LYCTUS SPP. (POWDER POST BORER) ATTACK ON W.A. SHEOAK AND REGROWTH KARRI.

INTRODUCTION.

The sapwood of a number of Australian timbers are susceptible to *Lyctus* spp. attack. Limiting factors preventing attack are pore size of the timber (in relation to the size of the female ovipositor) and starch content of the sapwood. Both N.S.W. and Queensland have legislation enforcing timber manufacturers to treat all Lyctus susceptible sapwood with preservative. (Bootle, 1983)

With more sapwood from W.A. sheoak and karri being included in finished timber products, many cases of Lyctus attack have been reported to the Department of Conservation and Land Management. In some cases this has forced manufacturers to replace attacked timber products.

Samples from mature and small W.A. sheoak and regrowth karri logs were used in a survey to measure pore size and estimate starch content. The results of the survey are compared with the work done by Clarke (1933), who examined 108 specimens representing at least 71 species of 32 genera.

METHOD.

Regrowth karri samples were collected from a 50 year old tree grown in an even aged stand in Big Brook Block, Pemberton. The W.A. sheoak samples came from a cut-over sheoak stand in Bristol Block, Collie. Samples were cut into transverse sections, then sapwood width, starch content and pore diameter were assessed. Sapwood width was measured with a ruler, starch content using a starch test (graded heavy, moderate, sparse and very sparse) and pore diameter using a stage microscope with an attached grid.

A magnification of x5 was used to measure the pore diameter. One division on the grid equalled 20.7 ± 0.6 micron (μm). On each transverse wood section, approximately 12-15 of the largest pores were examined, with measurements taken of the radial and tangential diameters. The mean diameter and standard deviation of the pores in each direction were calculated, then the pore diameter was calculated from these two means. Only one regrowth karri tree was examined, with 5 mature and 6 small W.A. sheoak trees.

RESULTS.

Mean pore diameters, width of sapwood and starch grade for small and mature sheoak and regrowth karri are listed in tables 1 to 3. Table 4 summarises the mean pore diameter for all butt log, mid log and crown log samples, for each group of specimens. Results from table 4 are graphically represented in figure 1.

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Measurements of Lyctus brunneus egg diameters were done by Clarke (1933). He found the average diameter of eggs in the widest part was 150µm and the minimum diameter in the widest part was 137µm. The "Lyctus Lines" are included in figure 1. as XX - the minimum diameter and YY the average diameter.

Samples of mature sheoak had mean pore diameters between 5 and 30µm above the YY line and regrowth karri 98 and 116µm above the YY line. Small sheoak samples had 7 samples (41%) below the YY line and 3 samples (18%) below the XX line (Table 1). Mature sheoak had 4 samples (33%) below the YY line and 1 sample (8%) below the XX line (Table 2), whereas karri had no samples below either line (Table 3).

In all cases, the radial diameter was larger than the tangential diameter (Tables 1, 2 and 3) with mean differences of 64µm for small sheoak, 57µm for mature sheoak and 92µm for regrowth karri. The pores are in fact an oval shape not circular. Mean tangential pore diameters for mature and small sheoak were below the XX line, whereas mean radial diameters were well above the YY line (Tables 1 and 2). When considering the susceptibility to Lyctus attack, the ovipositor must be small enough to enable the insect to insert it into the pore. If the insect is unable to contort the ovipositor/egg into the oval shape pores, then the tangential diameter may limit attack.

From the limited sample, the karri sample had the largest pore (mean difference of 105 with the small sheoak) and the mature sheoak has a slightly larger pore than the small sheoak. For both mature and small sheoak, the crown pore diameter is larger than the butt (mean difference of 12µm for mature and 4µm for small W.A. sheoak). This is only a slight difference, but this may be significant if the ovipositor does not vary in size.

Results of the regrowth karri starch grading were better than for the sheoak samples. The reason being, the karri samples had been taken from a tree fallen approximately 1 month before assessment, whereas the sheoak samples had come from logs stored for approximately 1 year in a dry stockpile. Starch reserves may have depleted during this period. A trend of starch grade between butt, mid and crown samples cannot be established from this survey. According to Mr J. Creffield, the starch concentrations tends to be highest in the butt samples.

DISCUSSIONS.

Susceptibility to Lyctus spp. attack is a function of pore size, insect ovipositor and egg size. Where the largest pores of a given wood are less in diameter than the smallest lyctus egg, the woods are immune. Starch or some nutritional food base must be present in the sapwood for the larvae to survive.

