Extractives in Teak

By D. NARAYANAMURTI, JOSEPH GEORGE, H. C. PANT, and JAGRAJ SINGH

Forest Research Institute, Dehra Dun, India

(Received for publication February 27, 1962)

During the past few years the influence of extractives on the properties of wood has been under investigation in this laboratory (vide NARAYANAMURTI, NARAYANAMURTI, *et al*). More recently VERMA (1960) studied the variation of extractives in three species of wood and their effect on dimensional stability, durability, strength, etc. The caoutchouc content of various teak wood samples have also been studied in this laboratory during the past two years. In agreement with SANDERMANN and DIETRICHS (1959) the caoutchouc content appears to be of importance for abrasion resistance and possible resistance to acids. The present note deals with the examination of samples of wood of known origin.

Table 1. — Extractives content and durability of teak against fungus (*Polystictus* versicolor).

Age of tree, years	Location of specimens	Distance of specimen from pith cm	Initial density g/cm³	Decrease % in weight	Decrease % in Density	Decrease % in M of E	Caoutchouc content %	Extractives: Ether %	Extractives: Methyl alcohol %	Remarks
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
10	Radius **A**	0.8	0.73	26.4	21.9	55.4	0.80	2.0	4.5	
		2.5	0.71	26.2	25.4	56.4	0.66	—	—	
		3.8	0.63	25.8	20.6	40.1	0.33	2.2	4.4	
		4.8	0.78	5.2	9.6	18.4	0.73	3.3	4.9	
		5.8	0.69	1.0	1.4	3.5	0.99	3.7	5.5	
		6.9	0.66	55.0	51.5	94.7	—	1.6	2.3	Sap-wood
		7.7	0.72	40.8	37.5	86.7	—	—	—	Sap-wood
10	Radius B	1.7	0.69	44.2	27.5	77.5				
		3.9	0.69	3.4	2.9	12.7				
		4.9	0.71	2.5	1.4	18.0				
		6.0	0.75	8.3	8.7	19.9				
		7.4	0.70	3.5	1.5	3.4				
		8.7	0.67	44.9	43.3	86.1				Sap-wood
		9.9	0.62	31.8	17.7	75.3				Sap-wood
30	Radius **A**	0.7	0.58	16.9	15.5	55.7	—	3.3	3.0	
		2.2	0.56	29.0	25.0	78.0	0.69	3.7	3.5	
		4.2	0.58	4.3	3.5	12.9	0.58	4.0	3.1	
		6.4	0.60	16.0	8.7	25.0	1.47	—	—	
		8.8	0.67	2.0	3.0	18.1	—	4.5	2.8	
		11.1	0.71	5.6	4.2	13.1	1.70	—	—	
		13.4	0.67	2.7	3.0	2.6	—	5.0	4.4	
		15.8	0.75	4.1	4.0	18.0	1.84	—	—	
		18.6	0.62	3.1	3.2	21.3	2.22	6.5	3.0	
		20.7	0.73	29.1	23.3	66.2	—	3.4	2.0	Sap-wood
		22.0	0.59	21.6	11.9	42.6	—	—	—	Sap-wood
30	Radius B	0.8	0.59	22.4	22.0	66.2	—	—	—	
		2.0	0.67	7.9	9.0	32.9				
		4.3	0.66	4.7	4.5	14.9				
		6.4	0.65	3.9	3.1	5.2				
		9.0	0.62	2.0	1.6	19.7				
		11.2	0.73	7.0	6.8	19.4				
		12.7	0.60	62.8	55.5	—				Sap-wood
		14.2	0.63	59.0	60.0	88.2				Sap-wood
62	Radius **A**	1.0	0.61	8.8	9.8	31.8	1.18	3.2	2.3	
		3.0	0.62	15.1	14.5	30.6	1.58	—	—	
		5.3	0.71	3.8	4.2	9.9	1.47	3.7	3.7	
		7.6	0.61	12.4	11.5	24.0	1.73	—	—	
		10.4	0.63	4.8	3.3	6.2	—	5.0	3.1	
		12.7	0.61	1.1	1.7	4.7	2.04	—	—	
		15.3	0.68	3.6	3.0	8.4	—	7.3	3.4	
		17.9	0.69	2.9	4.5	5.0	2.65	—	—	
		20.3	0.70	1.8	1.4	8.7	—	7.9	4.4	
		22.2	0.69	3.6	2.9	12.0	4.60	—	—	
		24.0	0.77	2.7	2.6	12.4	2.57	10.0	4.3	
		25.9	0.70	10.7	14.3	29.2	—	3.6	4.9	Sap-wood
62	Radius B	1.5	0.58	27.8	22.4	76.8				
		3.9	0.64	29.0	26.6	78.4				
		5.8	0.56	9.9	10,7	22.4				
		8.1	0.61	5.3	4.9	14.5				
		10.4	0.65	0	0	6.5				
		12.6	0.71	10.0	7.1	20.9				
		14.7	0.72	2.7	1.4	5.6				
		16.4	0.69	0.9	1.5	11.2				
		17.8	0.74	0	0	11.3				
		19.2	0.66	25.4	19.7	44.9				Sap-wood

Table 2. — Durability (average for 2 radii) and extractives content (one radius) versus age of test specimens.

