3	134
15 ..	13	71	341	82·6	2	12–1–39	12–1–39		
20 ..	20	59	363	102·3	2	12–1–39	12–1–39		
Total	..	..	1,427	401·9	..	..	..	..	..
Mean	16·6	57·4	285·4	80·4	..	..	..	..	..

Table 1.—*continued.*

DATA ON LOGS AND TREATMENTS ON THE MENURA CREEK SITE—*continued.*

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 4—Creosote and "Dowicide G."									
7 ..	17	51	230	75·3	1	11–1–39	11–1–39		
11 ..	16	57	271	79·5	2	11–1–39	11–1–39		
22 ..	20	56	327	96·8	2	12–1–39	12–1–39	3	147
26 ..	19	56	310	92·2	3	12–1–39	12–1–39		
28 ..	18	62	360	96·8	1	12–1–39	12–1–39		
Total ..	..	..	1,498	440·6	..	..	..	..	..
Mean	18·0	56·4	299·6	88·1	..	..	..	..	..
Treatment 5—Creosote (Standard Rate).									
23 ..	19	48	228	78·7	3	12–1–39	12–1–39		
29 ..	20	55	315	95·2	2	12–1–39	12–1–39	$1\frac{3}{4}$	139
31 ..	14	57	237	70·0	1	12–1–39	12–1–39		
Total ..	..	..	780	243·9	..	..	..	..	..
Mean	17·7	53·3	260·0	81·3	..	..	..	..	..
Treatment 6—Creosote (One-fifth Standard Rate).									
24 ..	15	76	451	101·3	1	12–1–39	12–1–39		
30 ..	22	43	212	80·7	3	12–1–39	12–1–39	$\frac{2}{5}$	670
32 ..	20	50	260	86·0	2	12–1–39	12–1–39		
Total ..	..	..	923	268·0	..	..	..	..	..
Mean	19·0	56·3	307·7	89·3	..	..	..	..	..
Treatment 7—Creosote Bands.									
13 ..	24	42	221	85·9	4	11–1–39	12–1–39		
17 ..	22	57	372	108·0	4	12–1–39	12–1–39	$\frac{1}{4}$	..
Total ..	..	..	593	193·9	..	..	..	..	..
Mean	23·0	49·5	296·5	96·9	..	..	..	..	..
Treatment 8—Untreated.									
1 ..	14	70	357	87·3	1	11–1–39	..	..	..
6 ..	17	40	142	58·5	3	11–1–39	..	..	..
18 ..	14	64	299	79·2	1	12–1–39	..	..	..
27 ..	20	46	220	78·9	4	12–1–39	..	..	..
33 ..	16	44	161	60·9	3	12–1–39	..	..	..
Total ..	..	..	1,179	364·8	..	..	..	..	..
Mean	16·2	52·8	235·8	73·0	..	..	..	..	..

All treatments in this trial included creosote grade K55 Standard of the Standards Association of Australia and were as follows:—

1. Creosote emulsion (1 gal. creosote, 1 lb. soft soap, 4 gal. water).
2. Creosote and Kerosene (1 gal. creosote, 4 gal. kerosene).
3. Creosote and "Lignasan" (1 gal. creosote, 1 lb. soft soap, 2 oz. "Lignasan," 4 gal. water).
4. Creosote and "Dowicide G" (1 gal. creosote, 1 lb. soft soap, 2½ oz. "Dowicide G," 4 gal. water).
5. Creosote alone (standard rate).
6. Creosote alone (one-fifth of standard rate).
7. Creosote alone, applied in bands.
8. Untreated.

Treatments of creosote mixed with other materials were applied at the standard rate. Creosote alone, as a complete cover, was used at two different rates—standard and one-fifth standard. The latter gave a creosote cover comparable to the creosote component of the mixed solutions. All sprays readily adhered to the fresh log surface. The creosote bands around the circumference of the logs were six inches wide and spaced at intervals varying from one to four feet. Treatments and rates of application are shown in Table 1.

Cryptocarya Creek Site.

Felling on the Cryptocarya Creek site commenced also on January 11 and continued until January 16. Eleven trees provided the 42 logs. These involved a total of 18,155 super. feet of timber and 4,262 square feet of log surface; the logs therefore averaged 432·3 super. feet content and 106·2 square feet of surface area. Treatments in some instances were made on the day of felling, some on the following day and a few on the second day after felling. Details of log dimensions and dates of felling are given in Table 2.

The spray solutions in this trial included some of the diluents of creosote used in the Menura Creek trial, and other solutions of prior unknown value as log protectants against borer attacks.

The treatments were as follows:—

9. White oil and nicotine sulphate (1 gal. white oil, 1 pint nicotine sulphate, 20 gal. water).
10. Red oil (1 gal. red oil, 20 gal. water).
11. Washing soda solution (1 lb. washing soda, 1 gal. water).
12. "Borokil."
13. Resin-caustic soda-fish oil (10 lb. resin, 3 lb. caustic soda, 1½ lb. fish oil, 20 gal. water).
14. Kerosene.
15. Soft soap solution (1 lb. soft soap, 4 gal. water).
16. "Du Pont Le 5" (1 lb. "Du Pont Le 5," 16 gal. water).
17. "Du Pont Le 6" (1 lb. "Du Pont Le 6," 16 gal. water).
18. Untreated.

Some of these solutions were used with the idea that the oil or other constituent might repel the borers or mask attraction, or that the alkalinity might change the log surface and render it unattractive.

The materials used in treatments 12, 13, 14, 16 and 17 adhered to the fresh log surface reasonably well, and one application was sufficient to give a uniform distribution. Adherence was poor with treatments 9, 10, 11 and 15; run-off was excessive with one application and therefore two successive light applications were made. Most of these solutions were applied at a rate within the range of the standard, the upper area limit being slightly exceeded with kerosene and the soft soap solution. Treatments and rates of application are given in Table 2.

Table 2.

DATA ON LOGS AND TREATMENTS ON THE CRYPTOCARYA CREEK SITE.