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Mean pore diameters varied between samples from the same species, however the mean diameter for all samples were above the "Lyctus Line". The standard deviation and the range must be given a strong consideration in determining the probability of attack, as clearly it is the maximum pore size that will act as a limiting factor in the attack by Lyctus and not the average size.

Clarke (1933) states, "Any wood whose vessel distribution lies wholly to the left of the line (below in this case), the insect would find oviposition impossible, it is reasonable to assume that these woods are immune to attack, for the insect seems always to deposit its eggs in pores." Where the mean pore diameter is above the line, attack is very probable, though the closer the mean pore diameter is to the line, renders attack less likely.

Though the line XX, representing the minimum diameters recorded for the Lyctus burnneus eggs, must be near the critical point for attack, it is the region of the line YY that most of the eggs fall. (Clarke, 1933). Therefore it is the proximity of the mean pore diameter to the YY line that is of the greatest importance.

Clarke (1933), does not discuss the significance of the radial and tangential diameter (pore shape), only the mean diameters. In this survey, the radial diameter was greater than the tangential diameter, and the tangential diameters for the W.A. sheoak pores had mean diameters below the XX line. The ability of the insect to attack wood with this shaped pore would depend on their ability to contort the ovipositor and egg into the pore. If Lyctus brunneus is unable to do this, the tangential diameter may be the limiting factor not the mean diameter.

CONCLUSIONS.

1. The mean pore diameter of the small and mature W.A. sheoak and regrowth karri samples were greater than the average egg diameter of L. brunneus.

2. In all cases the radial pore diameter was greater than the tangential diameter, and the tangential diameters for the W.A. sheoak samples had mean diameters below the XX line

3. The significance of the tangential diameter in reducing susceptibility to attack will depend on the ability of the insects to contort their ovipositor/egg into an oval shape pore.

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TABLE 1.

SMALL W.A. SHEOAK: Pore Size, Sapwood Width and Starch Grade.

Sample No.	Pore Diameter (μm) Radial		Tangential		Mean	Sapwood Width (mm)	Starch Grade
	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$\bar{X}$		
1 Butt	197	19	124	20.7	160	25	Sparse
1 Mid	195	20.7	124	17	160	22	V. Sparse
1 Crown	166	29	112	20.7	145	35	V. Sparse
2 Butt	159	29	114	23	136	25	V. Sparse
2 Mid	159	31	132	20.7	146	27	V. Sparse
2 Crown	213	41	122	20.1	168	25	V. Sparse
3 Butt	215	23	149	8	182	37	Heavy
4 Butt	168	23	97	19	133	38	V. Sparse
4A Mid	172	20.7	122	14	147	34	No Starch
4B Mid	149	31	95	18.6	122	30	V. Sparse
4 Crown	188	27	126	19	157	33	No Starch
5 Butt	186	29	93	23	140	38	No Starch
5 Mid	199	25	128	19	164	25	No Starch
5 Crown	182	20.7	130	14	156	25	No Starch
6 Butt	215	25	137	19	176	25	Sparse to Moderate
6 Mid	190	31	147	23	168	33	V. Sparse
6 Crown	215	25	122	29	168	25	No Starch
Mean	186		122		154	30	

TABLE 2.

MATURE W.A. SHEOAK: Pore Size, Sapwood Width and Starch Grade.

Sample No.	Pore Diameter (μm) Radial		Tangential		Mean	Sapwood Width (mm)	Starch Grade
	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$\bar{X}$		
1A Butt	166	27.3	118	15.5	134	23	Moderate
1B Butt	192	7.2	128	18	160	22	Heavy
1A Crown	207	12.4	126	20.7	167	21	Moderate
1B Crown	180	22.8	130	17	155	22	Moderate to Heavy
2 Butt	199	18.8	145	26.9	172	24	V. Sparse
3A Butt	164	20.7	114	43.5	139	45	V. Sparse
3B Butt	164	31	126	24.8	145	50	No Starch
3 Mid	212	19	147	25	180	34	Moderate to Heavy
3 Crown	176	36	118	23	147	35	Sparse to Moderate
4 Butt	201	33	155	25	178	40	-
4 Crown	211	20.7	141	19	176	30	V. Sparse
5 Crown	221	14	157	27	189	50	V. Sparse
Mean	191		134		162	33	

TABLE 3.

REGROWTH KARRI: Pore Size, Sapwood Width and Starch Grade.

