IAWA BULLETIN

Contents

Front cover: Scanning electron micrograph of vestured intervessel pits (pit floors removed) in *Anogeissus acuminata* (Roxb. ex DC.) Wall. (Combretaceae). Courtesy G.J.C.M. van Vliet, Leiden.

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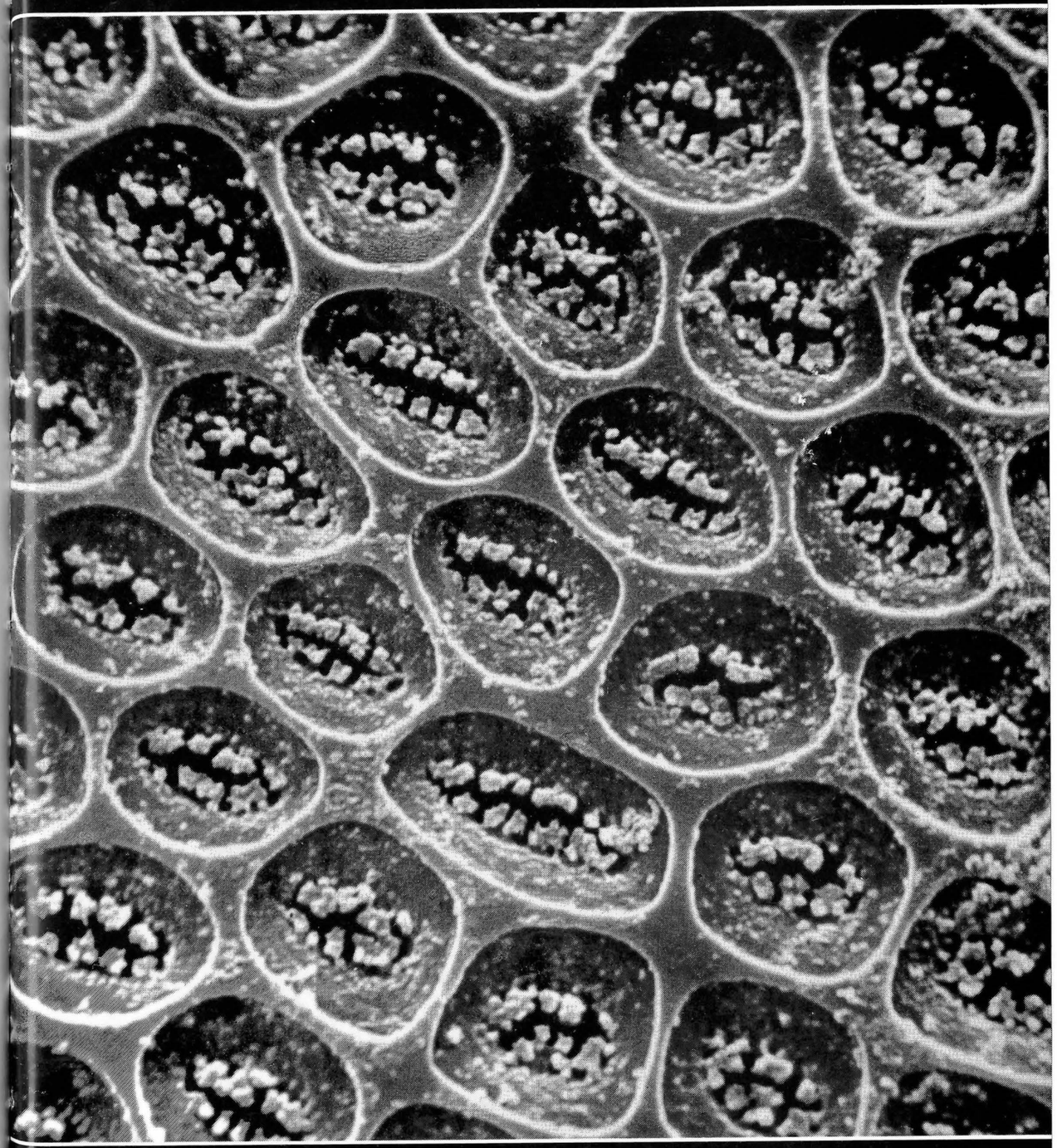

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EDITORIAL

Editorial columns in this Bulletin have often been used to voice sorrow and concern about financial limitations of our Association and about the need for active participation of all members to keep IAWA alive and its Bulletin provided with manuscripts. Although such sorrow and concern would still be justified, and the need for activities and initiatives from members remains urgent, we would like to write this editorial in a more happy key.

Our Association has enjoyed a good year. Numerous wood scientists joined IAWA, and many libraries discovered that even at this time of low financial tide, they could not do without a subscription to the IAWA Bulletin. It is a good sign in this respect that 1977/1 issues of the Bulletin, although printed in excess numbers, are out of stock now. Looking ahead at the future, there seems even more reason to rejoice. The regional committee for the Americas is in an advanced stage of planning their first joint meeting with the Botanical Society of America next June. Elsewhere regional committees are active as well. Contacts with IUFRO have been fruitful in the past, and hold the promise of more mutual benefit with the active participation of Division V Wood Quality Subject Group in the program of the regional 1979 meeting in Amsterdam.

It should be realized that these expanded activities would be financially impossible if our Association would not enjoy the facilities of the institutions housing its officers. IAWA owes a great debt of gratitude to the Forestry Commission of New South Wales for enabling the production of the new membership directory, to the institutes housing our regional committee members for clerical assistance and postage fees, and also to the Forest Products Institute TNO in Delft and to the Rijksherbarium in Leiden for distributing the Bulletin. Through these facilities our membership dues could be maintained at a very low level, and we shall continue our efforts to keep them low. It can do no harm, however, to keep in mind that the present low costs of our Association are artificial, and that expenditure would probably be more than double the present amount if we would have to run the affairs completely unaided. The work of our lay-out editor from the Rijksherbarium staff could even impossibly be expressed in terms of money!

Much of the satisfactory course of IAWA in the last year was due to the activity of Members in enrolling new members and subscribers and in contributing papers, notes and requests to the Bulletin. This editorial would be a waste of valuable printing space if we did not urge you to continue or even increase your activities in these fields. It really helps!