Age of tree, years	Age of speci-men, years	Test fungus (*Polystictus versicoler*) De-crease in weight %	De-crease in density %	De-crease in M of E %	Total ether and methyl alcohol extract, %	Caoutchouc content, %
1.	2.	3.	4.	5.	6.	7.
10	2	26.4	21.9	55.4	6.5	0.80
	3	35.2	26.5	67.0	—	0.66
	4	14.5	11.8	26.4	6.6	0.33
	5	3.9	5.5	18.2	8.2	0.73
	6	4.6	5.1	11.7	9.2	0.99
	7	3.5	1.5	3.4	—	—
30	2	19,7	18.8	61.0	6.3	—
	4	29.0	25.0	78.0	7.2	0.69
	8	6.1	6.3	22.9	7.1	0.58
	11	16.0	8.7	25.0	—	1.47
	14	2.0	3.7	18.1	7 2	—
	16	5.2	4.4	14.0	—	1.70
	19	3.3	3.1	3.9	9.4	—
	21	3.1	2.8	18.9	—	1.84
	23	7.0	6.8	19.4	—	—
	24	3.1	3.2	21.3	9.5	2.22
62	2	8.8	9.8	31.8	5.5	1.18
	3	21.5	18.5	53.7	—	1.58
	4	29.0	26.6	78.4	—	—
	6	3.8	4.2	9.9	7.4	1.47
	7	9.9	10.7	22.4	—	—
	9	12.4	11.5	24.0	—	1.73
	11	5.3	4.9	14.5	—	—
	13	4.8	3.3	6.2	8.1	—
	16	0	0	6.5	—	—
	18	1.1	1.7	4.7	—	2.04
	23	10.0	7.1	20.9	—	—
	24	3.6	3.0	8.4	10.7	—
	29	2.9	4.5	5.0	—	2.65
	30	2.7	1.4	5.6	—	—
	34	1.8	1.4	8.7	12.3	—
	38	0.9	1.5	11.2	—	—
	40	3.6	2.9	12.0	—	4.60
	47	0	0	11.3	—	—
	50	2.7	2.6	12.4	14.8	2.57

Table 3. — Durability and extractives content versus age of test specimens taken from teak discs from 62, 30 and 10 year old trees (Average values for the three discs).

Age of specimen, years	Test fungus *Polystictus versicolor* Decrease in weight %	Decrease in density %	Decrease in M of E %	Total ether and methyl alcohol ex-tractives, %	Caoutchouc content, %
1.	2.	3.	4.	5.	6.
2	18.6	17.6	52.8	6.1	1.00
3	28.3	22.5	60.3	—	1.12
4	21.8	13.8	52.3	6.9	0.51
5	3.9	5.6	18.2	8.2	0.73
6	4.4	4.8	11.3	8.8	1.23
7	6.7	5.6	12.9	—	—
8	6.1	6.3	22.9	7.1	0.58
9	12.4	11.5	24.0	—	1.73
11	10.6	6.8	19.8	—	1.47
13	4.8	3.9	6.2	8.1	—
14	2.0	3.0	18.1	7.2	—
16	5.8	4.4	11.5	—	1.70
18	1.1	1.7	4.7	—	2.04
19	3.3	7.1	2.6	9.4	—
21	3.1	2.8	18.9	—	1.84
23	8.5	7.0	20.1	—	—
24	3.4	3.1	14.9	10.1	2.22
29	2.9	4.5	5.0	—	2.65
30	2.7	1.4	5.6	—	—
34	1.8	1.4	8.7.	12.3	—
38	0.9	1.5	11.2	—	—
40	3.6	2.9	12.0	—	4.60
47	0	0	11.3	—	—
50	2.7	2.6	12.4	14.8	2.57

Material used for the investigation

Discs from about 22.5 cms from the butt end of trees, 10 years (from Chaliyamukh) 30 years (from Chaliyamukh)

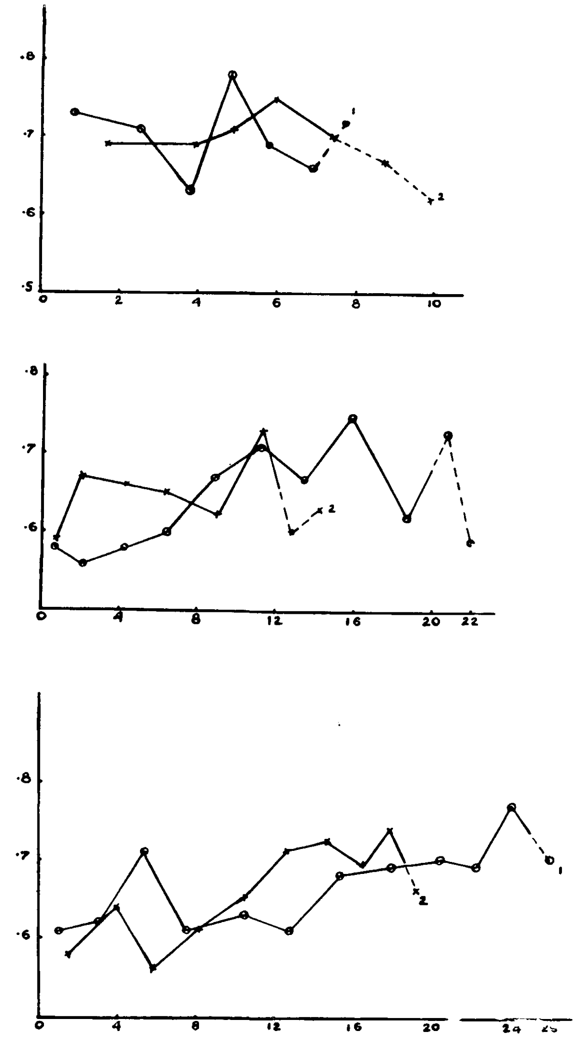

Fig. 1. — Abscissa: Distance from pith, cm. — Ordinate: Density, g/cm³. — Density versus distance along (1) Radius A and (2) Radius B. Broken lines represent sapwood. — *Top:* 10 year old tree. — *Middle:* 30 year old tree. — *Bottom:* 62 year old tree.

