Collection and Yield of Philippine Tanbarks

by

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SUMMARY

Seven upland tanbark species consisting of anabiong, bitaog, kalumpit, kamachile, kupang, narra, and sakat were studied for tanbark yield using four stripping methods for the collection of the bark. Except in one method, where the bark was completely peeled, the other three left continuous strips of bark along the trunks of experimental trees.

Bitaog had the thickest bark (1.53 cm.) and gave the highest average tanbark yield in green weight (9.7 kg./sq.m.), followed by kamachile (8.9 kg./sq.m.). Bitaog also had the highest air-dry yield (5.9 kg./sq.m.), followed by kalumpit (4.7 kg./sq.m.). The lowest average green and air-dry yields were obtained from narra (5.6 kg./sq.m. and 2.3 kg./sq.m., respectively). Of the species studied, the bark of narra was the thinnest (0.63. cm.).

Results indicated that callus formation was influenced by (a) extent of damage inflicted on the cambial layer in the process of stripping, (b) moisture content of the bark (season of stripping), and (c) species.

INTRODUCTION

In the Philippines, the barks of kamachile, an upland tanbark species, and some mangrove species are the main sources of tanning materials (4).[2] Among the common swamp tanbark species that were used for tanning leather are busáing (*Bruguiera gymnorrhiza* (L.) Lam.), langárai [B. *parviflora* (Roxb.) W. & A. ex. Griff.] pototan [B. *sexangula* (Lour.) Poir.], and tangál [*Ceriops tagal* (Perr.) C.B. Rob.]. Because of their high tannin content, these species provided tanbark for a group of tanneries that processed animal hides into finished leather (5). Today, kamachile [*Pithecellobium dulce* (Roxb.) Benth.] bark is used almost exclusively because of the light-colored leather it produces. The mangrove species are no longer used extensively as a source of tanbark because they produce hard, dark-red leather. This drawback, however, can be overcome by blending mangrove tanbark with other tanning materials.

Baens, *et al.* (1) and Gana (4) reported many native trees the barks of which have a fairly high tannin content (Table 1) and produce good leather. Among the species mentioned are anabiong [*Trema orientalis* (L.) Blume], kalumpit (*Terminalia microcarpa* Decne.), narra (*Pterocarpus indicus* Willd.), pili (*Canarium ovatum* Engl.), sakat (*Terminalia nitens* Presl), Benguet pine (*Pinus insularis* Endl.), bitaog (*Calophyllum inophyllum* L.), kariskis [*Albizia lebbekoides* (DC.) Benth.] and kupang (*Parkia roxburghii* G. Don). The tannin from kalumpit bark has been used in leather tanning but is not popular. The bark of narra is a potential source of commercial tannin, but since the trees are widely scattered in the forest the cost of bark collection seems uneconomical.

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[2] Numbers in parentheses refer to Literature Cited.

According to Brown (2), the name "cutch," which has been used for mangrove tanbark and bark extract, was originally applied to heartwood of *Acacia catechu* Willd. and was known all over India and Burma. It has gained recognition in foreign countries for processing heavy shoe sole and belting leather. For sometime, the "cutch" industry in the Philippines flourished. Unfortunately, however, the exportation of cutch from the Philippines became unprofitable because most of the good stands of mangrove species were considerably reduced by indiscriminate cutting. Botanically unsound methods of bark collection also resulted in the death of many trees.

This study was designed (a) to determine the yield of tanbark by diameter class and species, and (b) to determine the best method of stripping the bark without impairing the health of the trees.