Pieter Baas
Peter B. Laming

TRACHEOIDS IN THE PITH OF YEW (TAXUS BACCATA L.)

by

Ladislav J. Kučera[1]
Botany Department, University of Canterbury, Christchurch, New Zealand

Summary

Tracheoids are primitive xylem-like elements. They can be described as non-prosenchymatous tracheids. Their shape and size is identical to those of parenchyma cells. The morphological properties of their cell walls, however, are similar to those of xylem tracheids: thick, with bordered pits and helical thickenings. They are rare and irregularly distributed; mostly single or in small groups of two to seven. Their occurrence is a normal feature of the pith of yew. A possible function of the tracheoids (if there is any) is storage and short-distance transport of water.

Introduction

The occurrence of the tracheoids (non-prosenchymatous tracheids) in various parenchyma tissues has been frequently recorded. Despite some accurate light-microscopical observations (e.g. Nottberg, 1897; Rothert, 1899; Frey-Wyssling, 1938) there is a need for a scanning electron microscopical demonstration of these cells. Due to its great depth of field the scanning electron microscope gives a clear picture of the tracheoids, their outlines as well as revealing detail of the inner wall surface. A further aim of this study has been to obtain additional information on the origin, distribution, and function of the tracheoids in the pith of yew.

Materials and methods

Inclined lateral and upright shoots were cut from a number of *Taxus baccata* L. trees growing on the Campus of the University of Canterbury and also in some private gardens in Christchurch. Specimens selected for anatomical investigation contained both nodes and internodes and from three to fourteen growth rings. The occurrence of scars and scratches on the bark surface of the selected specimens was recorded. The specimens were fixed in formalin-aceto-alcohol, according to Purvis, Collier and Walls (1964). Cubes of wood were prepared for examination in the scanning electron microscope following the methods described by Exley, Butterfield and Meylan (1974) and examined in the vacuum dry state in the column of a Cambridge S 600 Stereoscan.

Results

The pith of yew is composed of large, thin-walled parenchyma cells. The parenchyma cells are circular in the central part of the pith (as seen in a longitudinal surface). The closer to the protoxylem strands the more angular is the shape of the parenchyma cells.

Tracheoids occur rarely and are irregularly distributed. They occur mostly solitary (Fig. 4), less frequently in groups of two to seven (Figs. 1, 2). The radial distribution of the tracheoids is random. They occur central and peripheral. They have, however, not been found in the immediate vicinity of the protoxylem cells. The vertical distribution is irregular and is not related to the position of nodes or the age of the pith: The tracheoids occur in nodes as well as in internodes. They have been found in the pith of the youngest (3 years old) as well as of the oldest (14 years old) investigated branches. The occurrence of the tracheoids in the pith is not related to the presence of scars and scratches on the bark surface. 92 specimens were investigated, 21 with and 71 without scars or scratches on the bark surface. In the 21 specimens with scratches, 3 tracheoids were found, in the 71 specimens without scratches 9 tracheoids (or groups of tracheoids) could be seen in the pith. A careful examination of the vicinity of the tracheoids did not show any structural changes suggesting an injury or another external influence. Due to these facts the tracheoids should be considered as a normal (although rare) structure in the pith of yew.

The tracheoids have the shape and size of an average pith parenchyma cell (Fig. 1). The cell walls of the tracheoids are thicker than the cell walls of the parenchyma cells. There are bordered pits in the horizontal and vertical walls (Figs. 1, 2, 3). These bordered pits are smaller than those of the tracheids of the secondary xylem of the same

[1] Present address: Institut für Mikrotechnologische Holzforschung ETH, Universitätsstrasse 2, 8006 Zürich, Switzerland.

species. The apertures of the bordered pits are circular (Figs. 3, 4). An important feature of the tracheoids are the helical thickenings. These thickenings are prominent although they vary in their thickness (Fig. 4). Their course, slope and number (density) does not follow any obvious pattern but branching (or fusion) is common (Fig. 4). The thickenings are more prominent but less regularly organised than the helical thickenings in the tracheids of the secondary xylem.

Discussion

The first description of the tracheoids in the pith was made by Rothert (1899). This author described the tracheoids in the pith of *Cephalotaxus pedunculata* Sieb. et Zucc. using the terms 'tracheidal parenchyma cells or parenchymatic tracheids'. He pointed out that these cells 'are identical in their shape with the neighbouring parenchyma cells of the pith and identical in the appearance and structure of their cell walls with the tracheids of the xylem'. The pith of yew has been investigated several times (Frank, 1864; Rothert, 1899; Tassi, 1906; Steinböck, 1926); these authors described it as composed solely of parenchyma cells 'without parenchymatic tracheids or any other peculiarities' (Rothert, 1899). Bosshard and Kučera (1972) observed tracheoids in the pith of yew using light and polarizing microscopy. The present study reinforces their results.

The tracheoids in the pith of *Taxus* and *Cephalotaxus* are basically similar to the cell types found in the wound tissue of many gymnosperms. Nottberg (1897) described the wound tissue in *Abies pectinata* DC., *Larix europaea* DC., *Picea excelsa* Link, *Pinus silvestris* L. and *Pinus strobus* L. He recorded for the first time the presence of 'tracheidal parenchyma: cells in all gradations between parenchyma and tracheids' in this tissue. Frey-Wyssling's (1938, 1946) results support Nottberg's observations. This author found irregularly shaped tracheidal cells in a wound resin pocket of *Larix europaea* and in *Picea abies* Karst. Tsoumis (1965) observed tracheoids ('hazy cell walls and bordered pits within cell lumina') in a tumor of *Picea glauca* Voss. Kučera (1971) recorded the occurrence of tracheoids in the wound tissue of yew. Tracheoids have also been found in normal trunk wood of *Abies alba* Mill. (Kučera, 1976). Tracheids with intermediate forms and properties have also been observed frequently in galls (e.g. Swamy and Krishnamurthy, 1971) and tissue cultures (e.g. Gautheret, 1959, Jacquiot, 1964). However, the investigated pith tissue did not show any signs of injury or wound tissue formation. A connection between the scars and scratches on the bark surface and the occurrence of the tracheoids could not be established. Thus, the tracheoids should be considered as a normal feature of the pith anatomy of yew.

The tracheoids appear to be morphologically similar to the transfusion tracheids in the leaves of the gymnosperms. This similarity is supported by the description of 'transfusion tracheids' in the stems of 40 *Cycas* species by Greguss (1969). The apparent similarity of the tracheoids in the pith to the transfusion tracheids suggests a possible role of the tracheoids in the storage and the short-distance transport of water. This assumption is based only on the morphological similarity of the transfusion tracheids and the tracheoids and needs therefore to be experimentally tested.