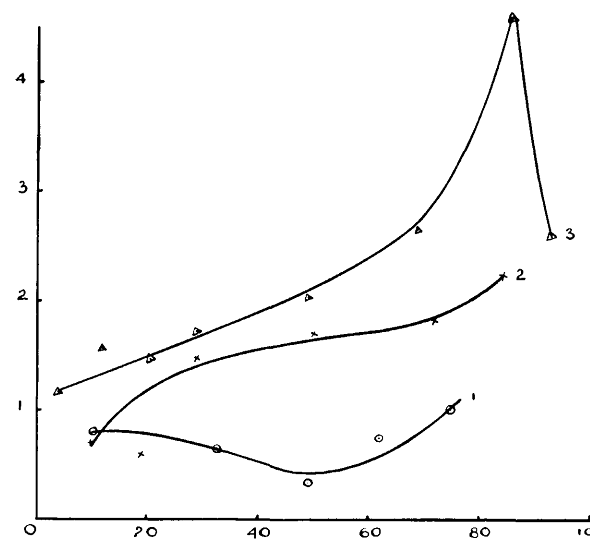

Fig. 2. — Abscissa: Distance from pith, %. — Ordinate: Caoutchouc content, %. — (1) 10 year old tree, (2) 30 year old tree, (3) 62 year old tree.

and 62 years (Kuralai range) old were used in this study. They were from Nilambur, plantation grown and of Nilambur origin.

Properties studied

The material was examined for caoutchouc content, ether and methyl alcohol extractives, density and modulus of elasticity along two radii in each disc. Specimens 7.5 × 1.0 × 0.2 cm taken along the radii from pith to bark were also subjected to the attack of *Polystictus versicolor* in Kolle flasks for 12 weeks to evaluate the decay resistance.

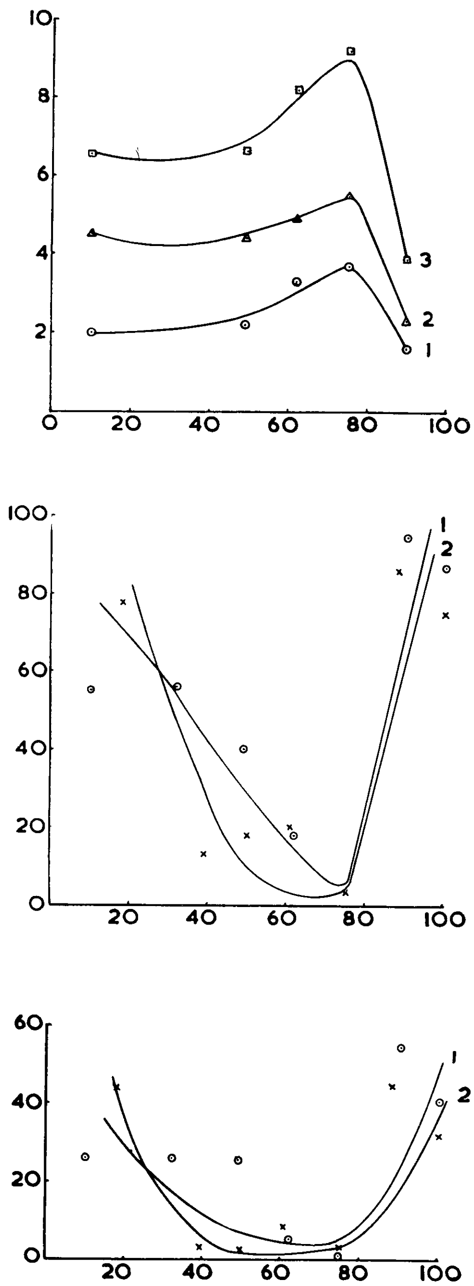

Fig. 3. — Abscissa: Distance from pith, %. — Ordinate: *Top* — Extractives, %. — *Middle* — Decrease, % in M of E. — *Bottom* — Decrease, % in weight. — Distance of specimen from pith versus: — *Top:* (1) Ether extractives, (2) Methyl alcohol extractives, (3) Total extractives. — *Middle:* (1) Decrease in M of E along (1) Radius A and (2) Radius B. — *Bottom:* Decrease in weight along (1) Radius A and (2) Radius B. — 10 year old tree. Arrows indicate point of demarcation between heartwood and sapwood.

Results

Results of all the work are assembled together in *tables 1—4* and *figures 1—10.*

Discussion

There is a definite trend for density (*fig. 1*) to increase from centre to bark in the 62 years old tree, but not in the other two trees. The caoutchouc content (*fig. 2*) shows a fall