MATERIALS AND METHODS

Selection of Trees (6, 7, and 8)

The species reported by Baens (1) as having high tannin content, and which were available in the Makiling Forest and vicinity, were selected for this study. A total of 64 trees, represented by seven upland tanbark species of different diameter classes. were studied as follows:

SPECIES	DIAMETER CLASS (cm.)	NO. OF TREES
Anabiong [*Trema orienatlis* (L.) Blanco]	30—40	9
	40—50	9
Bitaog (*Calophyllum inophyllum* L.)	40—50	4
Kalumpit (*Terminalia microcarpa* Decne.)	50—60	9
Kamachile (*Pithecellobium dulce* Roxb.)	20—30	4
	30—40	4
Kupang (*Parkia roxburghii* G. Don)	50—60	4
	70—80	4
Narra (*Pterocarpus indicus* Willd.)	50—60	8
	60—70	4
Sakat (*Terminalia nitens* Presl)	50—60	5

Preparation, Stripping and Labeling of Trees (6, 7, and 8)

Four experimental methods of stripping the bark were employed, designated as methods I, II, III and IV, which are illustrated in Figure 1. Generally, the stripping commenced from the base (at breast height or about one meter or less above the ground) up to the first branch of the tree. A sharp bolo, a hatchet and an improvised wooden debarking tool were used for the purpose. A bamboo ladder and a rope (ladder-fashioned) were used to reach the first branch of the tree. Except in method IV, where the bark was totally stripped or peeled, all other methods left unbroken strips of bark along the trunk or bole. Unbroken strips of bark left an uninterrupted pathway between roots and leaves to provide for a continuous supply of elaborated food materials. This enabled the tree to carry on its physiological functions more or less unimpaired, and afforded a good chance for bark regeneration. Each stripped tree was tagged with galvanized iron sheet (8 by 10 cm.) painted black, which indicated the method of stripping, species, tree number, diameter class and date of stripping.

Determination of Tanbark Yield (6, 7, and 8)

Freshly collected barks were bundled and weighed according to species and diameter class. To prevent fungal infection, the barks

collected from each tree were then sun-dried to almost air-dry condition. After sun-drying, the barks were again securely bundled and further air-dried indoors until the bark had attained constant air-dry condition.

RESULTS AND DISCUSSION

Table 2 gives data on the yield of tanbark by diameter class of the seven upland tanbark species found in the Makiling Forest and its vicinity. The comparative yield and bark thickness by diameter class are shown in Table 3. The comparative over-all average yield, moisture content of bark samples, average calculated area of bark stripped and average thickness of the bark are shown in Table 4. Callus formation, mortality and health condition of the experimental trees are presented in Table 5.

Over-all Tanbark Yield (Table 4)

The average yields of tanbark are expressed in kilogram per square meter (kg./sq.m.) of bark, based on green and air-dry weights. Based on over-all average tanbark yield, bitaog gave the highest, both in green and air-dry weights, 9.7 kg./sq.m. and 5.9 kg./sq.m., rsepectively. The lowest yield was obtained from narra, 5.6 kg./sq.m. (green weight) and 2.3 kg./sq.m. (air-dry weight).

Comparative Tanbark Yield and Bark Thickness by Diameter Class (Table 3)

In the present study, it was not possible to compare the tanbark yield and bark thickness of all the species by diameter class because of the limited number of experimental trees available in the sampling area.

In the 30-40 cm. diameter class, only anabiong and kamachile were studied. The latter species gave a higher yield than the former. Kamachile yielded 11.2 kg./sq.m. (green weight) and 5.2 kg./sq.m. (air-dry weight), while anabiong gave a yield of 7.6 kg./sq.m. and 2.5 kg./sq.m. in green and air-dry weight, respectively. In bark thickness, kamachile (1.05 cm.) had a thicker bark than anabiong (0.84 cm.).

In the 40-50 cm. diameter class, anabiong and bitaog were investigated. Bitaog gave a higher yield in green and air-dry weights (9.7 kg./sq.m. and 5.9 kg./sq.m., respectively) as compared with 7.8 kg./sq.m. and 2.8 kg./sq.m., respectively for anabiong. The bark of bitaog (1.53 cm.) was thicker than that of anabiong (0.87 cm.).