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 9—White Oil and Nicotine Sulphate.									
34 ..	14	57	237	70·0	1	11–1–39	13–1–39		
42 ..	14	101	744	126·9	2	12–1–39	13–1–39		
51 ..	14	74	399	92·6	2	11–1–39	13–1–39	4½	127
62 ..	20	88	807	155·0	2	12–1–39	13–1–39		
64 ..	15	93	676	126·0	1	12–1–39	14–1–39		
Total	..	..	2,863	570·5	..	..	..	..	..
Mean	15·4	82·6	572·6	114·1	..	..	..	..	..
Treatment 10—Red Oil.									
35 ..	14	53	205	64·9	2	11–1–39	13–1–39		
41 ..	14	105	804	134·8	1	12–1–39	13–1–39		
49 ..	13	49	163	55·8	4	11–1–39	13–1–39	3	128
54 ..	14	54	213	66·0	4	11–1–39	13–1–39		
60 ..	13	55	205	63·2	5	11–1–39	13–1–39		
Total	..	..	1,590	384·7	..	..	..	..	..
Mean	13·6	63·2	318·0	76·9	..	..	..	..	..
Treatment 11—Washing Soda Solution.									
46 ..	14	70	357	87·3	1	11–1–39	14–1–39		
55 ..	18	47	207	69·8	5	11–1–39	14–1–39		
58 ..	14	77	432	96·1	3	11–1–39	14–1–39	3½	134
61 ..	14	95	658	120·7	1	12–1–39	14–1–39		
70 ..	18	61	349	95·5	3	16–1–39	16–1–39		
Total	..	..	2,003	469·4	..	..	..	..	..
Mean	15·6	70·0	400·6	93·9	..	..	..	..	..
Treatment 12—"Borokil."									
45 ..	15	89	619	120·3	5	12–1–39	14–1–39		
53 ..	14	59	254	72·8	3	11–1–39	14–1–39	2	145
56 ..	14	78	444	97·9	1	11–1–39	14–1–39		
Total	..	..	1,317	291·0	..	..	..	..	..
Mean	14·3	75·3	439·0	97·0	..	..	..	..	..

Table 2—continued.

DATA ON LOGS AND TREATMENTS ON THE CRYPTOCARYA CREEK SITE.

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 13—Resin-Caustic Soda-Fish Oil.									
36 ..	14	48	168	58·7	3	11–1–39	13–1–39	2	131
38 ..	20	48	240	82·7	1	11–1–39	13–1–39		
43 ..	14	95	658	120·7	3	12–1–39	13–1–39		
Total	..	..	1,066	262·1	..	..	..	..	..
Mean	16·0	63·7	355·3	87·4	..	..	..	..	..
Treatment 14—Kerosene.									
37 ..	20	43	193	73·6	4	11–1–39	13–1–39	1½	166
39 ..	14	39	111	46·8	2	11–1–39	13–1–39		
44 ..	16	91	690	128·0	4	12–1–39	13–1–39		
Total	..	..	994	248·4	..	..	..	..	..
Mean	16·7	57·7	331·3	82·8	..	..	..	..	..
Treatment 15—Soft Soap Solution.									
50 ..	13	44	131	49·9	5	11–1–39	14–1–39	1½	156
59 ..	13	59	236	67·9	4	11–1–39	14–1–39		
63 ..	16	82	560	116·9	3	12–1–39	14–1–39		
Total	..	..	927	234·7	..	..	..	..	..
Mean	14·0	61·7	309·0	78·2	..	..	..	..	..
Treatment 16—"Du Pont Le 5."									
48 ..	14	56	229	68·8	3	11–1–39	14–1–39	4½	142
65 ..	15	89	619	120·3	2	12–1–39	14–1–39		
68 ..	26	79	845	178·3	1	16–1–39	16–1–39		
73 ..	22	61	426	115·9	2	16–1–39	16–1–39		
75 ..	24	71	630	157·7	1	16–1–39	16–1–39		
Total	..	..	2,749	641·0	..	..	..	..	..
Mean	20·2	71·2	549·8	128·2	..	..	..	..	..
Treatment 17—"Du Pont Le 6."									
47 ..	14	62	280	76·3	2	11–1–39	14–1–39	5	136
66 ..	20	80	667	140·2	3	12–1–39	14–1–39		
69 ..	25	75	732	162·6	2	16–1–39	16–1–39		
72 ..	27	75	791	175·1	1	16–1–39	16–1–39		
76 ..	23	63	475	125·3	2	16–1–39	16–1–39		
Total	..	..	2,945	679·5	..	..	..	..	..
Mean	21·8	71·0	589·0	135·9	..	..	..	..	..
Treatment 18—Untreated.									
52 ..	14	64	299	79·2	2	11–1–39			
67 ..	17	75	498	112·6	4	12–1–39			
71 ..	17	52	239	76·8	4	16–1–39			
74 ..	28	49	350	117·0	3	16–1–39			
77 ..	20	55	315	95·2	3	16–1–39			
Total	..	..	1,701	480·8	..	..	..	..	..
Mean	19·2	59·0	340·2	96·2	..	..	..	..	..

First Examination on the Menura Creek Site.

The weather experienced while the various treatments on the Menura Creek site were applied was hot and dry. This was not conducive to borer activity and while these conditions continued there was little evidence of attacks even on untreated logs. Following about an inch of rain during the early morning of January 18, increased borer activity was evident immediately, and by the next day progress observations on borer attacks on the experimental logs were possible. At this time all borer holes were not counted and the attacks were determined by inspection. Results are given in Table 3.

Table 3.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE. (SEVEN TO EIGHT DAYS AFTER TREATMENT AND TWO DAYS AFTER RAIN.)