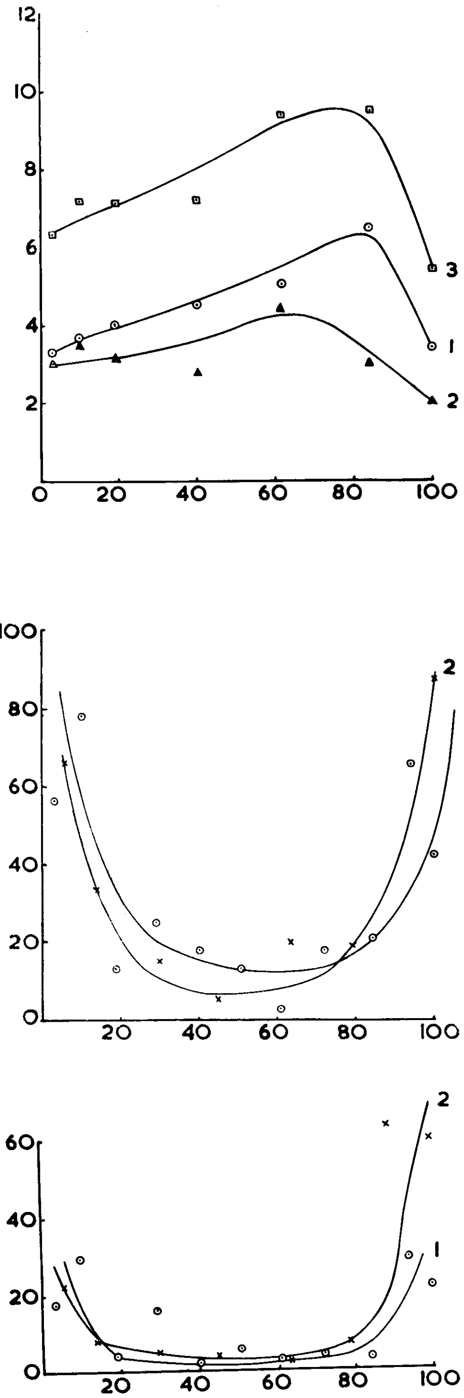

Fig. 4. — Abscissa: Distance from pith, %. — Ordinate: *Top* — Extractives, %, — *Middle* — Decrease, % in M of E, — *Bottom* — Decrease, % in weight. — Distance of specimen from pith versus: — *Top:* (1) Ether extractives, (2) Methyl alcohol extractives, (3) Total extractives. — *Middle:* Decrease in M of E along (1) Radius A and (2) Radius B. — *Bottom:* Decrease in weight along (1) Radius A and (2) Radius B. — 39 year old tree. Arrows indicate point of demarcation between heartwood and sapwood.

from inner heart wood to middle heart wood and rises again with the 10 year old tree. With the 62 year old one there is a steady increase and a fall again at the outermost heart wood. SANDERMANN and DIETRICHS (1959) with their samples found a rise with a fall again, a rise and a final fall. The rubber content (maximum) was in the ratio of 1 : 2.2 : 4.6 for 10; 30; 62 year old trees and the averages were 0.70, 1.41, 2.29% respectively.

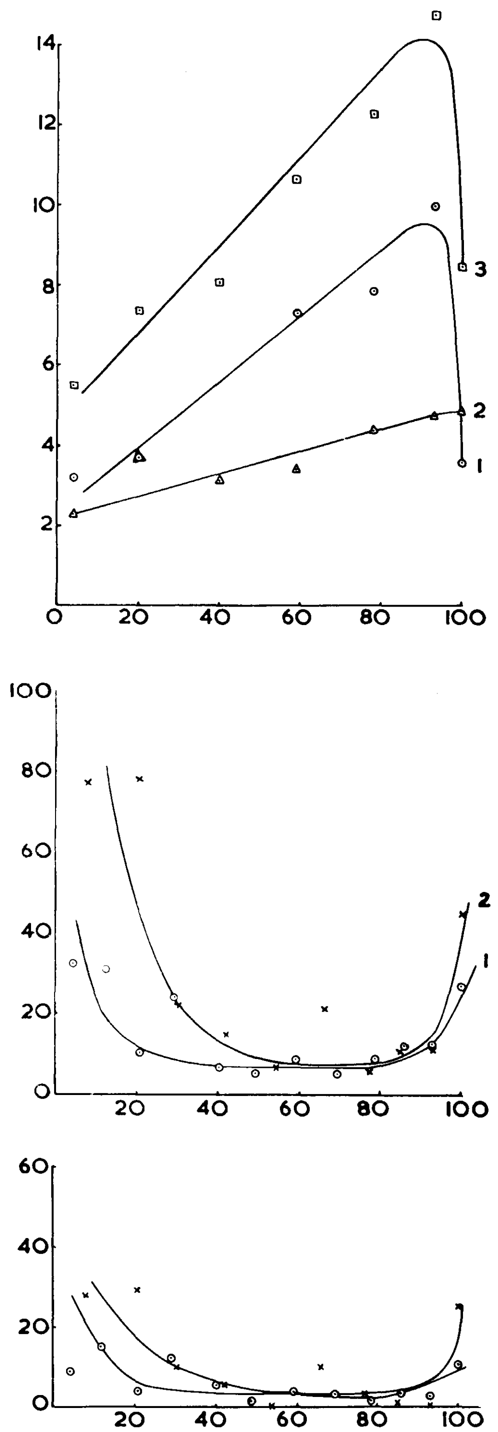

Fig. 5. — Abscissa: Distance from pith, %. — Ordinate: *Top* — Extractives, %, — *Middle* — Decrease, % in M of E, — *Bottom* — Decrease, % in weight. — Distance of specimen from pith versus: *Top* — (1) Ether extractives, (2) Methyl alcohol extractives, (3) Total extractives. — *Middle* — Decrease in M of E along (1) Radius A and (2) Radius B. — *Bottom* — Decrease in weight along (1) Radius A and (2) Radius B. — 62 year old tree. Arrows indicate point of demarcation between heartwood and sapwood.

The ether extractives (*figs. 3—5*) showed a gradual rise from inner heart to outer heart in all cases, the maximum values being 3.7, 6 5 and 10%. The averages were 2.8, 4.5 and 6.2%. The jump from inner to outer heart was the same (2 times) with 10 and 30 year old trees and 3 times with the 62 year old one. With regard to the methyl alcohol extractives (*figs. 3—5*) there was regular rise with the 10 years old from pith to periphery but not so with the other two trees. Both the maximum and average values were higher for the youngest tree.

From *figs. 3—5* it will be seen that durability as indicated both by weight loss and loss in modulus of elasticity increases with age especially the percentage of the disc (durable part). The middle to outer heart wood is the most durable region and this region also contains the maximum of extractives (ether and methyl alcohol). The loss in weight and elasticity as a function of extractives content is plotted in *figs. 6—8*. The *table 4* below gives an analysis of the results (see p. 62).