Four species were studied in the 50 to 60 cm. diameter class. Their yields, green and air-dry, in descending order were as follows: kalumpit (8.8 and 4.7 kg./sq.m.), sakat (8.1 and 4.5 kg./sq.m.), kupang (6.9 and 2.5 kg./sq.m.), and narra (5.6 and 2.0 kg./sq.m.). In bark thickness, kalumpit (0.96 cm.) and sakat (0.95 cm.) produced the thickest bark, followed by kupang (0.73 cm.). Narra had the thinnest bark (0.56 cm.).

Observation Notes by Species (Table 5)

Anabiong. — In the 30 to 40 cm. diameter class, two trees each stripped by Methods I and IV, and one tree treated under method II, completely regenerated their barks. The period of complete callus formation ranged from eight months and 23 days (Method IV) to one year and ten months (Method II). Of these trees only two are still living (Methods I and IV); the other three died (Methods I, II and IV). One of the surviving trees (Method IV) was healthy and the other tree (Method I) was very sickly probably because one of the main branches was broken by strong winds. Of the three dead trees, one was broken by strong winds (Method II), one was felled by kaiñgineros (Method IV), and one died because of an unknown malady (Method I). Very little to fair callus was formed on the other four trees (one tree in Method II and three trees in Method III), but they were either broken or uprooted by strong winds.

Of the nine trees in the 40 to 50 cm. diameter class, four trees stripped by Methods III (Plates 1 and 2) and IV had complete callus formation, the period of callusing ranged from four months (Method III) to 1-1/2 years (Method IV.) Three of these

trees were still healthy, but one had been uprooted by strong winds. The complete callus formed on the trees was flush with the old unstripped bark (Plate 3). One tree (Method I) had almost complete callus formation after a lapse of 2-1/2 years from date of stripping and was still vigorous. The remaining four trees (two each, under Methods I and II) were either broken by wind or died from an undetermined cause. These trees had callus which ranged from none to fair.

Bitaog. — All the four trees debarked by the four stripping methods completely regenerated their bark. The period of callusing ranged from 9-1/2 months (Method IV) to 10 months for Methods I, II and III. All the trees were healthy but two of them were purposely felled. In all instances, callus was unevenly formed (Plate 4) but flush with the old bark.

Kalumpit.—None of the trees stripped by the four methods completely regenerated its bark four years from the date of stripping. Callus formation ranged from very little (Method III) to almost complete (Methods I and II). All surviving trees were healthy. The two trees, stripped by Method IV died from damage inflicted on the cambial layer in spite of the care taken during the process of stripping.

Kamachile. — Except for one tree (30 to 40 cm. diameter class), stripped by Method IV which died six months after stripping because of severe termite infestation, all other trees (7) were healthy. Of these seven surviving trees, six have fair callus formation (Plate 5) and one has almost complete callus formation three years after stripping.

Kupang.—In the 50 to 60 cm. diameter class, only the tree stripped by Method I completely regenerated its bark after more than two years. Callus tissue was smoother than the old bark. The tree stripped by Method II had only fair callus and was healthy, and the exposed sapwood had been attacked by wood-decaying fungi (Plate 7). The tree treated under Method III was broken at the bole by a typhoon (Plate 8). No callus was formed on the tree under Method IV at the time it died from a broken bole after one year and ten months from stripping.

In the 70 to 80 cm. diameter class, callus formation was complete on the tree stripped by Method IV. Callus formed was irregular and swollen (Plate 9). Two trees had callus which ranged from very little (Method II) to almost complete (Method I). The three trees were healthy. The bole of the tree stripped by Method III was broken by strong winds.

Narra. — The trees stripped by the four methods in the 50 to 60 cm. and 60 to 70 cm. diameter classes were healthy, except one in Method II of the 60 to 70 cm. diameter class. Callus formation ranged from very little (Plate 10) to almost complete approximately 2-1/2 years after stripping. It was noted that the trees which developed very little callus in patches were those in which the cambial layer was damaged in the process of stripping.