Log No.	Attack Rating.	Log No.	Attack Rating.
Treatment 1— *Creosote Emulsion.*		*Treatment* 2— *Creosote and Kerosene*—	
3	Slight	8	Slight
5	Nil	12	Nil
10	Nil	16	Nil
14	Nil	21	Nil
19	Nil	25	Slight
Treatment 3— *Creosote and "Lignasan"*		*Treatment* 4— *Creosote and "Dowicide G"*	
2	Moderate	7	Slight
4	Nil	11	Slight
9	Slight	22	Slight
15	Light	26	Nil
20	Light	28	Nil
Treatment 5— *Creosote alone (standard rate)*		*Treatment* 6— *Creosote alone (one-fifth standard rate)*	
23	Nil	24	Nil
29	Nil	30	Nil
31	Nil	32	Nil
Treatment 7— *Creosote Bands*		*Treatment* 8— *Untreated*	
13	Slight in 4 feet spacings, but as close as 6 inches from a band	1	Moderate
17		6	Slight
		18	Moderate
		27	Heavy
		33	Moderate

Second Examination on the Menura Creek Site.

During the three-weeks period after the first examination further rain fell, providing a continuation of conditions favourable to borer activity. Attacks were intensified and a full count was made on February 8 (i.e., four weeks after the treatments were applied). The results are detailed in Table 4.

Table 4.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE.
(FOUR WEEKS AFTER TREATMENT.)

Log No.	Borer Species.	Position of Attack.	Number of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
Treatment 1—Creosote Emulsion.					
3	1	a, b	18	0·22	Moderate
5	1, 2	a, b	47	0·74	Heavy
10	1	a	4	0·05	Slight
14	..	..	0	0·00	Nil
19	1	a, b	5	0·05	Slight
Treatment 2—Creosote and Kerosene.					
8	1, 2, 3	a, b, c	53	0·69	Heavy
12	1	a, b, c	14	0·17	Light
16	1	a, b, c	15	0·14	Light
21	1, 2	a, b, c	14	0·25	Moderate
25	1	a, b, c	9	0·10	Light
Treatment 3—Creosote and "Lignasan."					
2	1, 2	a, b	65	0·71	Heavy
4	1, 2	a, b	8	0·11	Light
9	1, 2	a, b, c	16	0·29	Moderate
15	1, 2, 3	a, b, c	32	0·39	Moderate
20	1, 2, 3	a, b, c	59	0·58	Heavy
Treatment 4—Creosote and "Dowicide G."					
7	1, 2, 3	a, b, c	58	0·77	Heavy
11	1, 2, 3	a, b, c	39	0·49	Moderate
22	1, 2	b, c	34	0·35	Moderate
26	1, 2	a, b, c	35	0·38	Moderate
28	1	b	4	0·04	Slight
Treatment 5—Creosote (Standard Rate).					
23	..	..	0	0·00	Nil
29	..	..	0	0·00	Nil
31	..	..	0	0·00	Nil
Treatment 6—Creosote (One-fifth Standard Rate).					
24	..	..	0	0·00	Nil
30	1	b	2	0·03	Slight
32	..	..	0	0·00	Nil
Treatment 7—Creosote Bands.					
13	1, 2, 3	a, b, c	..	..	Heavy*
17	1, 2	a, b, c	..	..	Moderate*
Treatment 8—Untreated.					
1	1, 2, 3	a, b, c, d, e	193	2·21	Heavy
6	1, 2, 3	a, b, c, d, e	120	2·05	Heavy
18	1, 2, 3	a, b, c	230	2·90	Heavy
27	1, 2, 3	a, b, c	175	2·22	Heavy
33	1, 2, 3	a, b, c	187	3·07	Heavy

* Attacks occurred on exposed wood between all bands.

Analysis.

Necessary difference for significance = ·413 (5 per cent. level); ·563 (1 per cent. level)

Treatment.	Mean.	Significantly less at 1 per cent. Level than—
1	0·212	8
2	0·270	8
3	0·416	8
4	0·406	8
8	2·490	..
5	0·000	3, 4, 8
6	0·010	3, 4, 8

5 and 6 are not included in general analysis, because of low variability.

It was noted that three species were operating. These are referred to in Table 4 by numbers as follows:—1. *P. froggatti;* 2. *P. australis;* and 3. *C. omnivorus.* It was shown later that other species attacked logs on the Menura Creek site. While these possibly were present at this examination, they were not detected.

Third Examination on the Menura Creek Site.

As certain of the creosote treatments were promising, the logs concerned were allowed to remain in the forest. Humid weather continued, but rain prevented further examination until March 21 (i.e., 10 weeks after the treatments were applied). The results of this examination are given in Table 5.

Table 5.

ASSESSMENT OF BORER ATTACKS ON SOME CREOSOTED LOGS ON THE MENURA CREEK SITE. (TEN WEEKS AFTER TREATMENT.)

Log No.	Borer Species.	Position of Attack.	Number of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
Treatment 5—Creosote Alone (Standard Rate).					
23	1	a	3	0·04	Slight
29	..	..	0	0·00	Nil
31	..	..	0	0·00	Nil
Treatment 6—Creosote Alone (One-fifth Standard Rate).					
24	1, 2	a, b	12	0·12	Light
30	1	b	9	0·11	Light
32	1	a	4	0·05	Slight

Examination of Logs on the Cryptocarya Creek Site.

An examination of logs on the Cryptocarya Creek site was made on February 9, four weeks after the treatments were applied. The results obtained are given in Table 6. These logs were in a virgin stand and a

greater number of borer species was present than was shown on the Menura Creek site. The species are referred to in the table as follows:—1. *P. froggatti;* 2. *P. australis;* 3. *C. omnivorus;* 4. *P. semigranosus* and *P. subgranosus;* 5. *X. perforans* and *X. eucalypticus.*

Table 6.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE CRYPTOCARYA CREEK SITE.
(FOUR WEEKS AFTER TREATMENT.)