Acknowledgements

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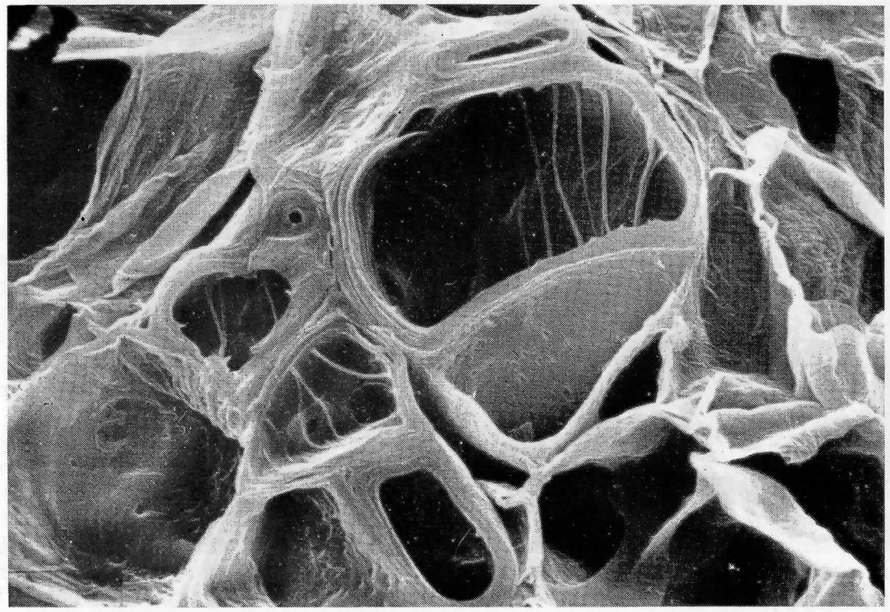

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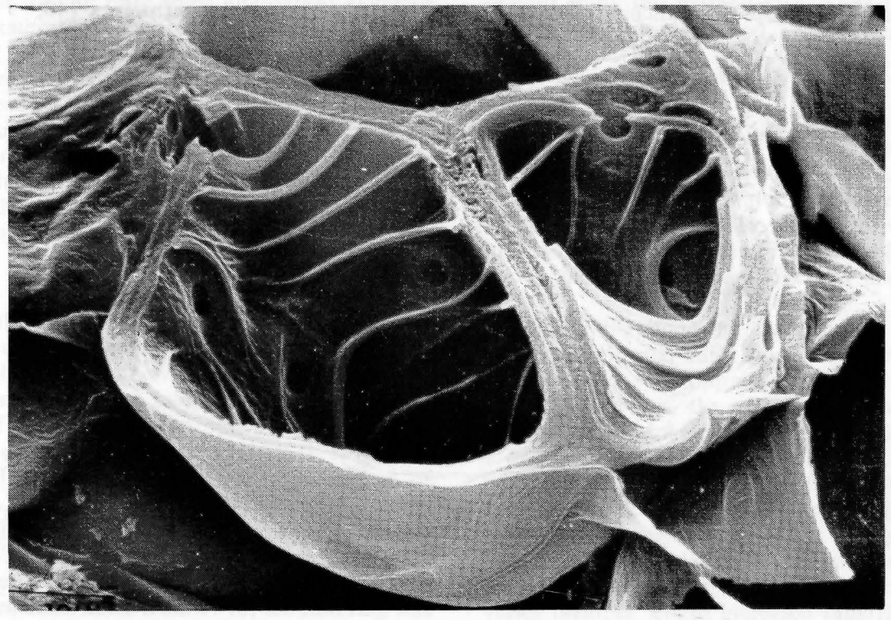

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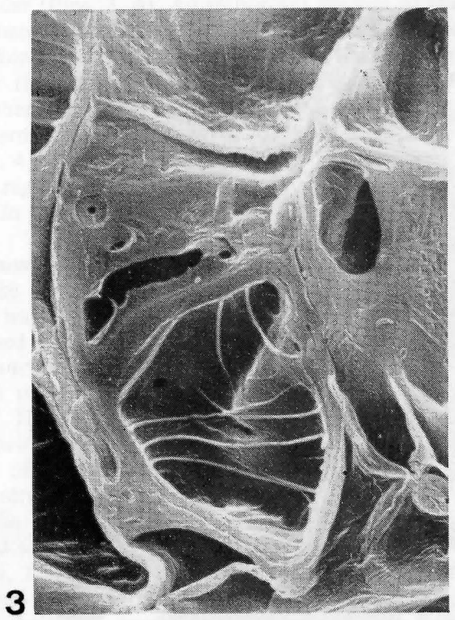
Fig. 1. Parenchyma cells and tracheoids in the pith of yew (*Taxus baccata* L.). x 1120. —— Fig. 2. Twin tracheoids. Not the prominent helical thickenings and the bordered pits. x 1770.



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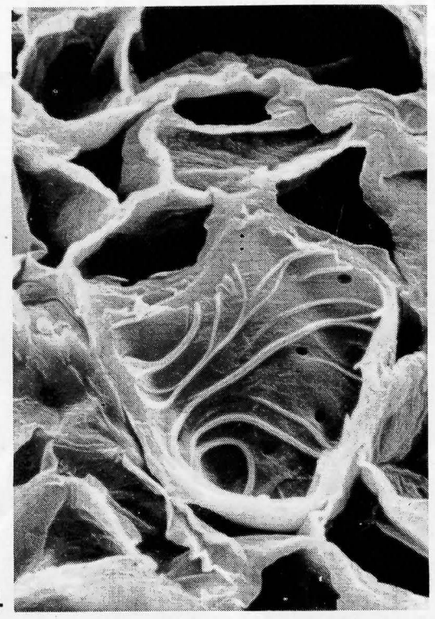

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Fig. 3. Twin tracheoids. Note the bordered pit. x 880. — Fig. 4. Solitary tracheoid with prominent helical thickenings. Note the branching of the thickenings and the circular pit apertures. x 740.

