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THE DURABILITY OF CREOSOTE-TREATED MALAYSIAN TIMBERS

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DALJEET SINGH, K., TAM, M.K., & MOHD. DAHLAN JANTAN 1988. The durability of creosote-treated Malaysian timbers. The paper summarizes the results of exposure trials of 96 Malaysian timber species treated with Creosote. Timbers with absorptions in excess of 320 $kg\ m^{-3}$ had very low failure rates. It was also seen that there was variation in service life with different absorptions which needs further investigation. Based on the results a durability classification for treated timber is proposed.

Keywords: Creosote durability - Malaysian timbers - durability classification.

Introduction

Trials on the natural durability of Malaysian timbers were initiated in 1918. They were further increased in 1930 and have continued since then. The results of these trials have been published (Foxworthy & Woolley 1930, Thomas 1937, Mohd. Dahlan Jantan & Tam 1985).

Trials on the durability of treated timber were started in 1930. The preservative used then was creosote. Creosote is the main preservative for railway sleepers. It is also recommended in the double treatment with copper-chrome-arsenic (CCA) for timbers in marine environment. Subsequent trials included timber treated with other preservatives such as CCA, copper naphthenate, *et cetera*. The tests are still in progress and additional test material is being added. This paper is a summary of more than 50 years of observations on the durability of timbers treated only with creosote.

Materials and methods

Test material

Rough sawn stakes were used for all the trials. The stakes were obtained from botanically identified trees. The test stakes were 5 x 5 x 60 *cm* in cross section. The test stakes were air seasoned to about 14 to 18% moisture content which is the equilibrium moisture content in this country. Each stake was labelled with an

aluminium number plate. The number of test stakes for each species varied depending on the quantity of timber available. However, in every case, the tests were equally divided between the two test grounds used.

Treatment

The preservative used for the treatment was Creosote which met the specifications in British Standard 144. Most of the timbers were treated using the Hot and Cold Open Tank Method. The test stakes were weighed before being completely submerged in the tank containing 100% creosote. The creosote was then heated by steam coils to a temperature of $87°C$ - $105°C$ and the temperature was maintained for 1 *h*. After this, the creosote was allowed to cool for 16 *h*. The test stakes were then taken out and drip-dried before final weighing. For some of the trials, the timbers were treated by using the Bethell method.

Test procedure

The two sites are in the grounds of the Forest Research Instiute, Kepong, Malaysia (Jackson 1957). The specimens were placed in 45 *cm* deep trenches which were then filled to ground level. The stakes projected 15 *cm* above ground level. The stakes were placed at an angle to the vertical and each stake was in contact with the stakes on either side. The rows were 30 *cm* apart.

The above method, used by Foxworthy (1930), differs from that used in other laboratories where specimens are set vertically and are about 30 *cm* apart. Foxworthy's method is believed to create a very hazardous situation as it allows termites and fungi to spread easily from one stake to the next. It may thus be a slightly accelerated test.

Inspection

The test stakes have been inspected at six-month intervals throughout the life of the test. The stakes are pulled out of the ground one by one (after loosening the earth with a spade if necessary) and the adhering earth is scraped off. The exterior of the specimen is examined, and the presence or absence of internal termite attack is deduced from the appearance as well as the sound made when the specimen is struck with a light hammer. If internal infestation is detected, its extent is determined by probing with a sharp instrument, and the internal cavities of termite attack are exposed. A blunt-edged knife or back of a knife blade is rubbed on the surface to determine the extent of fungal attack on the stakes. Excessive picking out of the soft wood fibre in the specimens is avoided. When the timber is very wet, especially in the wet season, softness alone is not a good criterion for grading naturally soft timber. In this case a 'clunk test' is carried out. A test stake is held at one end and the other end is knocked lightly against the ground. If the stake breaks abruptly, it indicates that there is rot in the timber core. A test

stake is considered destroyed when 50% or more of its cross-sectional area at groundline is removed by termites or from rot caused by fungi.

Results

The mean average service life of each species was calculated for those species in which all the test stakes had been destroyed (Table 1). Also included are results of tests in which not all of the stakes have been destroyed; their service life was extrapolated using Maclean's (1926) chart for determining probable life of rail ties. These results give a reasonable indication of possible service life. The service life of the timbers in relation to nett absorption of creosote are also presented (Table 2). The nett absorption is divided into six categories which correspond to the treatability classes of the timber.