Log No.	Borer Species.	Position of Attack.	Number of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
Treatment 9—White Oil and Nicotine Sulphate.					
34	..	..	0	0·00	Nil
42	3, 4, 5	b, c, d, e	20	0·16	Light
57	3	b	4	0·04	Slight
62	2, 3, 4, 5	b, c, d	32	0·21	Moderate
64	2, 3, 4, 5	c, d	19	0·15	Light
Treatment 10—Red Oil.					
35	3, 4, 5	b, c, d, e	13	0·20	Light
41	3, 4	b, c	5	0·04	Slight
49	..	..	0	0·00	Nil
54	..	..	0	0·00	Nil
60	3	b	2	0·03	Slight
Treatment 11—Washing Soda Solution.					
46	3, 4, 5	c, d	11	0·13	Light
55	3, 4, 5	a, b, c	40	0·57	Heavy
58	3, 4, 5	c, d, e	0	0·09	Light
61	3, 4, 5	b, c, d	125	1·04	Heavy
70	3, 5	b, c, d	15	0·16	Light
Treatment 12—"Borokil."					
45	3, 4, 5	b, c, d	15	0·13	Light
53	3	c	12	0·17	Light
56	3, 4, 5	b, c, d, e	41	0·42	Moderate
Treatment 13—Resin-Caustic Soda-Fish Oil.					
36	3, 4, 5	b, c, d	8	0·14	Light
38	3	b	2	0·02	Slight
43	3, 4, 5	a, b, c	40	0·33	Moderate
Treatment 14—Kerosene.					
37	3, 4, 5	b, c, d	35	0·48	Moderate
39	3, 5	c	3	0·06	Light
44	3, 4, 5	a, b, c, d	120	0·94	Heavy

Table 6—continued.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE CRYPTOCARYA CREEK SITE.
(FOUR WEEKS AFTER TREATMENT.)

Log No.	Borer Species.	Position of Attack.	Number of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
Treatment 15—*Soap Solution.*					
50	3	c	1	0·02	Slight
59	3	b, c	3	0·04	Slight
63	2, 3, 4, 5	b, c, d, e	93	0·80	Heavy
Treatment 16—"*Du Pont Le* 5."					
48	3	c	2	0·03	Slight
65	1, 2, 3	a, b, c	32	0·27	Moderate
68	3, 5	b, c, d	28	0·16	Light
73	3, 4, 5	b, c, d	23	0·20	Light
75	3	c, d, e	11	0·07	Light
Treatment 17—"*Du Pont Le* 6."					
47	3, 4	b, c	13	0·17	Light
66	1, 2, 3	a, b, c	52	0·37	Moderate
69	3, 4	b, c, d	27	0·17	Light
72	3, 4, 5	b, c, d, e	51	0·29	Moderate
76	3, 4	a, b, c, d	11	0·09	Light
Treatment 18—*Untreated.*					
52	3, 4	a, b, c	84	1·06	Heavy
67	1, 2, 3	a, b, c, d, e	205	1·82	Heavy
71	3, 4	b, c, d	21	0·27	Moderate
74	3, 4, 5,	b, c, d, e	176	1·50	Heavy
77	3, 4	b, c	59	0·62	Heavy

Analysis.

Necessary difference for significance—

	5% Level.	1 % Level.
5 v 5	·413	·555
5 v 3	·476	·641
3 v 3	·533	·716

Treatment.	Replicates.	Mean.	Significance.
9	5	0·112	
10	5	0·054	14 significantly less than 18 at the 5 per cent. level. All other treatments significantly less than 18 at the 1 per cent. level
11	5	0·398	
12	3	0·240	
13	3	0·163	
14	3	0·493	
15	3	0·287	
16	5	0·146	
17	5	0·218	
18	5	1·054	

SECOND EXPERIMENT.

Menura Creek Site.

As weather conditions continued to be favourable to borer activity a second experiment was commenced immediately to confirm the results of the promising treatments in the first experiment and to test certain variations. This work was carried out in the Menura Creek area partly on and partly adjacent to the site of the first experiment, so that borer populations present would provide a severe test for the treatments.

Felling commenced on February 15 and was completed two days later. Twelve trees provided 52 logs. These involved 16,936 super. feet of timber and 4,650 square feet of log surface, with an average content of 325·7 super. feet and an average surface area of 89·4 square feet. Log dimensions and dates of felling are given in Table 7.

The treatments used in this experiment were as follows:—

19. Creosote alone (standard rate).
20. Creosote alone (one-fifth standard rate).
21. Cresote alone (one-third standard rate).
22. Creosote Emulsion (*a*) (1 gal. creosote, 1 lb. soft soap, 4 gal. water).
23. Creosote Emulsion (*b*) (1 gal. creosote, ½ lb. soft soap, 2 gal. water).
24. Creosote and Kerosene (1 gal. creosote, 2 gal. kerosene).
25. Creosote and "Lignasan" (1 gal. creosote, ½ lb. soft soap, 1⅕ oz. "Lignasan," 2 gal. water).
26. Cresote and "Dowicide G" (1 gal. cresote, ½ lb. soft soap, 1½ oz. "Dowicide G," 2 gal. water).
27. "Du Pont Le 5" (standard rate).
28. "Du Pont Le 6" (standard rate).
29. Red Oil (standard rate).
30. Untreated.

Creosote alone was used at three different rates. Two of the rates were comparable to those used in the first experiment; the third was intermediate and intended to approximate the cover rate of that proportion of creosote in the mixtures with kerosene, "Lignasan," "Dowicide G" and Creosote Emulsion (*b*).

All logs were treated at the stump, the treatments being applied in the same manner and mostly at the same general rate as in the first experiment. Some treatments were made on the day of felling, others on the following day. The treatments and rates of application are given in Table 7.

Table 7.

DATA ON LOGS AND TREATMENTS ON THE MENURA CREEK SITE (SECOND EXPERIMENT).