STATISTICAL ANALYSIS OF WOOD STRUCTURE VARIATION AS RELATED TO DISTANCE FROM THE PITH IN ENTANDROPHRAGMA UTILE (MELIACEAE)

by

B. Giraud

Université Pierre et Marie Curie, Laboratoire de Paléobotanique, 12, rue Cuvier, 75005 Paris, France

Introduction

Among numerous factors affecting wood structure, age, or more precisely variation in successive growth rings from the pith to the bark is very important. Sanio (1872) recorded the variability of tracheid dimension in wood of *Pinus silvestris* for the first time. The observations of Shimakura (1936) on some coniferous woods indicate that the height and the frequency of rays fluctuate. Hamilton (1961) noted a direct relationship between fibre-length and age, in *Quercus falcata.* Courtois *et al.* (1964), in a study of *Quercus robur* and *Quercus petraea*, observed an increase of vessel diameter and a modification of the percentage of various elements (fibres, vessels, parenchyma). Many studies have been carried out on this topic, showing the variability as related to age, but usually only some anatomical elements were examined; therefore, in this study the behaviour of *all* anatomical features which contribute to define the wood structure of a member of the Meliaceae: *Entandrophragma utile* is analysed. The purpose of this investigation is to present detailed information on the anatomy of this species throughout the development of the tree and to determine whether or not it is possible to find constant characteristics.

Materials and Methods

The specimen studied came from a plantation established by the 'Service des Eaux et Forêts' in 1948, at Sibang near Libreville (Gabon). The climate of this region is of a tropical rain-forest type, with a single dry season which lasts three months (from June to August). A transverse surface of the tree trunk (approximately 50 cm above the ground) has been cut and polished. Twenty growth rings have been counted, each year being characterized by one ring (Détienne, 1975). The pith formation dates from 1948, the first ring was formed in 1949. The growth is fast and regular, with an average annual diameter increment of 0.9 cm.

Blocks were cut from each growth ring, of which transverse, radial longitudinal, and tangential longitudinal sections were made (15 μm), in the usual way. Macerations, using the Franklin's method were also made of those blocks.

Measurements were made by using a micrometer-eyepiece and a Reichert Visopan projection microscope which gives a direct image on a screen. Scales with divisions for each objective magnification were constructed with the aid of a stage micrometer. An integrating ocular was used for measuring the volume of the different tissues.

The mean of each set of measurements was calculated, together with its standard error and correlation coefficients (Kakou and Vuong, 1976). Data obtained from the measurements are plotted against the age in Fig. 1–10. Besides, a statistical analysis of these data was made, viz. factorial analysis of correlations (Benzecri, 1975). This method will be elaborately discussed elsewhere. For the present study this method gave us exactly the duration of the juvenile period, i.e. four years.

Results and Conclusions

Vessels

1. Density: the number of vessels per sq.mm decreases through the juvenile period; then, in adult wood, a constant value is observed (Fig. 1; cf. also Giraud, 1975a). The same result was found in other woods, e.g. *Eucalyptus regnans* (Dadswell, 1958) and *Fagus silvatica* (Sarkany and Stieber, 1958).

2. Grouping mode: no changes were found between juvenile and adult wood, but important variations in each grouping mode were observed (Fig. 2). However, the most frequent modes are always the multiples of 2 cells (40 to 65 %), followed by solitary vessels (20 to 40 %), multiples of 3 (6 to 20 %) and multiples of 4 (less than 6 %). From the 12th ring, we noted an increase of multiples of 2 at the expense of the solitary vessels.

3. Diameter and length: results similar to many previous studies were found, i.e., diameter and vessel member length increased rapidly with increasing age near the pith and then showed a further slow increase (Desch, 1932; Sarkany and Stieber, 1958; Taylor, 1973; see also Giraud, 1975b). The correlation between vessel dimensions and age is well marked, correlation coefficients are statistically significant (Fig. 11).

4. Eccentricity: according to Courtois *et al.* (1964) vessel eccentricity can be defined as the ratio of tangential and radial diameter. We have calculated this ratio, and as can be seen in Fig. 8 it remains constant from the pith to the periphery.

5. Vascular surface area: the percentage of vascular surface area in each growth ring has been calculated in the following way. The vessels were treated as rectangles, the vascular area being calculated from the formula: Sv = (L . H . d . 0.785) where L and H are tangential and radial diameter, respectively, d the density of vessels and 0.785 a correction coefficient. The result was then related to the annular surface of the ring: (Sv/Sa) . 100. For the annular surface, the formula $Sa = \pi r^2 - \pi(r-h)^2$ was used, where r = the radius of outer circumference of the ring and (r−h) = the radius of the inner circumference of the same ring.

Fig. 4 shows the vascular surface area-on-age variation. The decrease in the first years is due to the fact that the number of vessels decreases (see Fig. 1). Subsequently, when the density of vessels remains constant, the increase of vessel diameter in the last rings has a prevailing influence. The great difference between the vascular surface area in juvenile (15 to 5 %) and adult (less than 2 %) wood rings should be noted.

6. Diameter of intervascular pitting: in Fig. 5 an increase of pit border size can be seen throughout the immature period. There is an increase in the following rings as well, but the process is slower. There is a relationship between age and pit diameter with a correlation coefficient r = 0.715 (Fig. 11).

Fibres

1. Length and width: the fibre dimensions increase through successive growth rings from the pith for four years and reach a more or less constant value. The width/length ratio does not vary (Fig. 9). Age and fibre length are significantly correlated (Fig. 11), but the coefficient for width-on-age is not statistically significant.

2. Thickness of the fibre walls: the variability of this feature is not well marked, its mean value is 3 or 4 μm in all rings.

Rays

1. Density: the wood has more rays per sq.mm near the pith than at the periphery (Fig. 6). This decrease with age has a negative correlation coefficient (r = − 0.746; Fig. 11).

2. Width: in tangential view the wood of Sipo shows uniseriate and multiseriate rays. The marginal cells are higher than wide in tangential section. We examined the width of hundred rays for each ring, expressed in cell number, in order to know the percentages for each category (Fig. 3). A detailed account of their variation has been given in a recent note (Giraud, 1977: fig. 1, p. 101). As a reminder it has to be stressed that in juvenile wood the uniseriate rays are numerous (57 %), followed by the biseriate rays (40 to 65 %), and some scarce triseriate rays (less than 5 %). From the fifth to the fifteenth ring, a few uniseriate rays (7 %) can be seen, together with a majority of biseriate and triseriate rays. After the fifteenth ring, the uniseriates remain at a low percentage, the biseriates decrease simultaneously with an increase of the triseriates, while some quadriseriate rays also appear. This means that the change in width of the rays is fast for the first twenty years; it would be interesting to know the variation after this period, for 200(or more)-year-old trees.