Discussion

From Table 1, it can be seen that the service life of the timbers is increased considerably when it is compared with that of untreated timbers. Generally, increased absorption gave a better service life. For example in damar hitam the absorption in the open-tank process was only 22.56 $kg\,m^{-3}$ and in another lot 60.8 $kg\,m^{-3}$ (Table 1). When using the full cell process, the absorption of 102.4 $kg\,m^{-3}$ was obtained. The service life of the open-tank treated specimens were 6.5 and 9 *y* while it was 18.3 *y* for those treated by the full cell process.

In keledang *(Artocarpus lanceifolius)* at absorption of 1.31 $kg\,m^{-3}$ of creosote the average service life was 14 *y* whereas at 145.6 m^3 the average service life increased to 31 years. The various Keruing (*Dipterocarpus* spp.) species when treated with creosote had a service life ranging from 20.7 to 28 years and Kempas (*Koompassia malaccensis*) had a service life of 32.3 to 39.2 years. There were annulous cases too, like giam in which slightly lower absorptions (0.27 $kg\,m^{-3}$ gave marginally longer service life of 23.3 *y* against 21.6 *y* for a 0.49 $kg\,m^{-3}$ absorption.

Based on the service life of the timbers (Table 1), a durability classification for treated timbers is proposed:

Table 1. Durability classification

Durability Class	Service life (*y*) for (5 x 5 x 60 *cm* stakes)
Class 1 Perishable	0 to 5
Class 2 Non perishable	5 to 10
Class 3 Moderately Durable	10 to 15
Class 4 Durable	15 to 20
Class 5 Very Durable	25

As mentioned earlier this durability classification is based on 5 *cm* square samples exposed in ground contact at the two test sites in Kepong. It would therefore be reasonable to suggest that much longer service life for timber of larger cross-sections may be expected in normal hazard situations.

The treated timbers are classified into different categories of absorption (Table 2). The timbers in each category are further classified into the various durability classes proposed above. From Table 2, it can be seen that the service life not only varies among the different categories but also within each category.

In absorption category 1, there are timbers in every durability class. Although the amount of preservative absorbed was low, nevertheless, there were six timber species which had a service life over 25 *y* and 21 timber species of 16 - 25 *y*. This trend was also seen among timbers in absorption categories 2 and 3. In category 2, there were 11 timber species that were durable and 13 that were very durable. In category 3, there were six timber species that were durable and ten that were very durable. In categories 4, 5 and 6, all the timber species (eight species, two species and seven species respectively) were very durable.

From Table 2 it can be seen that each timber inherent quality of durability which can be enhanced with the use of preservatives. This was even observed among timbers which were naturally non-durable or moderately durable like merawan, melantai, perupok and meranti tembaga which obtained service life in excess of 25 years with preservative absorption of between 96 to 160 $kg\ m^{-3}$.

All in, there are 41 timbers which could be classified as very durable and these include kempas, keruing, mengkulang and kulim (Table 2).

The difference in durability with varying retentions is quite interesting and warrants further investigation. In general, higher absorptions gave longer service life. Timbers having absorptions in excess of 320 $kg\ m^{-3}$ have low failure rates (Table 1). Jelutong after 36 *y* had a failure of 50% of the stakes at one site while there were no failures yet in the other site. After 50*y* of service geronggang (absorption 468.8 kg m^{-3}) had only 20% failure in one site and none at the other site; geronggang (absorption 481.6 $kg\ m^{-3}$) had 55% failure at one site and only 10% failure in the other site. After 33 *y* mempisang had no failure in either of the test sites. These examples clearly illustrate that sufficient loading service life in excess of 30 *y* could be easily obtained. It must be pointed out here that in the past only the average absorption was calculated. This meant that there would be stakes which had higher absorptions while others had lower absorptions. The service life obtained is thus an average for these stakes. It would be therefore be safe to assume that had all the stakes been treated to the same absorption, higher service life would have been obtained for each species.

Conclusion

It can be seen that timber treated with 100% creosote had considerably longer service life than untreated timber. Timbers with higher loadings gave a service life in excess of 30 *y* and there a were number which would definitely have a service life

in excess of 45 *y*. There was some variation in the service of life of timbers with different retentions and this needs to be investigated further.