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 19—Creosote (a).									
89 ..	14	59	254	72·8	1	15–2–39	16–2–39		
93 ..	16	74	456	105·0	2	16–2–39	16–2–39		
98 ..	15	66	340	87·6	2	16–2–39	16–2–39	$3\frac{1}{4}$	134
103 ..	14	68	337	84·4	3	16–2–39	16–2–39		
107 ..	14	68	337	84·4	2	16–2–39	16–2–39		
Total	..	..	1,724	434·2	..	..	..	..	..
Mean	14·6	67·0	344·8	86·8	..	..	..	..	..
Treatment 20—Creosote (One-fifth Standard Rate).									
90 ..	18	52	253	81·1	2	15–2–39	16–2–39		
96 ..	22	51	298	96·6	5	16–2–39	16–2–39		
97 ..	14	70	357	87·3	1	16–2–39	16–2–39	App. $\frac{3}{4}$	Approx. 600
102 ..	14	73	388	90·8	2	16–2–39	16–2–39		
106 ..	14	73	388	90·8	1	16–2–39	16–2–39		
Total	..	..	1,684	446·6	..	..	..	..	..
Mean	16·4	63·8	336·8	89·3	..	..	..	..	..
Treatment 21—Creosote (One-third Standard Rate).									
78 ..	14	59	254	72·8	1	15–2–39	16–2–39		
83 ..	14	55	220	67·7	2	15–2–39	16–2–39		
86 ..	15	55	236	72·3	1	15–2–39	16–2–39	App. $1\frac{1}{8}$	Approx. 380
92 ..	13	78	412	91·4	1	16–2–39	16–2–39		
100 ..	29	51	393	126·3	4	16–2–39	16–2–39		
Total	..	..	1,515	430·5	..	..	..	..	..
Mean	17·0	59·6	303·0	86·1	..	..	..	..	..
Treatment 22—Creosote Emulsion (a).									
80 ..	26	40	217	88·6	3	15–2–39	15–2–39		
84 ..	18	50	234	77·6	3	15–2–39	15–2–39	App. 2	Approx. 130
88 ..	21	41	184	73·6	3	15–2–39	15–2–39		
Total	..	..	635	239·8	..	..	..	..	..
Mean	21·7	43·7	211·7	79·9	..	..	..	..	..
Treatment 23—Creosote Emulsion (b).									
79 ..	14	56	229	68·9	2	15–2–39	15–2–39		
82 ..	15	59	272	77·8	1	15–2–39	15–2–39		
87 ..	18	47	207	69·8	2	15–2–39	15–2–39	3	128
91 ..	20	46	220	78·9	3	15–2–39	16–2–39		
94 ..	15	66	340	87·6	3	16–2–39	16–2–39		
Total	..	..	1,268	383·0	..	..	..	..	..
Mean	16·4	54·8	253·6	76·6	..	..	..	..	..

Table 7—continued.

DATA ON LOGS AND TREATMENTS ON THE MENURA CREEK SITE (SECOND EXPERIMENT).

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 24—Creosote and Kerosene.									
99 ..	16	59	290	82·7	3	16–2–39	16–2–39		
101 ..	14	77	432	96·1	1	16–2–39	16–2–39		
108 ..	14	63	289	78·0	3	17–2–39	17–2–39	3½	131
115 ..	20	69	496	120·1	5	17–2–39	17–2–39		
120 ..	16	58	280	80·8	4	17–2–39	17–2–39		
Total	..	..	1,787	457·7	..	..	..	..	..
Mean	16·0	65·2	357·4	91·5	..	..	..	..	..
Treatment 25—Creosote and "Lignasan."									
95 ..	20	59	363	103·7	4	16–2–39	16–2–39		
105 ..	22	53	322	100·2	5	16–2–39	16–2–39		
109 ..	20	58	350	100·2	4	16–2–39	16–2–39	3½	138
112 ..	13	84	478	98·6	2	17–2–39	17–2–39		
119 ..	14	64	299	79·2	3	17–2–39	17–2–39		
Total	..	..	1,812	481·9	..	..	..	..	..
Mean	17·8	63·6	362·4	96·4	..	..	..	..	..
Treatment 26—Creosote and "Dowicide G."									
104 ..	21	62	420	112·5	4	16–2–39	17–2–39		
110 ..	20	50	260	86·0	5	16–2–39	17–2–39		
113 ..	14	79	455	99·1	3	17–2–39	17–2–39	3½	131
118 ..	14	68	337	84·4	2	17–2–39	17–2–39		
124 ..	15	57	254	74·8	4	17–2–39	17–2–39		
Total	..	..	1,726	456·8	..	..	..	..	..
Mean	16·8	63·2	345·2	91·4	..	..	..	..	..
Treatment 27—"Du Pont Le 5."									
117 ..	15	74	428	98·8	1	17–2–39	17–2–39		
123 ..	14	62	280	76·3	3	17–2–39	17–2–39	2¼	125
128 ..	20	62	400	107·3	3	17–2–39	17–2–39		
Total	..	..	1,108	282·4	..	..	..	..	..
Mean	16·3	66·0	369·3	94·1	..	..	..	..	..
Treatment 28—"Du Pont Le 6."									
114 ..	16	74	456	105·0	4	17–2–39	17–2–39		
121 ..	14	71	367	88·5	1	17–2–39	17–2–39	2¼	125
127 ..	14	70	357	87·3	2	17–2–39	17–2–39		
Total	..	..	1,180	280·8	..	..	..	..	..
Mean	14·7	71·7	393·3	93·6	..	..	..	..	..

Table 7—continued.

DATA ON LOGS AND TREATMENTS ON THE MENURA CREEK SITE (SECOND EXPERIMENT).

Log No.	Length.	Girth.	Timber Content.	Surface Area.	Position on Tree.	Date Felled.	Date Treated.	Quantity of Spray Used.	Surface Area per Gallon.
	Ft.	In.	Sup. Ft.	Sq. Ft.				Gal.	Sq. Ft.
Treatment 29—*Red Oil.*									
116 ..	30	58	526	148·5	6	17–2–39	17–2–39	$2\frac{3}{4}$	121
125 ..	20	51	271	88·1	5	17–2–39	17–2–39		
126 ..	14	76	421	94·9	1	17–2–39	17–2–39		
Total	..	..	1,218	331·5	..	..	..	..	..
Mean	21·3	61·7	406·0	110·5	..	..	..	..	..
Treatment 30—*Untreated.*									
81 ..	22	42	202	78·9	4	15–2–39	..	..	..
85 ..	22	46	242	86·6	4	15–2–39	..	..	..
111 ..	22	41	193	77·1	1	16–2–39	..	..	..
122 ..	14	66	318	82·1	2	17–2–39	..	..	..
129 ..	22	53	322	100·2	4	17–2–39	..	..	..
Total	..	..	1,277	424·9	..	..	..	..	..
Mean	20·4	49·6	255·4	85·0	..	..	..	..	..