3. Height: statistical analysis showed that bi- and triseriate ray height (expressed as number of cells) are correlated with age (Fig. 11). It has in fact been observed that ray height increases with distance from the pith.

4. Ray cell size: this was obtained from radial longitudinal sections. Marginal and procumbent cell size (height and width) increases with age, faster in juvenile than in adult wood. The ratios of their respective sizes are constant.

Parenchyma

1. Cell size: the results show few changes in both height and width of the axial parenchyma cells, and their size ratio is constant.

2. Distribution: in transverse sections the paratracheal parenchyma can be seen in more or less regular bands. To obtain the average of parenchyma distribution in each growth ring, two different methods were used: a) the number of bands was counted on ten equidistant straight lines and averages were calculated for each year; b) the parenchyma surface area was calculated with the aid of an integrating ocular. These methods gave similar results, i.e., the parenchyma distribution shows great changes from one ring to another.

Variation in xylem composition

As observed by Taylor (1973), we found only little variation from pith to bark in the proportion of the different tissues (fibres, vessels, rays and parenchyma). However, a slight decrease of the fibre percentage in mature wood, together with an increase of the vascular surface percentage could be observed (see Fig. 12).

Conclusions

The above results lead to the following conclusions:

1. In our wood sample the juvenile period is very short.

2. From pith to bark, cell size increases and cell number per unit area decreases. Therefore, the juvenile wood, compared with mature wood, has short and numerous cells. This fact also ap-

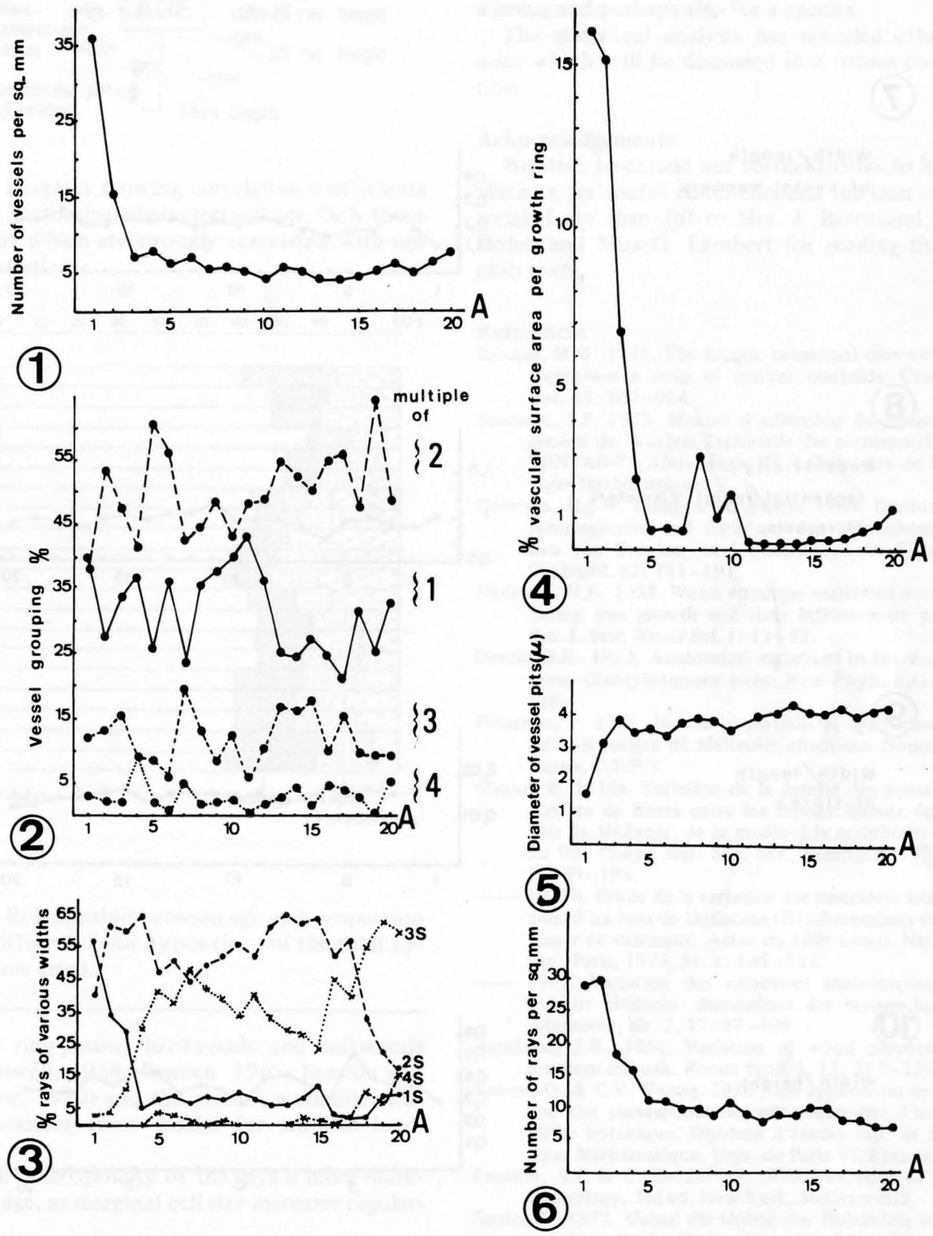

Fig. 1–6. Variation of some wood anatomical characters according to age. Data points are average values for each ring. A = age from pith in years; 1S, 2S, 3S and 4S = uni-, bi-, tri-, and quadriseriate rays.