Sakat. — Only two, one each under Methods I and III, out of the five trees stripped by the four methods were still vigorous. The tree stripped by Method I had almost complete callus at the end of 4-1/2 years from stripping (Plate 11), whereas under Method III only very little callus was formed almost three years from stripping.

General Observations

The form and soundness of the trunk or bole of the tree exerts some influence on the facility of stripping or peeling of the bark. Trees with bark relatively free from knots and other imperfections were easier to debark. Easy stripping was also noted when the trunk had more moisture content on account of recent rain (6, 7, and 8).

Of the four experimental stripping methods employed, Methods I and II required longer time in debarking because more strips

of bark have to be stripped than in Methods III and IV. The latter two methods, however, were decidedly easier and faster than the first two methods for the bark stripper.

Apparently, Method IV which completely removed the bark of the experimental trees did not seriously impair the health of anabiong and bitaog. All the trees of these two species stripped by Method IV were able to regenerate their bark completely and remain healthy.

As shown in Table 5, it appears that the different stripping methods had no significant effect on callus formation. It will be noted that the number of trees that were able to regenerate their bark partially or fully was nearly the same regardless of the method of stripping.

From this study, it was not possible to determine the factors that really affected the callus formation and health of the trees. Some factors, which obviously influenced the regenerative capacity of the bark, such as season of stripping and damage to cambial layer, were beyond experimental control. However, the over-all results tended to show that the most important factor that affected the health of the stripped trees was the extent of callus formation. Bark regeneration may be influenced by the following factors (6, 7, and 8):

1. *Extent of damage to the cambial layer in the process of stripping.* — It was generally observed that callus formation was, to some degree, dependent upon the extent of damage inflicted on the cambial layer. This damage was characterized by the scraping of the thin layer of meristimatic cells, thereby exposing the woody tissue. Generally, trees that were easy to debark were less prone to cambial injury, hence enhancing the regenerative ability of the bark.

2. *Moisture content of the bark.* — Trees with bark of high moisture content were generally easy to debark. Variation in moisture content is an inherent characteristic of the species. Anabiong was found to have a relatively high moisture content (240.41 per cent on the oven-dry basis) while narra and kalumpit had relatively low moisture contents of 74.00 and 75.31 per cent, respectively. Anabiong was comparatively much easier to debark than the latter two species.

The moisture content of the bark may be dependent also on the season when stripping was made. It was observed that stripping or peeling of the bark was easier during the rainy season than during the dry season.

3. *Species.* — It appears that the ability of a tree to regenerate its bark is characteristically inherent to the species. Bitaog, irrespective of the stripping method used, was able to regenerate its bark completely. Other species, like kalumpit, narra and sakat, even with the apparently much less harmful methods of stripping (Methods I and II), failed to regenerate their bark fully.

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Table 1. *Philippine tanbarks*[1] *as compared with Australian tanbark.*

Species	Tannin content in per cent[2] based on oven-dry weight
Black wattle[3]	42.50
Kalumpit	42.00 (20.0)
Narra	30.70
Kamachile	30.10 (31.8)
Sakat	27.38
Kariskis	21.90
Kupang	20.60 (9.2)
Bitaog	19.20
Kulatingan	19.00
Dalinsi	17.80
Yakal	17.17
Anabiong	17.10 (8.1)

[1] Baens, L. et al. Tannin content of Philippine barks and woods. Phil. Jour. Sci. 55: 177-180.

[2] The species with low or no tannin content were deleted from the list. Figures in parentheses represent tannin content determinations by FPRI.

[3] This Australian species is included for comparison with indigenous species.