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Table 2. Service life of creosote-treated timber

TIMBER	BOTANICAL NAME	TREATMENT PROCESS	DATE PLANTED	NO. OF STAKES	AVERAGE ABSORPTION KG/M^3	SERVICE LIFE IN YEARS UPPER / LOWER GROUND		AVERAGE SERVICE LIFE IN YEARS	DESTRUCTION OF 1ST STAKE	DESTRUCTION OF LAST STAKE
Ara berteh	*Paratocarpus trianda*	Open tank	25.8.53	40	459.2	47.00	32.00	39.00	13	on-going
Balau kumus	*Shorea laevis*	Full cell	1.6.32	38	67.2	32.00	32.10	32.00	19	44
Balau laut	*Shorea glauca*	Open tank	15.7.58	40	N.A.	9.40	13.30	11.40	10	16
Batai	*Albizia soluccana*	Open tank	24.6.40	12	102.4	15.60	11.90	15.60	8	26
Bekak	*Ammoria rubiginosa*	Open tank	5.8.63	40	30.4	13.90	14.90	14.40	10	19
Bengang	*Neesia altissima*	Open tank	5.3.52	40	351.36	41.00	48.00	44.00	25	on-going
Bintangor	*Calophyllum kunstleri*	Open tank	21.12.40	23	171.2	32.20	26.70	29.50	12	41
Bintangor	*Calophyllum kunstleri*	Open tank	26.7.61	40	19.2	4.90	5.70	5.30	3	19
Bintangor	*Calophyllum kunstleri*	N.A.	26.7.66	40	N.A.	5.70	7.60	5.30	4	on-going
Bitis	*Madhuca utilis*	Full cell	1.6.32	40	51.2	19.00	22.10	20.60	16	30
Brazil nut	*Bertholletia excelsia*	Open tank	15.1.51	16	240.0	38.00	34.00	36.00	18	on-going
Chengal	*Neobalanocarpus heimii*	Full cell	23.7.31	39	68.8	30.20	33.40	31.80	18	48
Damar hitam	*Shorea resina nigra*	Open tank	24.3.38	20	22.4	5.10	7.80	6.50	3	8
Damar hitam	*Shorea resina nigra*	Full cell	24.3.38	40	102.4	21.50	15.10	18.30	11	27
Damar hitam	*Shorea resina nigra*	Open tank	28.8.67	40	60.8	10.00	8.50	9.00	8	on-going
Damar laut	*Shorea glauca*	Open tank	26.7.66	40	17.6	16.00	15.00	16.00	7	on-going
Damar laut kecil	*Shorea maxwelliana*	Open tank	8.12.38	20	3.2	23.00	22.60	22.80	20	23
Damar laut kecil	*Shorea maxwelliana*	Full cell	8.12.38	39	12.8	26.90	19.90	23.40	17	28
Damar laut merah	*Shorea kunstleri*	Open tank	7.11.34	40	36.8	16.90	14.90	15.90	7	28
Damar laut merah	*Shorea kunstleri*	Full cell	7.11.34	40	22.4	16.40	14.90	17.20	6	on-going
Dedali	*Strombosia javanica*	Open tank	30.12.49	40	256.0	24.00	27.00	26.00	12	on-going
Engkabang	*Shorea gysbertsiana*	Open tank	21.7.49	26	331.2	39.00	28.00	34.00	23	on-going
Eucalyptus	*Eucalyptus robusta*	Open tank	15.1.51	20	46.4	5.00	4.10	4.50	3	6
Eucalyptus	*Eucalyptus robusta*	Open tank	20.2.70	24	113.6	8.30	7.10	8.00	7	12
Geronggang	*Cratoxylon arborescens*	Open tank	15.8.36	20	468.8	50.00	50.00	50.00	28	on-going
Geronggang	*Cratoxylon arborescens*	Open tank	15.8.36	40	469.12	50.00	50.00	50.00	27	on-going
Gerutu	*Parashorea lucida*	Open tank	15.12.35	20	107.2	14.00	8.70	11.40	5	16
Gerutu	*Parashorea lucida*	Full cell	15.12.35	40	94.4	17.20	11.70	14.40	5	30
Giam	*Hopea nutans*	Open tank	6.12.41	20	17.6	20.60	22.50	21.60	20	26
Giam	*Hopea nutans*	Full cell	6.12.41	40	9.6	22.90	23.60	23.30	20	26
Giam lintah bukit	*Hopea helferi*	Open tank	23.1.58	40	38.4	14.70	14.50	14.60	7	24
Hopea sangal	*Hopea sangal*	Full cell	5.12.35	20	64.0	19.10	20.10	19.60	8	32
Hopea sangal	*Hopea sangal*	Open tank	5.12.35	20	52.8	11.80	17.20	14.50	7	33
Jangkang	*Blumeodendron tokbrai*	Open tank	23.8.55	40	500.8	31.00	31.00	31.00	24	on-going
Jelutong	*Dyera costulata*	Open tank	4.1.50	40	515.2	33.00	39.00	36.00	29	on-going
Jongkong	*Dactyloclados stenostachys*	Open tank	22.7.62	24	556.8	24.00	24.00	24.00	on-going	ongoing
Kapur	*Dryobalanops aromatica*	Full cell	23.7.31	12	84.8	20.70	N.A.	20.70	17	34
Kapur	*Dryobalanops aromatica*	Open tank	5.7.58	40	N.A.	12.50	11.10	12.20	7	18
Kasai	*Pometia pinnata*	Open tank	23.12.48	40	57.6	15.70	12.00	14.00	8	20
Kedondong	*Canarium rufus*	Open tank	21.12.40	16	64.0	9.90	10.20	10.10	5	33
Kedondong kerantai	*Santiria laevigata*	Open tank	3.8.71	20	72.0	7.30	6.90	7.00	6	9
Keladan	*Dryobalanops oblongifolia*	Open tank	2.8.38	20	36.8	16.20	13.70	16.10	7	18
Keladan	*Dryobalanops oblongifolia*	Full cell	8.12.38	39	96.0	24.80	21.90	23.40	11	28
Kelat jambu	*Eugenia griffithii*	Open tank	23.12.48	40	216.0	32.00	28.50	30.00	7	on-going