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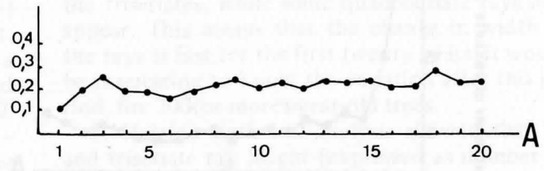
Width/length of vessel members



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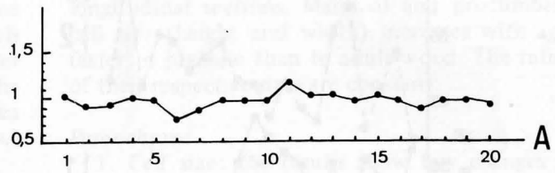
Eccentricity; tangential/radial diameters of vessels



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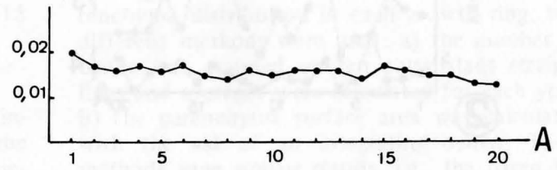
Width/length of fibres



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Width/height of parenchyma cell size

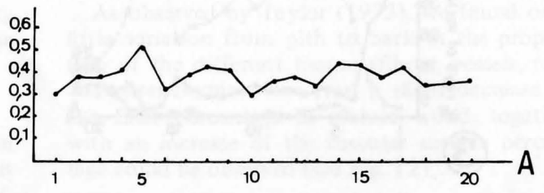

Fig. 7–10. Graphs showing relation between age and width/length ratio of vessels (7); eccentricity of vessels (8); width/length ratio of fibres (9); and width/height ratio of parenchyma cells (10).

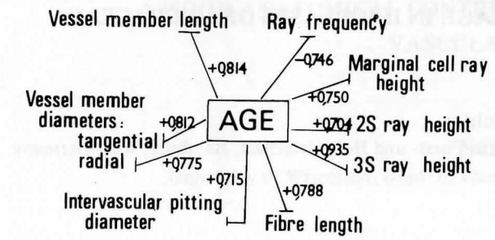

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Fig. 11. Diagram showing correlation coefficients between anatomical characters and age. Only those characters which are strongly correlated with age are indicated.

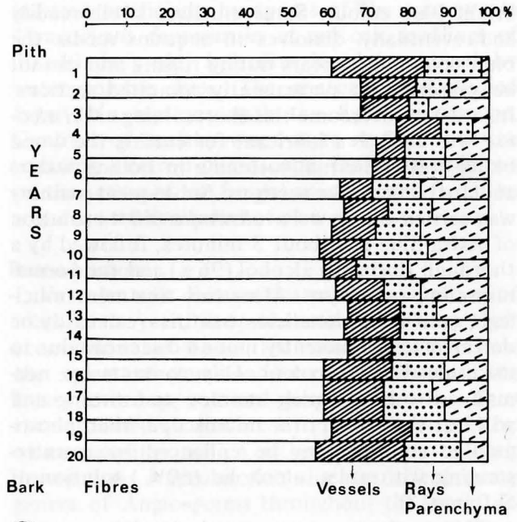

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Fig. 12. Relationship between age and proportion of the different tissue types (in of the total xylem surface area).

plies to ring-porous hardwoods and softwoods (cf. Dadswell, 1958; Bannan, 1965; Panshin and De Zeeuw, 1970) and the present work allows us to corroborate these results for tropical hardwoods.

3. The heterogeneity of the rays is more marked with age, as marginal cell size increases regularly.

4. The parenchyma distribution is independent of the age.

5. Vessel eccentricity (tangential diameter/radial diameter) is not affected by the age and we think this feature has to be emphasized in wood descriptions.

6. The size ratio for one cell type does not vary with age. It is of particular interest to use this constant character for the identification of timbers and chiefly of fossil woods when the sample studied may be derived from any part of the bole. We suspect that this size ratio is characteristic for a genus and perhaps also for a species.

The statistical analysis has revealed other results which will be discussed in a future publication.

Acknowledgements

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DIFFERENTIAL STAINING OF OIL AND MUCILAGE IN IDIOBLASTS OF LAURACEAE

by

Hans Georg Richter
Institut für Holzbiologie und Holzschutz, Bundesforschungsanstalt für Forst- und Holzwirtschaft, Hamburg, West Germany

During a comprehensive investigation of the wood anatomy of Lauraceae nearly 500 samples have been studied so far. Among the features noted as particularly characteristic, so-called 'oil and mucilage cells' merit the full attention of the anatomist. They occur regularly throughout the family showing considerable variation with regard to quantity, appearance and contents. In the literature they are hardly ever referred to as specifically oil *or* mucilage cells; commonly they are lumped together indicating the difficulties in distinguishing microscopically between oily and mucilaginous contents. Since both types of idioblasts are not necessarily different in shape, size and location only the permanent differentiation of their contents will enable the wood anatomist to make full use of the potential diagnostic value of this character in lauraceous timbers.

Based on the experience that oily contents dissolve during treatment with solvents such as ethyl alcohol or xylene, wood sections were stained in a 1% *aequous* solution of Chrysoidin/Acridin-Red (0.5% – 0.5%) for 2 to 4 minutes. After this procedure the contents of oil-bearing idioblasts obtained a distinct reddish hue varying from pink to bright crimson to a diaphanous purple, depending on the species or genus involved. Mucilage, however, was not affected at all and could not be recognized microscopically. Counterstaining with a 1% *aequous* solution of Astra-Blue (in 2% solution of tartaric acid for mordant action and higher storage life) already reveals the presence of mucilage which in sufficient quantities will exhibit a bright blue colour. Since mucilage swells readily and eventually dissolves in aequous media the blue colour disappears during rinsing and cannot be preserved in permanently mounted sections. In order to overcome this shortcoming *ethyl alcohol* was used as a lubricant for cutting the wood blocks (after normal softening in boiling water) and for storing the sections. Subsequent staining was carried out in a 1% *alcoholic* (60%) solution of Astra-Blue for about 3 minutes, followed by a thorough rinsing in alcohol (96%) and the normal mounting procedure. After this treatment mucilage, even in the smallest quantities, can easily be detected in permanently mounted sections due to its intensive blue colour. Oily contents are normally dissolved during staining and rinsing and will not show under the microscope. Microphotographic contrast may be enhanced by counterstaining with a 1% alcoholic (60%) solution of Safranine B.

This method seems somewhat tedious since it requires two sets of sections – one to be stained in aequous, the other in alcoholic solutions. This is, however, an almost negligible disadvantage compared to the considerable diagnostic value of selective staining of oil *and* mucilage, as has been experienced while investigating the wood anatomy of Lauraceae.

A WOOD ANATOMICAL CONTRIBUTION TO THE UNDERSTANDING OF VASCULAR WILT DISEASE

by

Suzę M. Jutte[1]
University of Wisconsin, Dept. of Plant Pathology, Madison, Wisconsin 53706, U.S.A.