Table 2. *Yield of tanbark by diameter class of seven upland tanbark tree species found in the Makiling National Park, College, Laguna and Bayog, Los Baños, Laguna.*

Species	Method of stripping	No. of trees stripped	Av. height of stripped bole	Av. calculated area of bark stripped	Av. bark thickness	Average yield (kg./sq.m.)	
						Green wt.	Air-dry wt.
			(meters)	(sq.m.)	(cm.)		
			(30-40 cm. diameter class)				
	I	2	3.61	1.88	0.80	7.4	2.0
	II	2	7.25	3.43	0.83	7.3	3.0
Anabiong	III	3	7.30	3.74	0.86	7.4	2.4
	IV	2	4.06	4.01	0.85	8.2	2.6
	Average		5.56	3.27	0.84	7.6	2.5
			(40-50 cm. diameter class)				
	I	3	8.36	4.84	0.93	8.5	3.2
	II	2	7.15	4.26	0.90	7.6	2.7
Anabiong	III	2	5.00	3.04	0.80	6.3	2.0
	IV	2	5.52	6.70	0.83	8.8	3.4
	Average		6.51	4.71	0.87	7.8	2.8
			(40-50 cm. diameter class)				
	I	1	1.47	1.04	1.50	9.5	7.5
	II	1	1.63	1.07	1.60	12.6	5.9
Bitaog	III	1	4.50	3.13	1.50	7.2	4.5
	IV	1	1.50	2.14	1.50	9.6	5.8
	Average		2.55	1.85	1.53	9.7	5.9

Species	Method of stripping	No. of trees stripped	Av. height of stripped bole	Av. calculated area of bark stripped	Av. bark thickness	Average yield (kg./sq.m.)	
						Green wt.	Air-dry wt.
			(meters)	(sq.m.)	(cm.)		
			(50-60 cm. diameter class)				
	I	2	9.20	6.55	0.85	8.4	4.6
	II	4	8.35	6.05	1.04	8.9	5.2
Kalumpit	III	1	10.38	8.10	1.00	8.6	4.3
	IV	2	6.81	10.37	0.95	9.3	4.5
	Average		8.69	7.77	0.96	8.8	4.7
			(20-30 cm. diameter class)				
	I	1	0.86	0.38	0.80	5.8	2.4
	II	1	0.96	0.33	0.70	5.5	1.8
Kamachile	III	1	1.00	0.44	1.50	9.1	3.6
	IV	1	0.70	0.72	0.60	6.0	2.5
	Average		0.88	0.47	0.90	6.6	2.6
			(30-40 cm. diameter class)				
	I	1	1.14	0.64	1.30	10.6	4.7
	II	1	1.72	1.02	1.30	10.8	5.6
Kamachile	III	1	1.10	0.70	1.00	8.6	3.7
	IV	1	0.70	0.77	0.60	14.8	6.9
	Average		1.17	0.78	1.05	11.2	5.2
			(50-60 cm. diameter class)				
	I	1	3.81	3.18	0.60	6.8	2.4
	II	1	8.10	5.72	0.70	7.1	2.3
Kupang	III	1	4.18	3.23	0.90	7.1	2.5
	IV	1	4.29	8.46	0.70	6.8	2.7
	Average		5.35	5.15	0.73	6.9	2.5
			(70-80 cm. diameter class)				
	I	1	12.80	13.72	1.20	9.9	4.2
	II	1	11.27	11.44	0.90	7.6	3.2
Kupang	III	1	10.32	9.50	0.80	6.8	2.3
	IV	1	4.80	11.50	1.00	9.6	3.8
	Average		9.80	11.54	0.98	8.5	3.4
			(50-60 cm. diameter class)				
	I	2	3.49	2.57	0.55	4.2	1.8
	II	2	4.39	3.34	0.65	6.8	2.2
Narra	III	2	2.76	2.19	0.60	5.3	1.8
	IV	2	3.11	4.64	0.50	5.6	2.3
	Average		3.44	3.18	0.56	5.5	2.0