First Examination.

Moist conditions were prevailing when this trial was started and further rain fell a few days after the applications were completed. Borer attacks readily developed and preliminary observations were made two weeks after treatment. The results are given in Table 8.

Table 8.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE. (SECOND EXPERIMENT).

(TWO WEEKS AFTER TREATMENT.)

Log No.	Attack Rating.	Log No.	Attack Rating.
Treatment 19— *Creosote* (*Standard Rate*)— No attack on any log		*Treatment* 20— *Creosote* (*One-fifth Standard Rate*)— No attack on any log	
Treatment 21— *Creosote* (*One-third Standard Rate*)— No attack on any log		*Treatment* 22— *Creosote and Kerosene*— No attack on any log	
Treatment 23— *Creosote Emulsion* (*a*)— No attack on any log		*Treatment* 24— *Creosote Emulsion* (*b*)— No attack on any log	

Table 8—continued.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE. (SECOND EXPERIMENT). (TWO WEEKS AFTER TREATMENT.)

Log No.	Attack Rating.	Log No.	Attack Rating.
Treatment 25— *Creosote and "Lignasan"*—		*Treatment* 26— *Creosote and "Dowicide G"*—	
95	Slight	104	Nil
105	Slight	110	Light
109	Light	113	Slight
112	Nil	118	Slight
119	Nil	124	Slight
Treatment 27— *"Du Pont Le 5"*—		*Treatment* 28— *"Du Pont Le 6"*—	
117	Nil	114	Slight
123	Light	121	Light
128	Nil	127	Slight
Treatment 29— *Red Oil*—		*Treatment* 30— *Untreated*—	
116	Nil	81	Nil
125	Light	85	Slight
126	Nil	111	Light
		122	Light
		129	Moderate

Second Examination.

Continued wet weather prevented a complete examination until March 30 (i.e., six weeks after the treatments were made). The results of this count are given in Table 9. It was shown that, in a few instances, particularly on untreated logs, all five species of borers recorded on the Cryptocarya Creek site were present. The reference numbers for these in Table 9 are the same as those used previously (page 92).

Table 9.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE (SECOND EXPERIMENT). (SIX WEEKS AFTER TREATMENT.)

Log No.	Borer Species.	Position of Attack.	No. of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
Treatment 19—*Creosote* (*Standard Rate*).					
89	1	*b*	5	0·07	Light
93	1	*b*	3	0·03	Slight
98	..	..	0	0·00	Nil
103	..	..	0	0·00	Nil
107	..	..	0	0·00	Nil

Table 9—continued.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE (SECOND EXPERIMENT). (SIX WEEKS AFTER TREATMENT.)

Log No.	Borer Species	Position of Attack.	Number of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
Treatment 20—Creosote (One-fifth Standard Rate).					
90	1, 3	b, c	28	0·35	Moderate
96	1, 3	b, c	10	0·10	Light
97	1	b	17	0·20	Light
102	1	b	5	0·05	Slight
106	1, 2	b, c	38	0·42	Moderate
Treatment 21—Creosote (One-third Standard Rate).					
78	..	..	0	0·00	Nil
83	1	b	4	0·06	Light
86	..	..	0	0·00	Nil
92	..	..	0	0·00	Nil
100	1, 3, 5	a, b, c	43	0·26	Moderate
Treatment 22—Creosote Emulsion (a).					
80	3	b	8	0·09	Light
84	1	a, b	13	0·17	Light
88	1	b	8	0·11	Light
Treatment 23—Creosote Emulsion (b).					
79	1	b	1	0·02	Slight
82	..	..	0	0·00	Nil
87	..	..	0	0·00	Nil
91	3	c	3	0·04	Slight
94	1	a, b	16	0·18	Light
Treatment 24—Creosote and Kerosene.					
99	1	b	7	0·09	Light
101	..	..	0	0·00	Nil
108	1, 3	a	5	0·06	Light
115	..	..	0	0·00	Nil
120	1	b	4	0·05	Slight
Treatment 25—Creosote and "Lignasan."					
95	1	a	43	0·42	Moderate
105	1	b	18	0·18	Light
109	1, 3	a, b, c	51	0·51	Heavy
112	1	b	12	0·12	Light
119	1	a, b	15	0·19	Light
Treatment 26—Creosote and "Dowicide G."					
104	1, 3, 5	a, b, c, d	125	1·11	Heavy
110	1, 2, 3	a, b, c	116	1·35	Heavy
113	1, 3, 4, 5	b, c, d, e	52	0·53	Heavy
118	1, 3	a, b	32	0·38	Moderate
124	1, 3	b, c, d	34	0·46	Moderate

Table 9—continued.

ASSESSMENT OF BORER ATTACKS ON LOGS ON THE MENURA CREEK SITE (SECOND EKPERIMENT). (SIX WEEKS AFTER TREATMENT.)

Log No.	Borer Species.	Position of Attack.	No. of Borer Holes.	Holes per Sq. Ft.	Attack Rating.
		Treatment 27—"*Du Pont Le* 5."			
117	1, 4	a, b, c	27	0·27	Moderate
123	1	b, c, d	41	0·54	Heavy
128	1, 3, 4	a, b, c, d, e	51	0·48	Moderate
		Treatment 28—"*Du Pont Le* 6."			
114	1	b, c, d	28	0·27	Moderate
121	1, 3, 4	a, b, c, d	87	0·95	Heavy
127	1	b, c	19	0·22	Moderate
		Treatment 29—*Red Oil.*			
116	1	b, c	19	0·13	Moderate
125	1, 3, 4	b, c, d	87	0·99	Heavy
126	1, 3, 4	a, b, c, d	105	1·11	Heavy
		Treatment 30—*Untreated.*			
81	1, 3, 4, 5	b, c, d, e	217	2·75	Heavy
85	1, 2, 3, 4, 5	a, b, c, d, e	198	2·18	Heavy
111	1, 2, 3, 4, 5	a, b, c, d, e	185	2·40	Heavy
122	1, 3, 4, 5	b, c, d, e	203	2·47	Heavy
129	1, 3, 5	b, c, d, e	254	2·54	Heavy

Analysis.