Summary

Vascular wilt diseases destroy angiosperm trees quickly. This paper deals with Oak wilt disease, induced artificially by spores of the ascomycete *Ceratocystis fagacearum* in red oak seedlings of 30–40 days old. Infection has been traced by water soluble dyes. The anatomy was studied from thin sections with the light microscope. Controls of healthy wood were studied with the scanning electron microscope. Different opinions on the action of the fungus are discussed from the wood anatomical point of view.

Introduction

Vascular wilt diseases destroy large numbers of trees each year, and substancially reduce their economic value. Fungi, the causing agents, invade the xylem of stems and/or roots and cause the leaves to droop, wilt and drop off the trees. Thus the defoliated victims are left, prone to attacks by other parasites, which ultimately leads to their destruction. Vascular wilt diseases affect many genera of Angiosperms throughout the world. In Europe the phenomenon is, amongst others, known to occur in the genus *Ulmus*. Via infected boles, the wilt causing fungus was imported into the U.S.A. and Canada around 1930. In these countries the pest is called 'Dutch elm disease', because it was observed for the first time in the Netherlands. Here a major effort has been put into its research, on the anatomical aspect for instance by Elgersma (1970, 1973) and Miller and Elgersma (1976). Another example is Oak wilt. It causes severe losses in the U.S.A. and Canada to the genus *Quercus*. The parasite in both cases is an ascomycete of the genus *Ceratocystis*. *Ulmus* is invaded by *C. ulmi* and *Quercus* by *C. fagacearum*.

The main problem with these wilts is: how to destroy the fungus and save the tree. A better solution would even be to grow resistant trees. Before the fungus can be tackled effectively, its behaviour within the tree has to be clarified. Interestingly both *Ulmus* and *Quercus* are ring-porous, and their axial hydrosystem (Braun, 1970) is of the tracheid-vessel type. This means that the water transport in healthy trees is via the vessels and the tracheids. Both genera, however, differ in their anatomy, as do the parasitic fungi.

The infection in the xylem can, in short, be described as follows. The fungal spores enter the xylem, germinate in the vessels of the last formed growth-ring, and sporadically in the preceding ring (Henry and Riker, 1947). Hyphae then grow quickly in the vessels and tracheids, and tyloses, gummy and grainy deposits are formed in the lumina. Soon the tree starts to show the wilt symptoms.

In this paper only Oak wilt and some aspects of this infection will be dealt with. In the literature, different opinions are given to explain the oak wilt disease. Most authors attribute the destruction of the trees to the fact that developing tyloses and gummy substances in the vessels block the main channels for water transport to the crown. By the lack of water the leaves wilt and the tree dies (Beckman *et al.*, 1953; Struckmeyer *et al.*, 1954, 1958).

Wilson (1961), however, stated that the invasion and degradation of the xylem parenchyma by the fungal hyphae are the main cause of the wilt. With such a vast and important problem, steps to be taken are at least: a study of the interrelationship between the xylem-elements and the fungus. This is a difficult and complex task, because in nature mature trees are the victims, and the disease is only detected in an advanced stage. It is not feasible to sacrifice a series of healthy trees for artificial infection, to study the very basics of the disease. Moreover, the pathways to the crown are too complicated to analyze step by step. A study of the leaves, while they are still attached to the tree, is nearly impossible. To avoid the above problems, seedlings have been

[1] On leave from the Organization for Industrial Research TNO, The Hague, The Netherlands.

This article is dedicated to Dr. Bep Mennega on the occasion of her retirement.

used for this study. The seedlings, however, are far from mature, but it was considered that the main principles can be studied this way and later applied to the full-grown trees.

Materials and Methods

A. Red oak seedlings, grown from acorns to the first whirl stage (30–40 days, height about 10 cm) under controlled conditions at 25° C, were inoculated by placing a drop of washed conidia on the lower stem. This induced infection of about 95% of the seedlings in 10 days. To check the water uptake, the stems were cut off and put in water soluble dyes (0.2% of acid fuchsin, rhodamin B or easin Y). Stem parts with impaired uptake and normal stems were fixed in FAA and embedded in paraffin (Berlyn and Miksche, 1976). Cross sections and longitudinal sections (10 μm thick) were then prepared, using an A.O.Spencer no.820 microtome with a freezing module attached. These were stained according to the periodic acid-Schiff method (Farris, 1966), whereby the spores and hyphae stain bright red. The sections were studied light microscopically.

B. Parts of a healthy white oak branch of 3 years old (diameter 5 cm), stored in FAA.

C. A disc of a healthy red oak stem of 20 years old (diameter 18 cm), dried at room temperature.

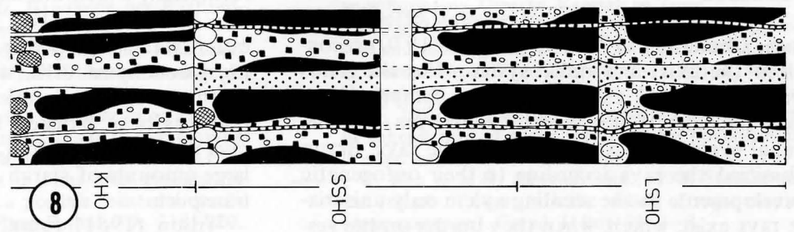
Parts of the white oak and of the outer growth ring of the red oak were prepared for scanning electron microscopy (JSM-U3) by mounting split off radial parts on stubs with double sided adhesive tape. The specimens were coated with gold-palladium (60:40) and examined at a 45° tilting angle at 10 and 20 KV.