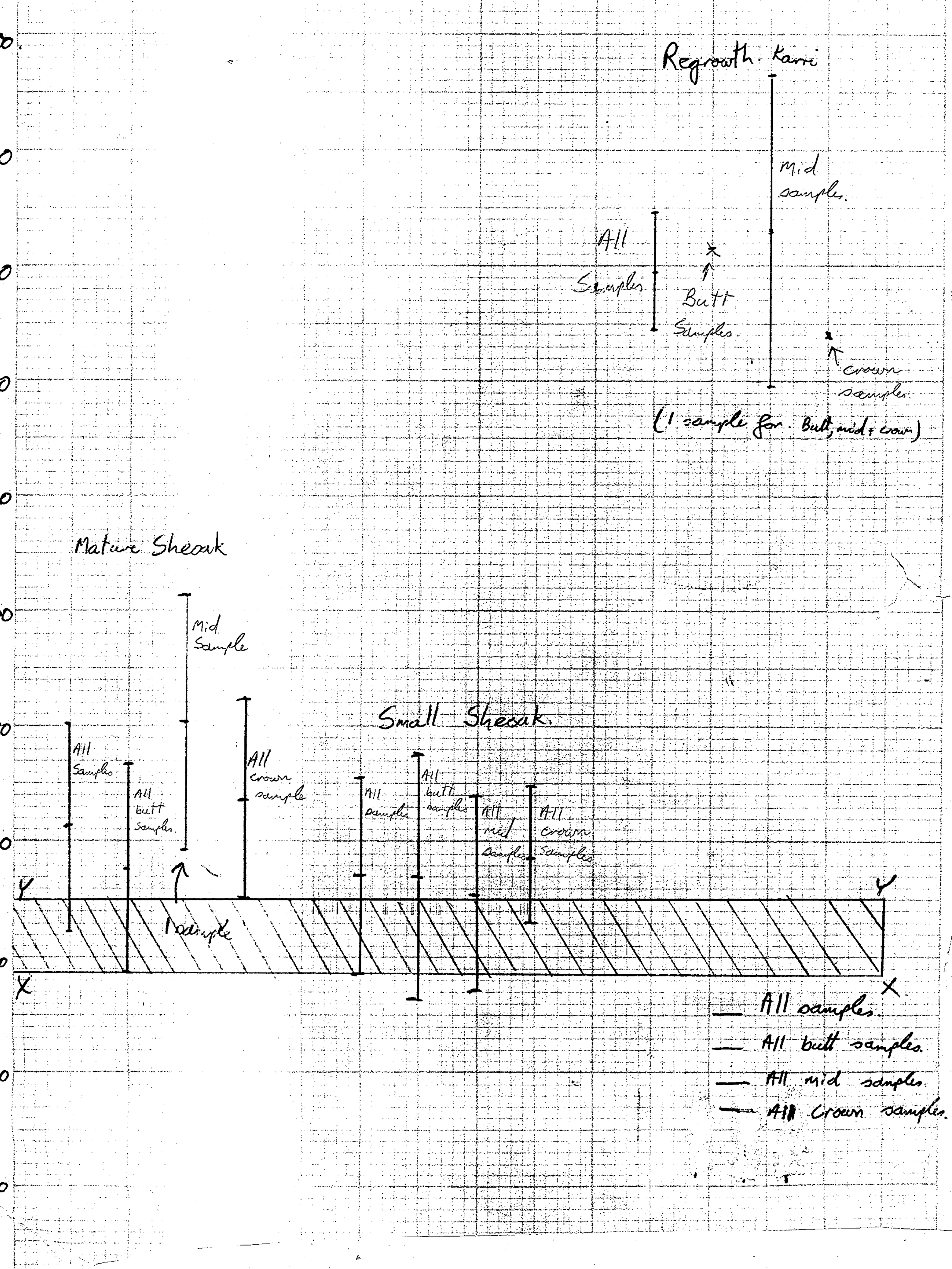
Sample No.	Pore Diameter (μm) Radial		Tangential		Mean	Sapwood Width (mm)	Starch Grade
	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$\bar{X}$		
1 Butt	323	62	203	12	263	29	Heavy
1 Mid	310	31	221	23	266	20	Moderate
1 Crown	282	64	215	23	248		Heavy
Mean	305		213		259	24	

TABLE 4.

The Mean Pore Diameters (μm) For Mature W.A. Sheoak, Small W.A. Sheoak and Regrowth Karri.