Keledang	*Artocarpus lanceafolia*	Full cell	29.5.48	40	144.0	35.00	27.00	31.00	16	on-going
Keledang	*Artocarpus lanceafolia*	Open tank	14.7.65	40	46.4	16.50	12.00	14.00	12	on-going
Kempas	*Koompassia malaccensis*	Full cell	23.7.31	38	291.2	42.20	36.20	39.20	16	51
Kempas	*Koompassia malaccensis*	Open tank	5.12/35	20	227.2	38.30	26.20	32.30	7	45
Kempas	*Koompassia malaccensis*	Full cell	1.12.32	50	164.8	46.00	25.20	35.60	15	on-going
Kerantai	*Santiria laevigata*	Open cell	24.6.40	12	76.8	11.10	13.40	12.30	7	35
Keruing	*Dipterocarpus baudii*	Full cell	1.12.32	48	240.0	25.90	25.30	25.60	16	36
Keruing	*Dipterocarpus cornutus*	Full cell	1.6.32	13	185.6	20.70	N.A.	20.70	11	25
Keruing	*Dipterocarpus crinitus*	Open tank	24.3.38	20	57.6	29.00	26.30	27.70	17	37
Keruing	*Dipterocarpus crinitus*	Full cell	24.3.38	40	85.3	32.00	28.10	30.10	17	41
Keruing	*Dipterocarpus lowii*	Full cell	28.3.38	35	161.6	28.10	27.90	28.00	17	36
Keruing	*Dipterocarpus lowii*	Open tank	24.3.38	19	203.3	23.60	25.70	24.70	17	32
Kulim	*Scorodocarpus borneensis*	Full cell	1.6.32	40	198.4	36.90	33.50	32.70	21	48
Kungkur	*Pithecellabium confertua*	Full cell	23.7.56	40	81.6	20.00	12.60	16.00	10	on-going
Machang	*Mangifera foetida*	Open tank	25.8.53	40	313.6	31.00	28.00	30.00	12	on-going
Mango	*Mangifera foetida*	Open tank	25.8.53	16	182.4	20.20	18.80	19.50	15	26
Medang	*Litsea firma*	Open tank	25.8.53	16	134.4	10.60	8.70	9.70	7	15
Medang gatal	*Schima wallichi*	Open tank	15.2.56	20	54.4	12.60	5.60	9.10	5	19
Medang padang	*Litsea pulutris*	Open tank	18.7.62	30	81.6	13.90	8.50	11.20	3	18
Medang tandok	*Dehaasia nigrescens*	Open tank	21.12.40	20	51.2	27.30	14.30	20.80	10	34
Melantai	*Shorea mecroptera*	Open tank	7.11.34	20	67.2	18.70	19.80	19.30	8	on-going
Melantai	*Shorea macroptera*	Full cell	7.11.34	40	129.6	30.90	24.20	27.60	12	5
Melawis	*Gonstylus bancanus*	Open tank	8.12.38	19	N.A.	22.00	35.00	27.90	17	43
Melunak	*Pentace triptera*	Open tank	6.8.49	40	89.6	11.00	14.20	12.60	7	21
Membatu	*Shorea guiso*	Open tank	5.3.52	40	19.2	7.60	6.70	7.00	4	12