It will be seen that for ether extractives a larger percentage was indicated with age; the reverse was the case for methyl-alcohol extractives. For the total extractives

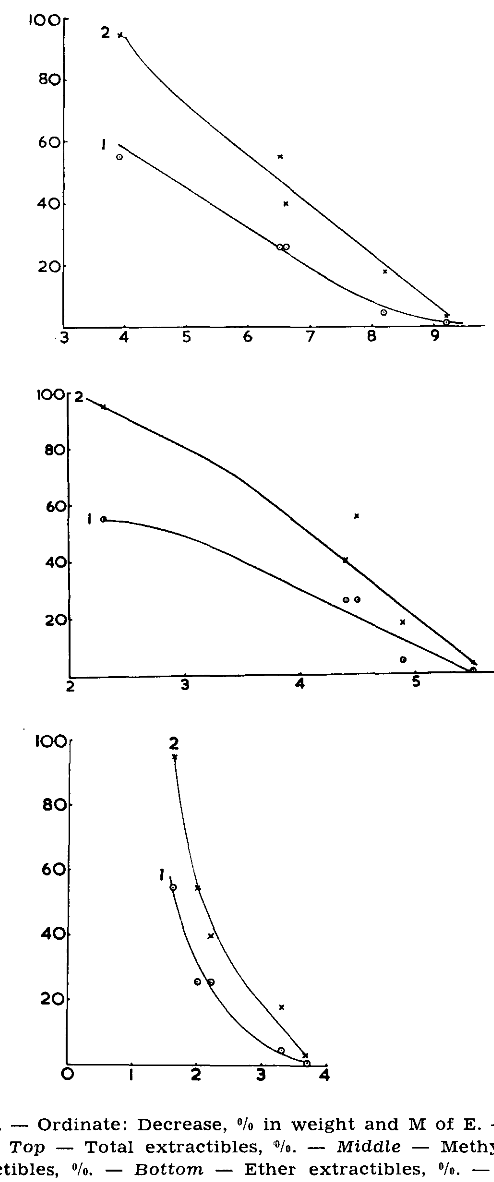

Fig. 6. — Ordinate: Decrease, % in weight and M of E. — Abscissa: — *Top* — Total extractibles, %. — *Middle* — Methyl alcohol extractibles, %. — *Bottom* — Ether extractibles, %. — Decrease in weight and M of E versus extractibles in 10 year old tree: (1) Weight. (2) M of E.

also with age a lesser quantity appears to be sufficient. While one cannot read too much into this it is probable with age some cell wall changes take place and such changes have to be taken into account.

The variations from the general trends along the radius noticed may possibly be due to thinning cycles.

VERMA (1960) found that the basal portion of a teak tree was not very durable, the most durable portion being at about 380 cm. from the base. This would suggest that the material now examined came from better trees. As pointed out by DA COSTA *et al.* (1960) *Polystictus versicolor* even though it is very destructive to teak under laboratory conditions is not usually found on teak under natural conditions. This also supports the view that material examined comes from good stock. Moreover the specimens were thin in size and as such greater weight losses are to be expected than in standard tests.

Durability, wear resistance and strength properties are to be considered in the selection of material. As durability, specific gravity, rubber content and modulus of elasticity can be determined on cores taken out from living trees they may be used as additional supporting criteria in the selection of plus trees for cross breeding work.

We are grateful to Dr. KEDARNATH, Forest Geneticist, for the discs and Dr. B. K. BAKSHI, Officer-in-Charge, Forest Pathology Branch for the cultures of *Polystictus versicolor*.

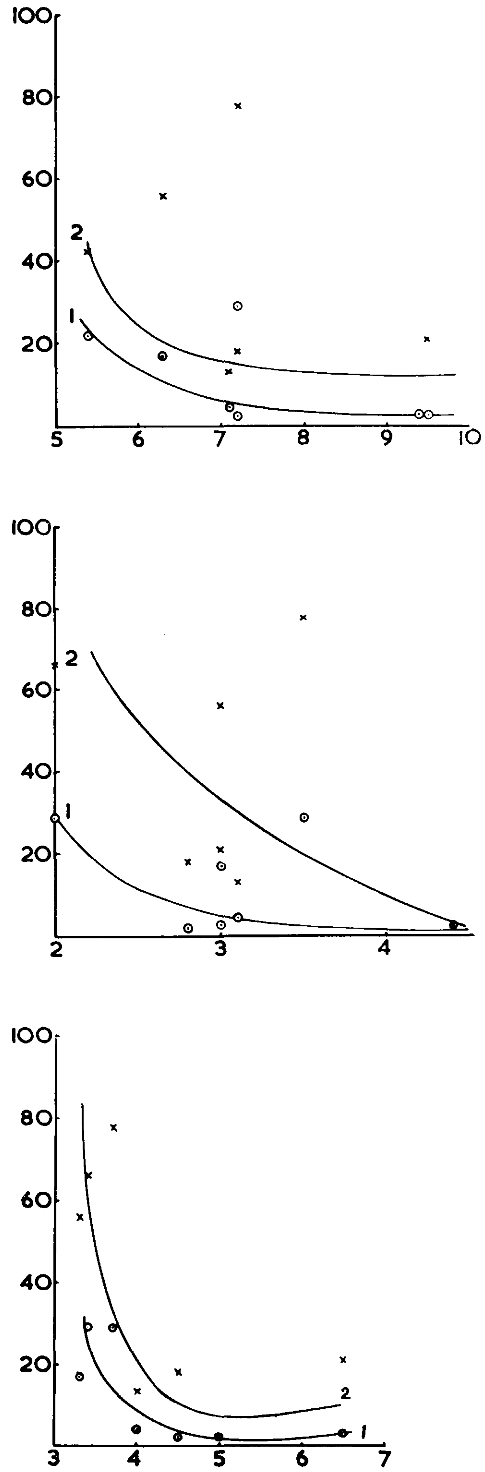

Fig. 7. — Ordinate: Decrease, % in weight and M of E. — Abscissa: — *Top* — Total extractibles, %. — *Middle* — Methyl alcohol extractibles, %. — *Bottom* — Ether extractibles, %. — Decrease in weight and M of E versus extractibles in 30 year old tree: (1) Weight. (2) M of E.