Species	Method of stripping	No. of trees stripped	Av. height of stripped bole	Av. calculated area of bark stripped	Av. bark thickness	Average yield (kg./sq.m.)	
						Green wt.	Air-dry wt.
			(meters)	(sq.m.)	(cm.)		
			(60-70 cm. diameter class)				
	I	1	2.65	2.40	0.60	6.1	2.7
	II	1	3.68	3.10	0.80	6.3	1.9
Narra	III	1	3.50	3.10	0.70	5.8	2.4
	IV	1	2.69	4.80	0.70	4.7	2.8
	Average		3.13	3.35	0.70	5.7	2.5
			(50-60 cm. diameter class)				
	I	2	7.15	5.78	1.00	9.7	5.1
	II	1	14.82	11.90	1.00	6.5	4.2
Sakat	III	1	8.43	6.97	1.00	9.6	5.3
	IV	1	8.93	12.64	0.80	6.5	3.3
	Average		9.86	9.42	0.95	8.1	4.5

Table 3. *Comparative yield and bark thickness by diameter class of certain upland tanbark species found in the Makiling National Park and vicinity.*[1]

Species	Av. yield (kg./sq.m.)		Av. calculated area of bark stripped	Average bark thickness
	Green wt.	Air-dry wt.		
			(sq. m.)	(cm.)
		(30-40 cm. diameter class)		
Anabiong	7.6	2.5	3.27	0.84
Kamachile	11.2	5.2	0.78	1.05
		(40-50 cm. diameter class)		
Anabiong	7.8	2.8	4.71	0.87
Bitaog	9.7	5.9	1.85	1.53
		(50-60 cm. diameter class)		
Kalumpit	8.8	4.7	7.77	0.96
Kupang	6.9	2.5	5.15	0.73
Narra	5.6	2.0	3.18	0.56
Sakat	8.1	4.5	9.42	0.95

[1] Insufficiency of experimental trees did not permit representation of all species in the different diameter class.

Table 4. *Comparative over-all average tanbark yield, moisture content of bark samples, average calculated area of bark stripped and average bark thickness.*

Species	Av. yield (kg./sq.m.)[1]		Av. calculated area of bark stripped	Av. thickness of bark	Av. moisture content[2]	
	Green wt.	Air-dry wt.			Green condiiton	Air-dry condiiton
			sq.m.	cm.	Per cent	Per cent
Anabiong	7.7	2.6	3.99	0.86	240.41	12.27
Bitaog	9.7	5.9	1.85	1.53	86.00	12.40
Kalumpit	8.8	4.7	7.77	0.96	75.31	14.63
Kamachile	8.9	3.9	0.63	0.98	152.90	13.00
Kupang	7.7	3.0	8.35	0.86	195.29	12.74
Narra	5.6	2.3	3.25	0.63	74.00	30.40
Sakat	8.1	4.5	9.42	0.95	107.61	12.60

[1] Yields are over-all averages for all trees of each species by all methods of stripping.
[2] Moisture percentages based on oven-dry weight.

Table 5. *Callus formation, mortality and health condition of experimental upland tanbark trees in the Makiling National Park and vicinity.*

Species	Method of stripping	Tree No.	Callus formation[1]	Period from date of stripping to complete callus formation or last observation	Health condition of tree[2]	Remarks
			(30-40 cm. diameter class)			
	I	1	complete	1 yr. 8 mo. & 21 days	very unthrifty	one main branch broken due to strong winds.
		2	complete	1 yr. 8 mo. & 26 days	—	tree was thrifty after 1 year and 10 months from stripping but died at the end of 3½ years.
	II	1	complete	1 yr. 9 mo. & 26 days	—	tree was thrifty up to 3 years from stripping, but broken by wind.
		2	—	—	—	fair callus formation, 2 yr. 1 mo. & 18 days after stripping, but tree was broken by wind.
Anabiong	III	1	very little	4 yr. 7 mo. & 23 days	unthrifty	bole broken and severely attacked by termites.
		2	—	—	—	fair callus formation, 2 mo. & 27 days after stripping, but tree was uprooted by wind at the end of 2 years.
		3	—	—	—	no callus formation and broken by wind, 2 mo. & 27 days after stripping.
	IV	1	complete	8 mo. & 29 days	thrifty	—
		2	complete	8 mo. & 23 days	—	felled by kaingineros, 1 yr. & 2 monhts after stripping.