Membatu jantan	*Shorea ochrophloia*	Open tank	14.12.64	40	12.8	8.60	10.20	9.40	2	13
mempening	*Quercus lamponga*	Full cell	2.2.66	40	89.6	17.00	11.50	14.00	8	on-going
Mempisang	*Cyathocalyx maingayi*	Open tank	28.5.53	32	542.4	33.00	33.00	33.00	on-going	on-going
Mendong	*Elaeocarpus sphaericus*	Open tank	8.3.68	40	123.2	7.70	5.80	7.00	6	7
Mengkulang	*Terrietia simplicifolia*	Open tank	5.12.35	20	153.6	34.00	29.80	31.90	12	on-going
Mengkulang	*Terrietia simplicifolia*	Full cell	5.12.35	40	118.4	25.90	22.10	24.00	14	36
Meranti bakau	*Shorea rugosa*	Open tank	15.8.36	20	72.0	15.50	14.80	15.20	7	44
Meranti bakau	*Shorea rugosa*	Full cell	15.8.36	40	113.6	17.50	11.70	14.60	5	44
Meranti bukit	*Shorea platyclados*	Open tank	15.7.58	40	N.A.	9.50	10.50	10.00	6	18
Meranti daun besar	*Shorea hamsleyana*	Open tank	22.7.62	28	144.0	15.00	21.00	18.00	9	on-going
Meranti paang	*Shorea bracteolata*	Open tank	12.10.33	20	153.6	25.70	30.00	27.90	14	49
Meranti paang	*Shorea bracteolata*	Full cell	1.12.33	40	145.6	25.10	25.40	25.30	14	on-going
Meranti sarang punai	*Shorea parvifolia*	Full cell	1.12.31	39	312.0	32.80	36.60	32.40	16	51
Meranti temak	*Shorea hypochra*	Full cell	1.12.33	38	120.0	34.70	28.60	31.70	14	48
Meranti temak	*Shorea hypochra*	Open tank	15.7.58	40	N.A.	15.50	17.00	16.10	6	20
Meranti temak	*Shorea hypochra*	Open tank	1.12.33	20	150.4	34.50	31.80	33.20	14	49
Meranti temak nipis	*Shorea talura*	Open tank	25.1.60	40	27.2	21.00	18.00	19.00	10	on-going
Meranti tembaga	*Shorea leprosula*	Open tank	5.12.35	20	88.0	13.50	10.70	12.20	5	19
Meranti tembaga	*Shorea leprosula*	Full cell	23.7.31	33	233.6	35.60	32.30	34.00	16	51
Meranti tembaga	*Shorea leprosula*	Full cell	1.6.32	20	164.8	29.20	N.A.	-	16	on-going
Merawan	*Hopea sulcata*	Full cell	21.12.40	19	67.2	31.00	27.00	29.00	20	41
Merawan	*Hopea sulcata*	Open tank	21.12.40	38	82.24	38.20	27.40	32.80	22	41
Merawan	*Hopea sulcata*	Open tank	6.12.41	18	128.0	26.10	23.40	24.80	18	40
Merbau	*Intsia palembanica*	Full cell	1.6.32	40	148.8	N.A.	22.30	22.30	16	on-going