Sample	Mean Pore Diameter (μm)											
	All Samples			Butt Samples			Mid Samples			Crown Samples		
	$\bar{X}$	s.d.	Range	$\bar{X}$	s.d.	Range	$\bar{X}$	s.d.	Range	$\bar{X}$	s.d.	Range
Mature Sheoak	162	18	134-189	155	18	134-178	180	-	-	167	17	147-189
Small Sheoak	154	17	122-189	154	21	133-182	151	17	122-168	158	12	139-168
Regrowth Karri	259	10	248-263	Only 1 Sample								

Figure 1. Mean pore diameters and Standard Deviation for Mature Sheoak, Small Sheoak and Regrowth Karri. XX is the minimum diameter recorded for the egg of *L. brunneus* (Measured in the widest part). YY is the average diameter of the egg of *L. brunneus*



To The Exe. Director
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16th Sept. 1986
File W.P. 9/86

Subject: Pore Diameter in Relation to *Lyctus brunneus* Egg Size

Dear Ian,

I reffer you to a report on the pore size of W.A.sheoak (*Allocasuarina fraerana*) and regrowth karri (*Eucalyptus diversicolor*) dated the 15th of September 1986. Since writing that report, I have read an article by **Cummiins and Wilson (1934)**, on pore size in relation to *Lyctus brunneus* attack. They evaluated **Clarke's** work and did some egg measurements themselve. Some of the finding follow;

Clarke (1933), reported the maximum diameter of the smallest egg measured was 137*um* and the average was 150*um*. He regards 137*um* as the minimum size possible , and concluded that, where the largest pores of a given wood are less than 137*um* in diameter, it would be highly improbable that the wood, could be attacked. **Clarke (1933)** also considered that the minimum measurement of the maximum diameter of a *Lyctus* egg is the critical figure, but it is not as important as the mean figure. The greater the percentage of pores whose mean diameter exceeds the mean egg diameter, the greater the probability of attack.

Cummins and Wilson (1934), believe **Clarke's** conclusions require certain modifications. Only 20 measurements of *Lyctus* eggs were given by him, the range of maximum diameter for 19 of these being from 137*um* to 159*um*, the remaining egg measuring 183*um*. The standard deviation for the 19 eggs is 7, so that 99.7 per cent of the measurements made on a larger number of eggs would be expected to fall within the range 126um to 168um. It appears safer on the data presented, to place a limiting pore size, assuming other factors are favorable, at a maximum of about 126um.

Even though only a small percentage of the pores are above the minimum size required for oviposition, there is still the probability of severe attack. Australian experience indicates that this definitely occurs.

Chowdhurry (1933) in Cummins and Wilson (1934), measured the maximum diameters of 10 eggs of *L.africanus*, and found these to be almost constant at about 130um. He also measured the pore size of 52 species of Indian timbers, measuring both radial and tangential pore diameters, and concluded that oviposition can only occur in those pores, whose tangential and radial diameters are each larger than the diameter of the egg.

The possibility of *Lyctus* attack depends upon the percentage of pores with a minimum diameter greater than 130um. Again, there is no evidence for assuming that the probability of attack depends upon the percentage of pores above a certain fixed minimum diameter, when in all cases there are some pores of sufficient size, available for oviposition.

Parkin (1933) in Cummins and Wilson (1934), gives a detailed account of the probable method of egg laying. It was found that the egg is considerably elongated in it's passage down the ovipositor of the insect, and as it issues from the ovipositor, it generally shortens in length and expands in diameter to give a so-called normal diameter. If the pore is smaller than the normal diameter, this expansion in not possible, and elongated eggs will result. Therefore the susceptibility to *Lyctus* attack is based on the relationship between pore diameter of the timber and the ovipositor diameter of the insect.

Measurements of the average ovipositor diameter of 34 insects of *L.brunneus* gave an average of 78um with a minimum of 56um. It is apparently possible for eggs to be laid in woods which have an average pore diameter sufficiently large to allow an introduction of the ovipositor.

Parkin (1933), measured 20 normal eggs of *L.brunneus* and recorded a range from 125um to 180um, with an average of 142um. Cummins and Wilson (1934), measured 75 eggs, measuring the maximum diameter, length of egg body and tail (if possible). Three separate readings being taken and averaged. The minimum, maximum, mean and standard deviation of the recorded maximum *Lyctus* egg are; minimum, 110um; maximum, 163um; mean, 136um ; and stardard deviation, 10.8um.