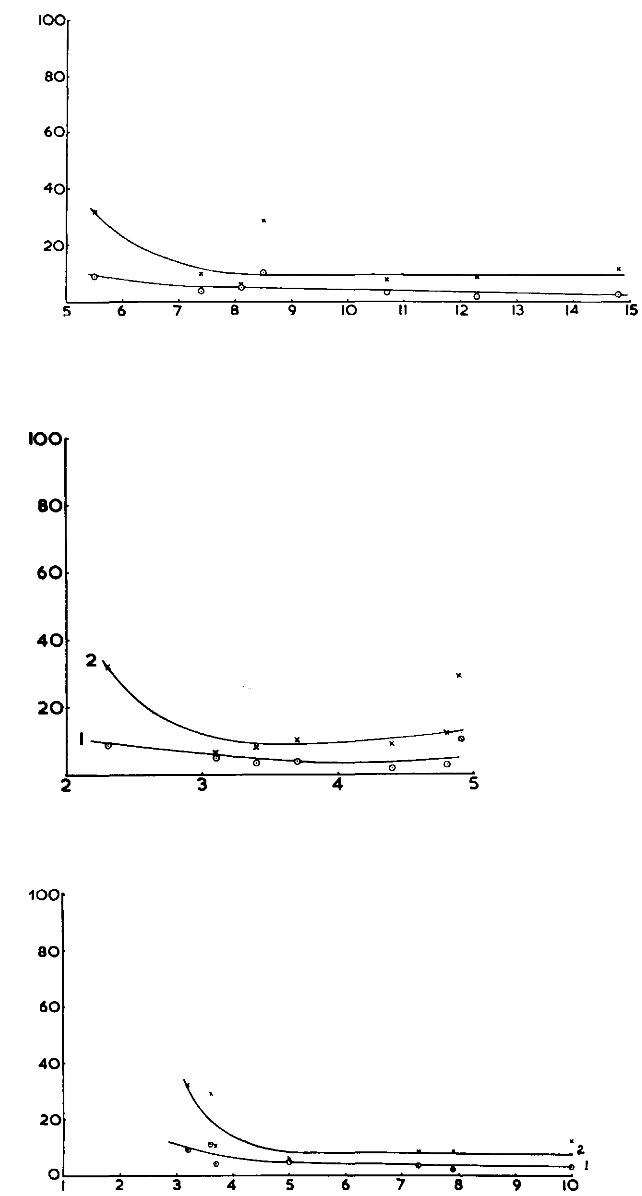

Fig. 8. — Ordinnate: Decrease, % in weight and M of E. — Abscissa: — *Top* — Total extractibles, %. — *Middle* — Methyl alcohol extractibles, %. — *Bottom* — Ether extractibles, %. — Decrease in weight and M of E versus extractibles in 62 year old tree: (1) Weight. (2) M of E.

Summary

The variation of the extractive content and its effect on durability along the radius in teak trees of known origin, 10 years, 30 years and 62 years old taken from the butt end of logs was investigated and the results reported in detail both in tables and graphs. The maximum caoutchouc content rose from 1.2% in the 10 year old tree to 2.0% for the 30 year old one to 4.6% for the 62 year old. The corresponding contents in ether extractive were 3.7, 6.5 and 10% respectively. The methyl alcohol extractives were maximum in the youngest tree. A sudden jump in the percentage of ether extractives was noticed from inner to outer heartwood. Durability as indicated by weight loss and loss in modulus of elasticity in Kolle flask tests was found to increase with age, the older the tree the greater was the percentage in durable part of the radius. The middle to outer heartwood which is also richest in total extractives were found to be the most durable part. With increase in age a smaller percentage of total extractives was found to be sufficient which suggest possibly cell wall changes also play some part. The possible use of such studies for the selection of plus trees for cross-breeding work is indicated.

Table 4.

Age	% of extract at which weight loss is 10%			% of extract at which M of E loss is 10%		
	Ether	Methanol	Total	Ether	Methanol	Total
10 years	2.8	5.0	7.8	3.4	5.56	8.85
30 years	3.9	2.55	6.4	4.45	3.65	7.9
62 years	3.2	2.40	5.4	4.4	3.25	8.0

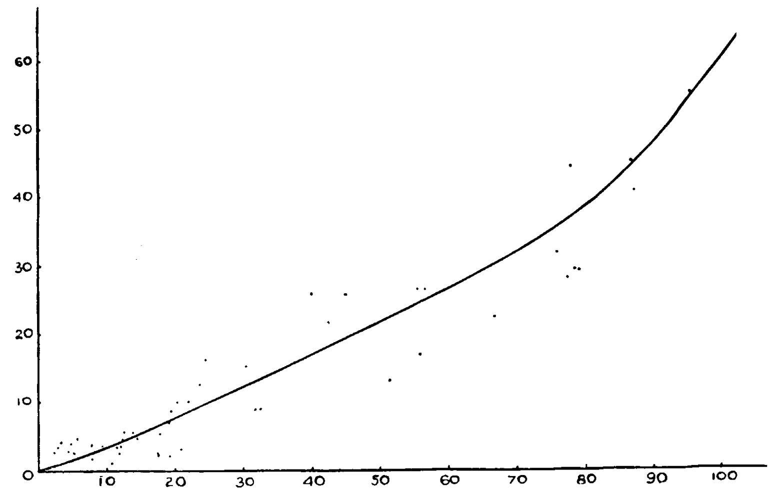

Fig. 10. — Abscissa: Decrease in M of E, %. — Ordinate: Decrease in weight, %.