[1] Callus formation was rated as follows: very little — callus over approximately 5 to 15 cent of stripped surface; fair — callus 20 to 40 per cent of srtipped surface; almost complete — callus 90 to 95 per cent of stripped surface; and complete — callus 98 to 100 per cent of stripped surface.

[2] Observation of health condition was made at date of last observation.

Species	Method of stripping	Tree No.	Callus formation	Period from date of stripping to complete callus formation or last observation	Health condition of tree	Remarks
				(40-50 cm. diameter class)		
Anabiong	I	1	—	—	—	fair callus formation, 22 months and 15 days after stripping but broken by wind.
		2	—	—	—	fair callus formation, 2 months and 21 days after stripping but broken by wind.
		3	almost complete	2 yr. 6 mo. & 25 days	thrifty	—
	II	1	—	—	—	no callus formation, 2 months and 12 days after stripping, but tree died at end of 22 months.
		2	—	—	—	very little callus, 21 months & 25 days after stripping, but tree was uprooted by wind.
	III	1	complete	8 mo. & 26 days	thrifty	callus was flush with, and smoother than old bark.
		2	complete	4 mo. & 2 days	thrifty	- ditto -
	IV	1	complete	1 yr. 7 mo. & 24 days	—	uprooted by wind at end of 1 year and 9 months after stripping.
		2	complete	8 mo. & 27 days	thrifty	callus was flush with and smoother than old bark.
				(40-50 cm. diameter class)		
Bitaog	I	1	complete	10 mo. & 1 day	thrifty	callus was flush with older bark but was unevenly formed.
	II	1	complete	10 mo. & 1 day	thrifty	callus was almost flush with old bark but unevenly formed.
	III	1	complete	10 mo. & 1 day	—	tree was thrifty but it was felled to give way to building construction.
	IV	1	complete	9 mo. & 19 days	—	- ditto -

Species	Method of stripping	Tree No.	Callus formation	Period from date of stripping to complete callus formation or last observation	Health condition of tree	Remarks
			(50-60 cm. diameter class)			
	I	1	fair	4 yr. 5 mo. & 28 days	thrifty	—
		2	almost complete	4 yr. 5 mo. & 28 days	thrifty	callus smoother than old bark.
	II	1	fair	4 yr. 6 mo. & 19 days	thrifty	exposed sapwood severely attacked by termites and wood-decaying fungi.
		2	fair	4 yr. 6 mo. & 18 days	thrifty	- ditto -
Kalumpit		3	almost complete	4 yr. 6 mo. & 17 days	thrifty	—
		4	almost complete	4 yr. 6 mo. & 10 days	thrifty	—
	III	1	very little	3 yr. and 20 days	thrifty	callus along margin of wound swollen.
	IV	1	—	—	—	no callus was formed until tree died 1 yr. 9 mo. and 23 days after stripping.
		2	—	—	—	very little callus was formed until tree died 3 years after stripping.
			(20-30 cm. diameter class)			
	I	1	fair	3 yr. 3 mo. & 3 days	thrifty	callus along margin of wood swollen.
	II	1	fair	- ditto -	thrifty	- ditto -
Kamachile	III	1	fair	- ditto -	thrifty	- ditto -
	IV	1	fair	- ditto -	thrifty	thick callus was formed along margin of wood. Sprouts developed at base.