Experimental Work by Cummins and Wilson (1934)

Microscopic sections were prepared from 94 different species of timber, the material being taken in all cases from stock infested with *Lyctus*. In 47 of these specimens, sections were prepared from the truewood (heartwood) adjoining the infested sapwood, and measurements were made of the radial diameters of the 10 largest pores in a cross section. It is reasonable, and it is assumed, that the measurements of pores in the sapwood ajoining the truewood are similar. Even allowing a small difference, all the woods so measured contained some pores greater than 180um.

Most of the species measured have their radial diameter greater than their tangential, but their pore sizes are so large that, even allowing a ratio of radial to tangential of 1.5 to 1, the minimum size would be above 120um. The truewood maximum radial diameters of 10 of the largest pores of karri ranged from 315um to 380um, with estimated tangential diameters of 210um to 253um. Measurements for W.A. sheoak are not documented in Cummins and Wilson (1934).

In the remaining 48 specimens, sections were prepared from infested sapwood. Minimum diameters for each of the largest pores in any section were recorded. (Minimum diameter being considered as the limiting factor for <u>normal</u> egg deposition). Results of the pore measurements by Cummins and Wilson (1934) are in the attatched table. The attached figure shows the distribution of the maximum diameters of 75 *L.brunneus* eggs.

Conclusions

Parkin (1933), considers it is apparently possible for eggs to be laid in timbers containing pores sufficiently large enough for the introduction of the ovipositor. That is pores with a minimum average diameter of about 56*um*. From the data available to Cummins and Wilson (1934), it does not appear possible for infestation to occur under Australian conditions in woods containing pores with a minimum diameter less than about 90*um*.

Sapwood of timbers with pores sizes above 90*um*, provided other factors are satisfied can not be considered immune to attack. Unfortunately, all the main commmcial species of Australian hardwoods have pores greater than 90*um*, therefore treatment of sapwood is of utmost importance.

Gary Brennan

References

Clarke, S.H. (1933). On the relationship between vessel size and *Lyctus* attack in timber. Forestry 7: 47-52.

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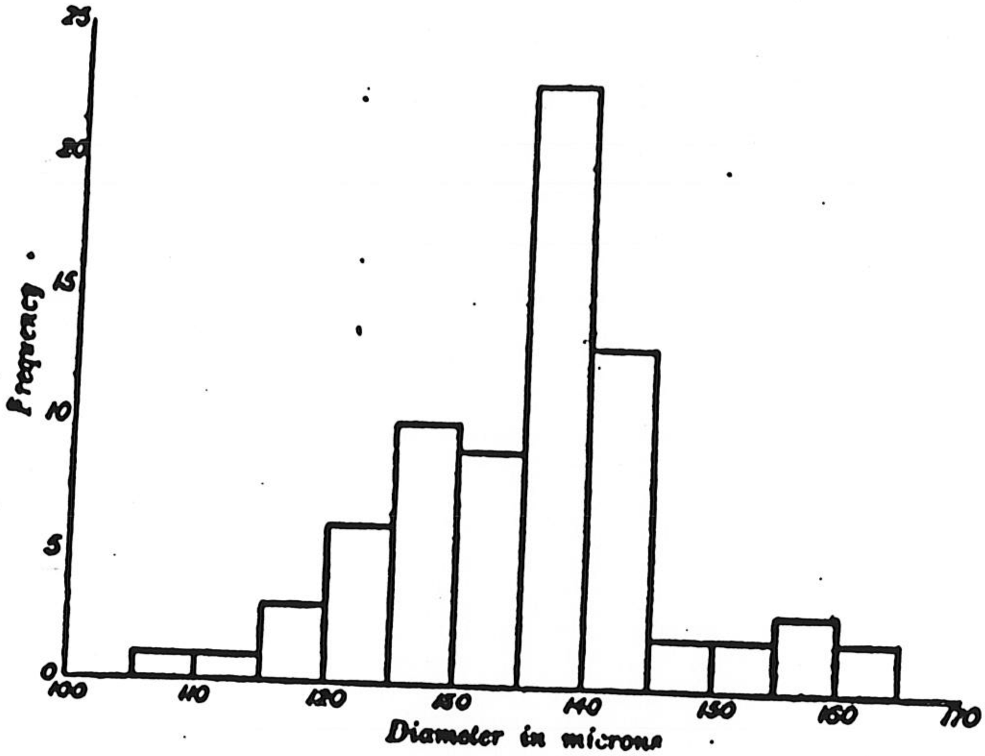

FIG. 1.—Frequency of maximum diameters of 75 *Lyctus brunneus* eggs.