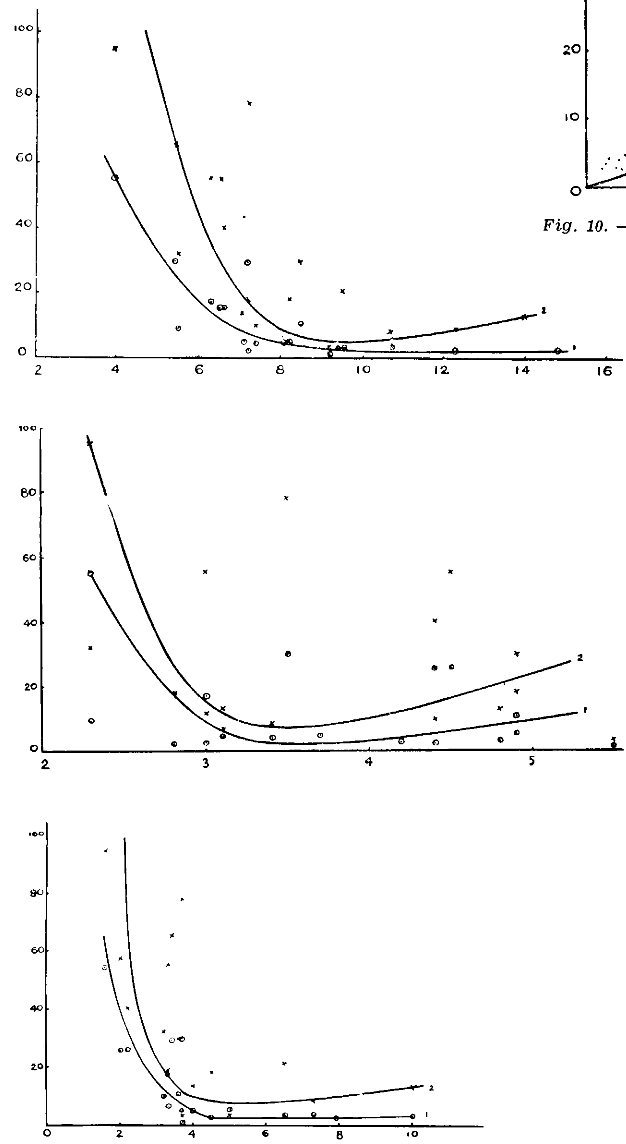

Fig. 9. — Ordinate: Decrease, % in weight and M of E. — Abscissa: — *Top* — Total extractibles %. — *Middle* — Methyl alcohol extractibles, %. — *Bottom* — Ether extractibles, % — Decrease in weight and M of E versus extractibles in 10, 30, and 62 year old trees: (1) Weight. (2) M of E.

Zusammenfassung

Titel der Arbeit: *Inhaltsstoffe im Teakholz.*

An 10, 30 und 62 Jahre alten Teakstämmen bekannter Herkunft wurde am Stammfuß die Variation des Gehalts an Inhaltsstoffen über den Radius und ihr Einfluß auf die Dauerhaftigkeit des Holzes untersucht. Die einzelnen Ergebnisse sind in Tabellen und Diagrammen dargestellt. Der maximale Gehalt an Kautschuk betrug bei 10jährigen Bäumen 1,2%, bei 30jährigen 2,0% und bei 62jährigen 4,6%. Der Gehalt an ätherlöslichen Stoffen betrug in gleicher Reihenfolge 3,7%, 6,5% und 10%. Der maximale Gehalt an Methanolextrakten wurde in den jüngsten Bäumen gefunden. Vom inneren zum äußeren Kernholz wurde ein scharfer Abfall im Prozentsatz ätherlöslicher Extrakte festgestellt. Die Dauerhaftigkeit des Holzes wurde im Kolleschalentest nach Gewichtsverlust und Abfall des Elastizitätsmoduls ermittelt, sie nahm zu mit steigendem Baumalter. Je älter der Baum, umso höher war der relative Gehalt an dauerhaftem Holz über dem Radius. Als dauerhaftester Teil wurde die mittlere Zone des äußeren Kernholzes festgestellt, die auch die meisten Gesamtextrakte enthält. Weiterhin wurde gefunden, daß mit steigendem Alter ein kleinerer Anteil der gesamten Inhaltsstoffe wirksam wird, es wird daher angenommen, daß auch Unterschiede in der Zellwandstruktur eine Rolle spielen. Auf die mögliche Bedeutung solcher Untersuchungen für die Auslese von Plusbäumen in der Züchtung wird hingewiesen.

Résumé

Titre de l'article: *Produits d'extraction chez le teck.*

L'objet de cette étude est la variation de la teneur en produits d'extraction et ses effets sur la durabilité suivant

le rayon de l'arbre, pour des tecks d'origine connue âgés de 10, 30 et 62 ans; les prélèvements ont été faits vers la section basale des grumes et les résultats ont été reportés en détail sous forme de tables et de graphiques. La teneur maximum en caoutchouc varie de 1,2% pour les arbres de 10 ans à 2,0% pour ceux de 30 ans et 4,6% pour ceux de 62 ans. Les teneurs correspondantes des extraits à l'éther étaient 3,7—6,5 et 10% respectivement. Les extraits à l'alcool méthylique étaient les plus élevés pour les jeunes arbres. La teneur en extraits à l'éther augmente brusquement lorsqu'on passe du bois de coeur interne au bois de coeur externe. La durabilité, exprimée par la perte de poids et la perte de module d'élasticité dans les essais au flacon de Kolle, augmente avec l'âge: plus l'arbre est vieux plus grande est la partie durable sur le rayon. Les parties médianes et externes du bois de coeur, qui sont aussi les plus riches en extraits totaux, sont les plus durables. Lorsque l'âge augmente, une valeur plus faible des extraits totaux apparaît suffisante, ce qui suggère la possibilité d'un changement dans les parois cellulaires. On signale l'emploi possible de ces études pour la sélection d'arbres plus en vue des croisements contrôlés.

References

(1) Da Costa *et al.*: Teak Subkommission Report. 1960. — (2) Narayanamurti, D.: Die Bedeutung der Holzextraktstoffe. Holz Roh- u. Werkstoff 15, 371 (1957). — (3) Sandermann, W., und Dietrichs, H.-H.: Chemische Untersuchungen an Teakholz. Holzforschung 13, 137—148 (1959). — (4) Verma, G. M., 1960 (Unpublished work).