Mersawa	*Anisoptera marginata*	Open tank	24.6.40	20	33.6	8.40	6.30	7.40	8	11
Mersawa	*Anisoptera marginata*	Full cell	24.6.40	39	41.6	11.40	8.60	10.00	8	17
Mersawa	*Anisoptera laevis*	Open tank	21.12.40	19	33.6	10.70	10.70	9.80	7	14
Mersawa	*Anisoptera laevis*	Full cell	21.12.40	40	49.6	12.20	10.70	11.50	7	21
Minyak berok	*Xanthophyllum varrucusuna*	Open tank	15.5.51	34	195.2	28.00	28.50	28.00	11	on-going
Nemesu	*Shorea pauciflora*	Open tank	7.11.34	20	54.4	16.00	14.00	15.10	5	20
Nipis kulit	*Memecylon pubescens*	Open tank	29.5.48	24	201.6	38.00	21.30	30.00	12	on-going
Nyalas	*Parastemon urophyllum*	Open tank	8.12.38	18	80.0	16.50	19.40	18.00	7	30
Nyalas	*Parastemon urophyllum*	Full cell	8.12.38	40	75.2	19.00	16.10	17.60	7	30
Nyatoh	*Palaquim* spp.	Open tank	21.7.49	49	284.8	29.00	30.00	30.00	7	30
Nyatoh	*Diplokema sebifera*	Open tank	3.8.71	40	68.8	7.00	5.00	6.00	5	on-going
Para rubber	*Hevea braziliensis*	Open tank	25.8.53	40	187.2	21.00	18.90	19.90	12	27
Pauh kijang	*Irvingia malayana*	Open tank	21.7.49	40	128.0	15.30	17.60	16.50	13	26
Pelong	*Pentaspadon velutinum*	Open tank	24.6.40	21	46.4	16.50	10.9	11.60	6	30
Penaga	*Mesua ferrea*	Open tank	21.1.58	20	N.A.	20.00	24.00	22.00	10	on-going
Penaga laut	*Calophyllum ionphylla*	Open tank	14.1.54	8	78.4	5.00	9.00	7.00	9	17
Penarahan	*Myristica gigantea*	Open tank	30.5.48	22	454.4	50.00	50.00	50.00	33	on-going
Perupok	*Lophopethlum* sp.	Open tank	21.12.40	47	156.8	29.60	23.60	26.60	10	42
Petaling	*Ochanostachys amentacea*	Open tank	30.5.48	40	206.4	41.00	40.00	40.50	15	on-going
Punah	*Tetramerista glabra*	Open tank	8.12.38	20	89.6	24.80	22.70	23.80	19	27
Punah	*Tetramerista glabra*	Full cell	8.12.38	40	83.20	22.40	21.80	22.00	12	23
Rengas	*Melanorrhoea torquata*	Open tank	5.3.52	40	270.4	47.00	39.00	43.00	17	on-going
Resak	*Vatica cuspidata*	Open tank	6.12.41	19	4.80	20.20	22.20	21.20	12	23
Resak	*Vatica cuspidata*	Full cell	6.12.41	40	N.A.	24.10	22.60	23.40	10	32
Sepam	*Mangifera* spp.	Open tank	21.2.40	28	238.4	37.40	33.50	35.50	13	42
Sepetir	*Sindora coriacea*	Open tank	9.7.50	40	140.8	26.00	26.00	26.00	6	on-going
Seraya	*Shorea curtisii*	Open tank	1.1.33	20	100.8	34.00	19.40	26.70	15	49
Seraya	*Shorea curtisii*	Full cell	1.12.33	40	132.8	30.70	30.30	30.50	14	48
Sesendok	*Endospermum malaccense*	Open tank	8.12.38	18	N.A.	16.60	17.80	17.20	6	25
Tempenis	*Sloetia clargata*	Open tank	3.5.48	30	59.2	17.00	17.60	17.30	16	28
Temponek	*Artocarpus rigidus*	Open tank	25.8.53	34	140.8	14.00	11.00	13.00	4	on-going
Terap	*Artocarpus scortechinii*	Open tank	25.8.53	24	182.4	14.00	14.50	14.00	1	on-going
Terentang	*Campnosperma auriculata*	Open tank	24.6.40	21	176.0	10.40	10.40	10.20	1	15
Tualang	*Koompassia excelsa*	Open tank	5.7.58	40	N.A.	15.20	13.30	14.30	8	20
Upun batu	*Upuna borneensis*	Open tank	15.1.51	38	11.2	21.50	21.50	21.00	15	28
West Indian Locust		Open tank	9.7.50	16	152.0	15.60	18.60	17.00	8	24
Yemane	*Gmelina arborea*	Open tank	26.7.61	40	57.6	9.5	12.90	11.20	9	19