Species	Method of stripping	Tree No.	Callus formation	Period from date of stripping to complete callus formation or last observation	Health condition of tree	Remarks
				(*30-40 cm. diameter class*)		
	I	1	almost complete	3 yr. 3 mo. & 3 days	thrifty	callus was swollen and surface smooth but irregular.
	II	1	fair	- ditto -	thrifty	—
Kamachile	III	1	fair	- ditto -	thrifty	callus was swollen and surface smooth but irregular.
	IV	1	—	—	—	tree died 6 months after stripping due to severe termite infestation.
				(*50-60 cm. diameter class*)		
	I	1	complete	2 yr. 2 mo. & 20 days	thrifty	callus smoother than old bark.
	II	1	fair	- ditto -	thrifty	callus along edge of wound swollen; exposed wood attacked by wood-decaying fungi and termites.
Kupang	III	1	—	—	—	callus formation was very little after a lapse of 2 years and 2 mo.; bole broken by typhoon.
	IV	1	—	—	—	no callus was formed until tree died due to broken bole 1 yr 10 mo. and 23 days after stripping.
				(*70-80 cm. diameter class*)		
	I	1	almost complete	3 yr. 11 mo. & 2 days	thrifty	callus smooth but swollen.
	II	1	very little	2 yr. 10 mo. & 2 days	thrifty	exposed wood drying-up
Kupang	III	1	—	—	—	very little callus formation after 1 mo. and 18 days; tree was broken by wind.
	IV	1	complete	2 yr. and 14 days	thrifty	callus formation was irregular and swollen.

Species	Method of stripping	Tree No.	Callus formation	Period from date of stripping to complete callus formation or last observation	Health condition of tree	Remarks
				(50-60 cm. diameter class)		
	I	1	almost complete	2 yr. 7 mo. & 1 day	thrifty	callus flush with old bark.
		2	fair to complete	2 yr. 5 mo. & 27 days	thrifty	callus formation was complete at the lower 1/3 portion of stripped bole and only fair on the upper 2/3 portion.
	II	1	fair	2 yr. 2 mo. & 3 days	thrifty	—
Narra		2	fair to complete	2 yr. and 6 mo.	thrifty	callus formation was complete in one of the two stripped areas; the second has fair callus.
	III	1	very little	2 yr. 7 mo. & 7 days	thrifty	—
		2	very little	2 yr. 8 mo. & 14 days	thrifty	callus along edge of wound swollen; small patches of callus scattered over the exposed wood.
	IV	1	very little to complete	2 yr. 7 mo. & 2 days	thrifty	callus formation was complete in one of the two stripped areas; the second has very little callus.
		2	very little	2 yr. 8 mo. & 27 days	thrifty	exposed wood whitish; roots developed on callus around the upper girdle.
				(60-70 cm. diameter class)		
	I	1	fair	2 yr. 6 mo. & 22 days	thrifty	callus formed along edge of wound swollen.
	II	1	very little	2 yr. 6 mo. & 21 days	unthrifty	—
Narra	III	1	very little	2 yr. 6 mo. & 15 days	thrifty	—
	IV	1	fair	2 yr. 6 mo. & 10 days	—	tree beginning to shed its leaves (normal summer shedding of leaves).

Species	Method of stripping	Tree No.	Callus formation	Period from date of stripping to complete callus formation or last observation	Health condition of tree	Remarks
			(50-60 cm. diameter class)			
Sakat	I	1	almost complete	4 yr. 6 mo. & 8 days	thrifty	—
		2	—	—	—	very little callus was formed until the tree died 1 yr. and 8 months after stripping.
	II	1	—	—	—	fair callus formation after 1-1/2 years from stripping but tree died at end of 1 yr and 11 mo.
	III	1	very little	2 yr. 11 mo. & 5 days	thrifty	—
	IV	1	—	—	—	very little callus formation 26 days after stripping, but tree died at end of 10 mo.

Figure I
Experimental methods of stripping. (X) showing bark sections to be stripped.