(Aus dem Lehrforstamt Bramwald der Forstlichen Fakultät Hann. Münden der Universität Göttingen)

Untersuchungen über Phototropismus bei Buchenkeimlingen

Von J. Krahl-Urban, Hemeln/Hann. Münden*)

(Eingegangen am 13. 1. 1962)

Im Rahmen meiner Buchenrassen-Forschungen (2—5) sind in den letzten Jahren mehrfach Untersuchungen über Phototropismus bei Buchenkeimlingen durchgeführt worden. Sie sollten prüfen, ob hinsichtlich des phototropischen Verhaltens Unterschiede zwischen Keimlingen verschiedener Herkunft vorhanden sind. Etwa vorhandene Unterschiede konnten vielleicht geeignet sein, schon in frühester Jugend Hinweise auf das Vorhandensein unterschiedlich veranlagter Buchenrassen und darüber hinaus auf manche ihrer, im allgemeinen erst später auftretenden Eigenschaften zu liefern.

Die verwendeten Bucheln. Die Gelegenheit zu derartigen Untersuchungen war insofern günstig, als aus den Masten 1953, 1954, 1956, 1958 und 1960 Bucheln verschiedener Herkünfte zur Verfügung standen, wenn auch bedauert werden muß, daß es sich in den genannten Jahren nur ausnahmsweise um gleiche Bestandes- oder auch nur Gebietsherkünfte handelte. Das zu erreichen war nicht möglich, da die Masten gebietsweise in verschiedenen Jahren eintraten.

Es sind — in nordsüdlicher Reihenfolge geordnet — Bucheln folgender Herkünfte zu den Untersuchungen herangezogen worden:

1953: Tönnersjöheden (Halland, Südschweden), Schöningen (Elm), Corvey (bei Höxter), Bramwald (Oberweser), Chausseehaus (Taunus), Ferlach (Karawanken).

1954: Tönnersjöheden (Halland, Südschweden), Glorup (Fühnen, Dänemark), Schleswig.

1956: Schleswig, Eutin (Holstein), Rotenburg (Hann.), Saupark (Deister), Schöningen (Elm), Bad Lauterberg (Südharz), Bramwald (Oberweser), Seelzerthurm (Solling), Corvey (bei Höxter) Bad Driburg (Westf.), Obereimer (bei Arnsberg/Westf.), Forêt des Soignes (bei Brüssel), Düdelsheim (Vogelsberg).

1958: Rendsburg (Schleswig), Bad Freienwalde (Brandenburg), Corvey (bei Höxter), Bramwald (Oberweser), Dalheim (Westf.), Johannisburg (Westerwald), Kottenforst (bei Bonn), Kirchheimbolanden (Rheinpfalz), Lich (bei Gießen), Baindt (Bodensee), Marquartstein (Obb.), Zwiesel (Bayer. Wald), Sihlwald (Zürich), Eisenkappel (Karawanken).

1960: Südschweden, Dänemark, Schleswig, Rendsburg (Schleswig), Ritzerau (Lübeck), Medingen (Lüneburg), Saupark (Deister), Schöningen (Elm), Harzburg (Nordharz), Bad Lauterberg (Südharz), Corvey (bei Höxter), Seelzerthurm (Solling), Bramwald (Oberweser), Obereimer (bei Arnsberg/Westf.), Forêt de Soignes (bei Brüssel), Schwarzenfels (Spessart), Düdelsheim (Vogelsberg), Jugenheim (Odenwald), Waldbrunn (bei Würzburg), Lichtenstein (Schwäb. Alb), Metzingen (Schwäb. Alb), Weingarten (Bodensee), Baindt (Bodensee), Zwiesel (Bayer. Wald).

Die für die Versuche benutzten Bucheln sind stets größeren Mengen entnommen worden, die für Provenienzversuche beschafft worden waren. Ausnahmlos handelt es sich um Bestandesherkünfte, d. h. sie stammen von möglichst zahlreichen Mutterbäumen aus Altbeständen, deren Eigenschaften als charakteristisch für die Buchen der Herkunftsgebiete gelten können. Das Einsammeln der Bucheln ist nach genauen Anweisungen stets von den örtlichen Forstverwaltungen vorgenommen worden.

Die bald nach dem Einsammeln dem Lehrforstamt Bramwald übersandten Bucheln sind im Jahre 1958 ganz, 1960 zum Teil zwecks möglichst sicherer Überwinterung an die Hessische Staatsdarre Wolfgang geschickt worden. In beiden Jahren wurde dieser Zweck voll erreicht. Kurz vor den Aussaaten in den folgenden Frühjahren sind die Bucheln aus Wolfgang abgerufen worden. Sie trafen beide Male in tadellosem Zustand hier ein. — Die Bucheln aus den Masten 1953, 1954, 1956 und zum Teil 1960 sind nach einer der ortsüblichen Methoden — ebenfalls mit guten Ergebnissen — hier überwintert worden.

Die Versuchsmethode. Die mit Bucheln aus der Mast 1953 im Sommer 1954 und mit Bucheln aus der Mast 1954 im Frühjahr 1955 durchgeführten Versuche hatten nur den Charakter von tastenden Vorversuchen. Ihr Zweck war es

*) Die Untersuchungen wurden durch Beihilfen der Deutschen Forschungsgemeinschaft sowie der Landesforstverwaltungen von Niedersachsen, Schleswig-Holstein, Nordrhein-Westfalen und Rheinland-Pfalz gefördert. Ihnen und allen Forstämtern bzw. Forstverwaltungen, insbesondere den schwedischen, dänischen und belgischen Forschungsinstituten, die Bucheln für die Versuche lieferten, gebührt ebenso mein Dank wie Professor Dr. Schmidt für seine Beratung und einigen Mitarbeitern für ihre Hilfe bei der Durchführung und Auswertung.