Necessary difference for significance—

	5% level.	1% level.
5 v 5	·300	·402
5 v 3	·347	·464
3 v 3	·388	·519

Treatment.	Replicates.	Mean.	Significantly less than—	
			5 % Level.	1 % Level.
19	5	0·020	26, 27, 28, 29, 30	26, 28, 29, 30
20	5	0·224	26, 29, 30	26, 29, 30
21	5	0·064	26, 27, 28, 29, 30	26, 29, 30
22	3	0·123	26, 29, 30	26, 29, 30
23	5	0·048	26, 27, 28, 29, 30	26, 29, 30
24	5	0·040	26, 27, 28, 29, 30	26, 29, 30
25	5	0·284	26, 29, 30	26, 30
26	5	0·766	30	30
27	3	0·430	30	30
28	3	0·490	30	30
29	3	0·743	30	30
30	5	2·468	..	..

DISCUSSION.

All non-creosote treatments reduced the intensity of borer attacks but the best of them was significantly inferior to creosote. Materials mixed with creosote in themselves added nothing to the value of the creosote; in fact, "Dowicide G" and "Lignasan" decreased its value.

Creosote diluted with soap solution, in the proportion of 1 to 2, provided an economic control. However, preparing the hot soap solution required for thorough emulsification places a limitation on the general use of the mixture in the forest. Creosote diluted with kerosene, in the proportion of 1 to 2, also provided an economic control, which was readily usable in the forest.

Creosote used alone at a rate of distribution comparable to that proportion of it in the emulsion or kerosene mixture was as effective as the mixed treatments. At the rate of 1 gal. to 140 sq. ft. of log surface it gave virtually complete protection for 10 weeks. However, creosote bands as close as one foot did not counter the chemotropic attraction of untreated surfaces. The effectiveness of the complete log cover therefore would seem to be due to a change which the creosote imposes on the attracting agents.

This investigation demonstrated that for practical purposes K 55 standard creosote applied to hoop pine logs within two days of felling, at the rate of one gallon to 150 square feet of surface, as a complete log cover, provides effective protection from borer attacks.

Immediately following this work creosote emulsion (1 part creosote, 2 parts soap solution) was adopted as a routine treatment, and subsequent borer infestation was within economic limits. Further, shortly after the results were released to the trade, creosote came into use in New Guinea for treating export logs; borer attacks in shipments of treated logs were negligible and in striking contrast to the extremely heavy attacks of earlier shipments.

Browne (1949) in Malaya has cast some doubt on the value of creosote for protecting logs. However, Taylor and Hadlington (1950), working on hardwood logs in the rain-forest of northern New South Wales, reaffirm that creosote is the most effective protectant against borers.

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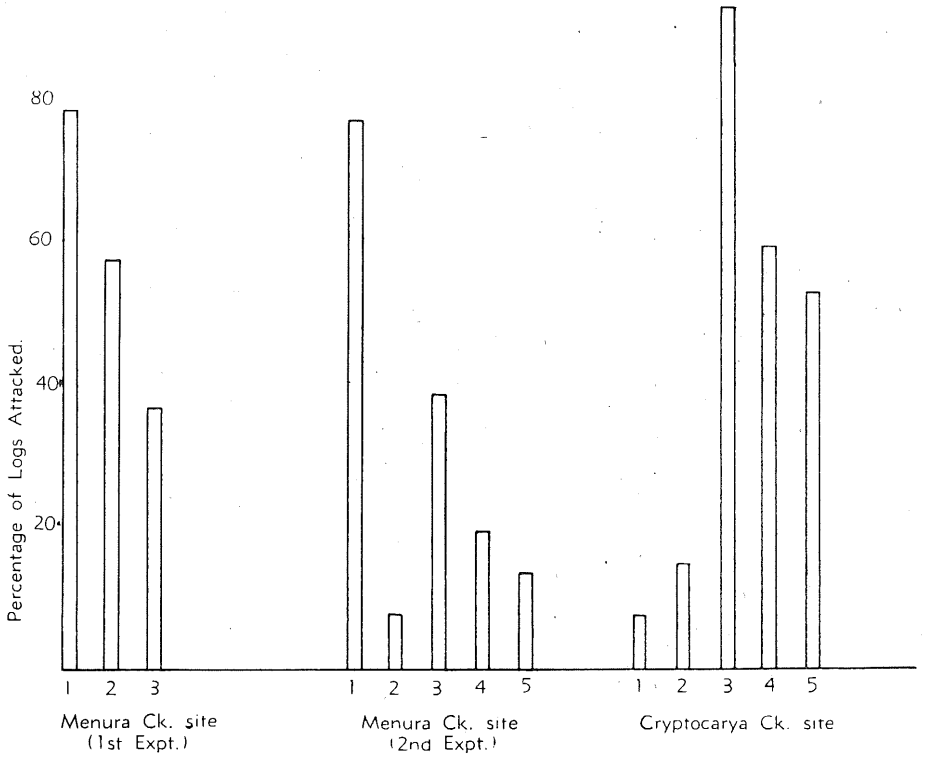
APPENDIX 1.

RELATIVE ABUNDANCE OF BORER SPECIES.

Quantitative observations were not made on borer populations; however, relative abundance was indicated by the percentage of logs attacked and estimates of the percentage of holes by each species. These are given in Figure 10. They confirmed the anticipation that *P. froggatti* would dominate the attacks on the Menura Creek sites, adjacent to a cut-over area, and that the smaller species would dominate on the Cryptocarya Creek site located within a virgin stand.