Measurements of Vessel Diameters

TABLE 2.

Vessel Diameters of Timbers Infested with *Lyctus*.

Species.	Diameter.
	(Microns.)
Acacia dealbata (1)	170–225
„ *implexa* (3)	200
„ *melanoxylon* (1)	170–225
Aleurites moluccana (2)	195–265
Angophora bakeri (1)	215–260
„ *intermedia* (1)	155–210
„ *lanceolata* (1)	175–250
„ *subvelutina* (3)	195
Baloghia lucida (2)	86–116
Cedrela australis (1)	235–340
Embothrium wickhami (1)	175–225
Ficus macrophylla (2)	135–265
Flindersia bennettiana (2)	102–139
Grevillea robusta (1)	205–270
Litsea reticulata (1)	175–230
Nothofagus moorei (2)	69–86
Orites excelsa (2)	105–129
Panax elegans (2)	79–107
„ *murrayi* (2)	120–160
Schizomeria ovata (2)	80–111
Sterculia acerfolia (2)	180–215
Syncarpia laurifolia (1)	135–215
Tarrietia peralata (1)	200–235
„ *actinophylla* (3)	190
Tristania suaveolens (1)	125–180
Eucalyptus accedens (2)	110–150
„ *aggregata* (2)	120–145
„ *amplifolia* (2)	125–155
„ *angophoroides* (2)	97–123
„ *australiana* (1)	200–310
„ *baileyana* (2)	135–180
„ *bancrofti* (2)	125–170
„ *baueriana* (2)	102–139
„ *bicolor* (2)	84–105
„ *bicostata* (2)	135–180
„ *blakeleyi* (2)	103–128
„ *bosistoana* (1)	200–230
„ *botryoides* (2)	175–210
„ *bridgesiana* (1)	200–250
„ *calophylla* (1)	245–340
„ *canaliculata* (2)	160–205
„ *cinerea* (2)	120–170
„ *coriaceae* (1)	155–225
„ *corymbosa* (2)	180–235
„ *crebra* (2)	125–150
„ *dalrympleana* (1)	210–310
„ *deanei* (2)	175–210
	(Microns.)
Eucalyptus de beuzevillei (2)	120–145
„ *diversicolor* (1)	315–380
„ *dives* (1)	165–265
„ *eleaeophora* (2)	200–260
„ *eximia* (2)	165–235
„ *fastigata* (1)	210–315
„ *fraxinoides* (2)	145–160
„ *gigantea* (1)	245–320
„ *globulus* (1)	180–315
„ *gomphocephala* (1)	180–270
„ *goniocalyx* (1)	200–335
„ *kirtoniana* (2)	165–200
„ *leucoxylon* (1)	160–260
„ *longifolia* (2)	102–138
„ *macarthuri* (1)	150–300
„ *macrorrhyncha* (1)	180–230
„ *maculata* (1)	165–280
„ *maideni* (1)	200–330
„ *melliodora* (1)	145–205
„ *microcarpa* (2)	120–138
„ *microcorys* (1)	200–290
„ *nitens* (2)	140–170
„ *obliqua* (1)	205–240
„ *ovata* (2)	120–155
„ *paniculata* (2)	135–150
„ *parramatensis* (2)	150–170
„ *patens* (1)	205–240
„ *perrineana* (2)	110–150
„ *pilularis* (1)	210–240
„ *piperita* (1)	185–295
„ *polyanthemos* (2)	125–160
„ *regnans* (1)	260–385
„ *resinifera* (2)	190–255
„ *robertsoni* (2)	165–210
„ *robusta* (2)	145–180
„ *rostrata* (2)	120–145
„ *rubida* (2)	135–195
„ *seeana* (2)	130–250
„ *sideroxylon* (2)	135–185
„ *smithii* (2)	120–150
„ *stellulata* (2)	110–150
„ *stuartiana* (1)	200–250
„ *tereticornis* (2)	155–255
„ *tesselaris* (2)	180–235
„ *trachyphloia* (2)	150–205
„ *umbra* (1)	175–235
„ *viminalis* (1)	200–335

(1) Range of maximum radial diameters of ten largest pores measured in the truewood.
(2) Range of minimum diameters of ten largest pores measured in sapwood.
(3) Approximate minimum diameter of largest pores.

5. The Relationship

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Species.
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Nothofagus moorei
Panax elegans
Schizomeria ovata
E. bicolor

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