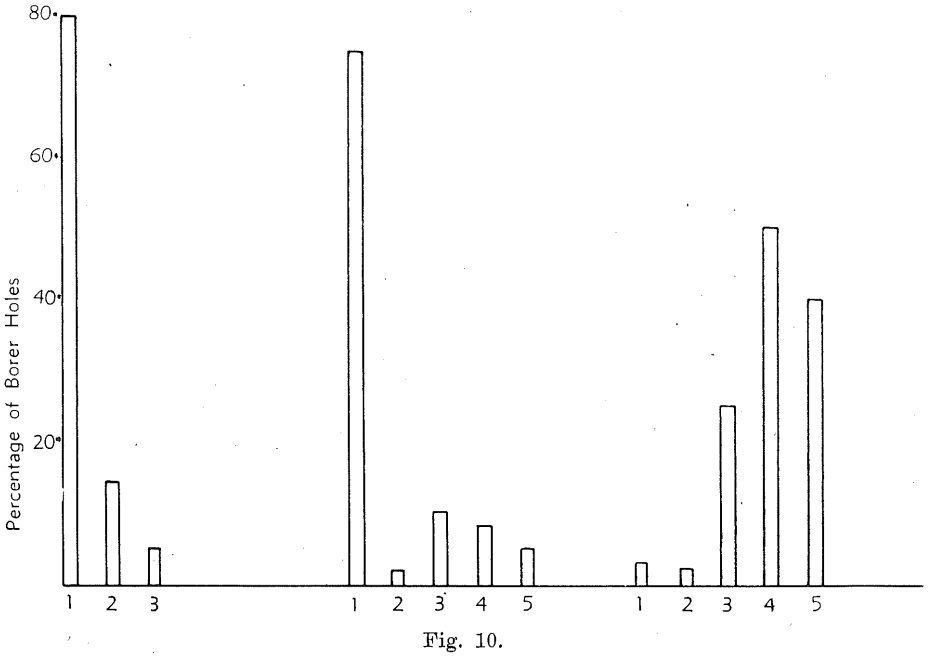


Fig. 10.

Relative Abundance of Borer Species as Shown by Percentage of Logs Attacked and Percentage of Borer Holes. The numbers refer to 1, *Platypus froggati;* 2, *P. australis;* 3, *Crossotarsus omnivorus;* 4, *Platypus semigranosus* and *P. subgranosus;* 5, *Xyleborus perforans* and *X. eucalypticus.*

APPENDIX 2.

POSITION OF ATTACKS ON LOGS.

The positions of borer attacks on the logs were recorded and are given in Tables 6, 7 and 11. The data proved to have no direct influence on control treatments but nevertheless are of technical interest. On the Menura Creek site (first experiment), where the canopy was severely destroyed and rain was intermittent, attacks dominated by *P. froggatti* were greatest on the lower sectors—"a," "b" and "c"—of both treated and untreated logs. The treatments, however, precluded attacks on the upper sectors, "d" and "e." In the second experiment rain was almost continuous and all untreated logs were attacked on each sector except "a," which in many instances was in contact with the ground. *P. froggatti* again dominated on sectors "a" and "b." The smaller species attacked on all sectors but dominated in sectors "d" and "e." Treated logs were attacked mostly on sectors "a," "b," and "c" and were dominated by *P. froggatti.* On the Cryptocarya Creek site, with an undestroyed canopy and intermittent rain, attacks dominated by the smaller species were greatest on sectors "b," "c," and "d" on both treated and untreated logs. The percentages of logs attacked in each sector for the three experiments are given in Figure 11.

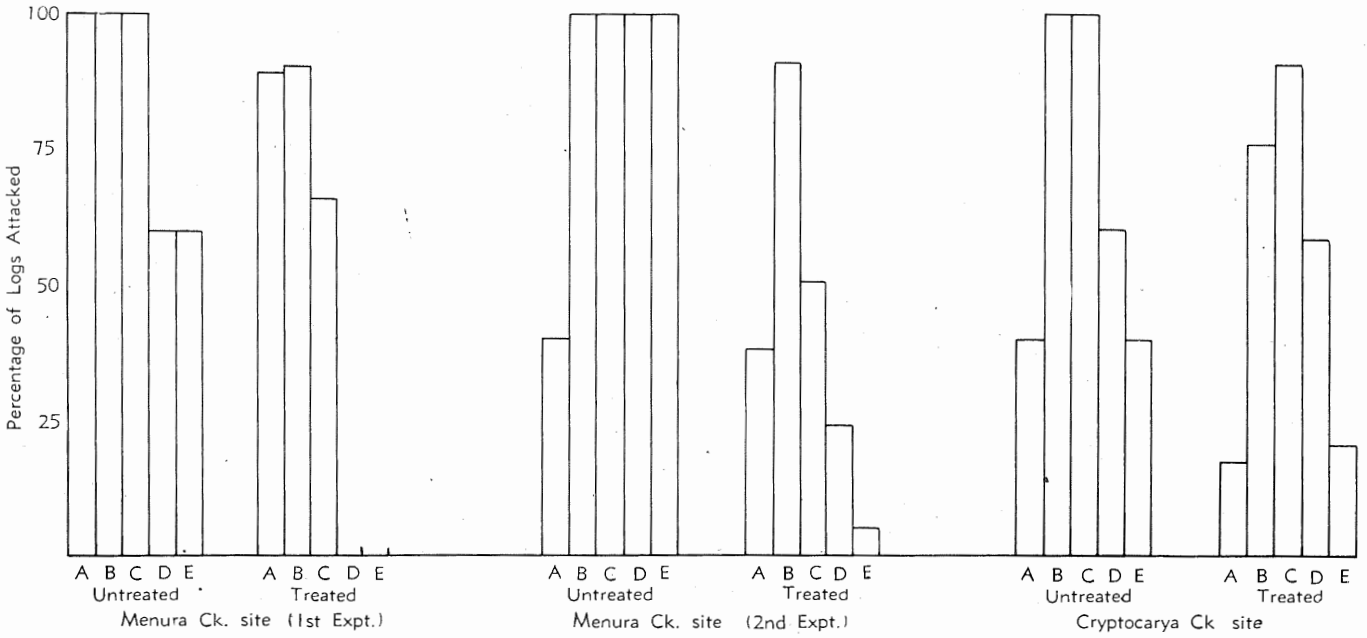


Fig. 11.

Percentages of Logs Attacked on Each Sector of Untreated and Treated Logs.