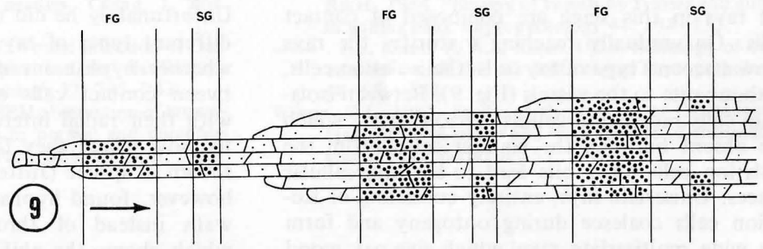
Results

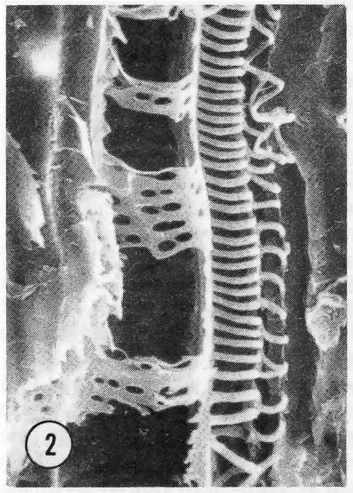
The dyes give information on the impaired water uptake in the infected seedlings. In the healthy seedlings they ascend readily in the primary and secondary xylem, the tracks colour red and the leaves become evenly supplied and turn red. At and above infected parts, the upward flow stops and herewith provides information. Caution should, however, be exercised with the uptake of dyes, because they can be filtered out. Still, when the first symptoms of impaired uptake occur, the leaf connected with this part wilts. In about 10 days, the uptake of the dye stops entirely and all leaves wilt.

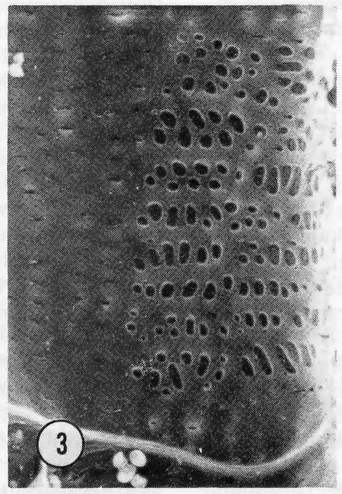
The seedlings display a large pith, primary xylem elements with helical and reticulate thickenings and a well developed layer of secondary xylem. This layer is not fully comparable with the 'stabilized' mature secondary xylem. This is shown for instance in the presence of much smaller vessels and rays in their first developmental stages, the wide multiseriate rays being altogether absent. Lindeman and Mennega (1963) were of the opinion that only outside a central core of about 15 cm diameter, mature xylem which displays all its characteristic features can be found. In the sections, tyloses are present in the vessels of the infected parts (Fig. 1). Gum-like deposits and grainy debris occur in both vessels and tracheids. In the later stages of infection, deposits are also present in the fibres. The parenchyma cells may show reddish brown globules, but starch grains often make the observation of this feature difficult. Fungal hyphae and spores are present in vessels and tracheids (Fig. 1) and also, but sporadically in the parenchyma cells. In the healthy stems no tyloses, 'gums', debris and globules are present. In the white oak branch, primary xylem with spiral and reticulate wall thickenings of the vessels can easily be recognized (Fig. 2). In the secondary xylem, the vessel-ray pit pairs show the same basic structure as in the mature red oak (Figs. 3 and 5). On the lumen side of both the white and the red oak vessels, apertures are present of the pits to the surrounding tracheids (Figs. 3 and 5). Figure 4 shows part of a perforation plate in a wide red oak vessel, with its simple perforation, and a part of a tracheid with its bordered pits. Between the wide, multiseriate rays in the red oak, radial intercellular spaces are present to which blind pits lead from the ray cells (Figs. 6 and 7).

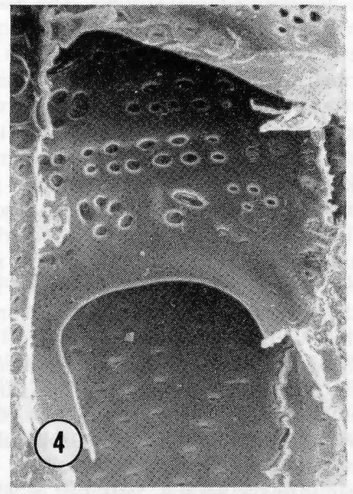
Fig. 1. Red oak seedling; tyloses and fungal hyphae in vessel. Light microscopy, x 400. — Fig. 2. White oak, spiral and reticulate vessels. SEM, x 500. — Fig. 3. White oak, lumen side of vessel with large pits towards contact ray cells and smaller apertures of pits towards tracheids. SEM, x 500. — Fig. 4. Red oak, lumen side of vessel with part of perforation plate with simple perforation. On its left a tracheid with bordered pits. SEM, x 400. — Fig. 5. Red oak, comparable with figure 3. SEM, x 400. — Fig. 6. Red oak, inside of wide ray with isolation cells, intercellular spaces and rows of blind pits. SEM, x 400. — Fig. 7. Close-up of figure 6, with rows of blind pits leading to intercellular spaces. SEM, x 4,000. — Fig. 8. European oak. End grain surface, schematic (after Braun, 1970); a) Completely functioning water conducting sapwood (LSHO), b) Storage sapwood (SSHO), no water conduction, only capable to store starch in living parenchyma cells, c) Heartwood (KHO), no water conduction, vessels with tyloses and dead parenchyma cells without starch. — Fig. 9. Ray ontogeny of the *Quercus* type. Schematic radial view (after Braun, 1970). Contact cells with heavy dots; isolation cells with light dots. FG: early wood vessels; SG: late wood vessels. Arrow points in direction of cambium.

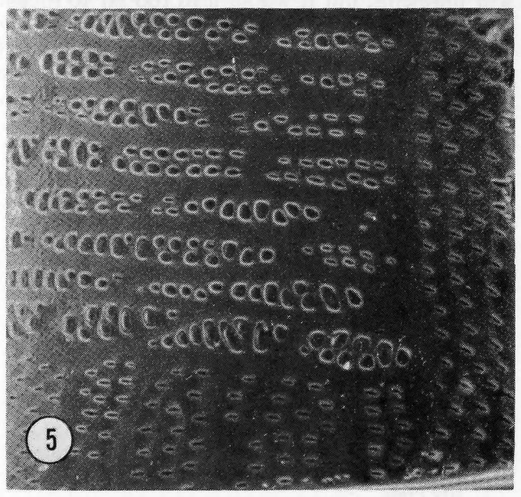


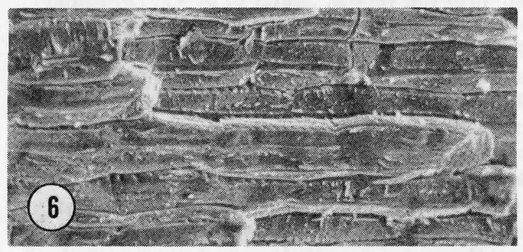


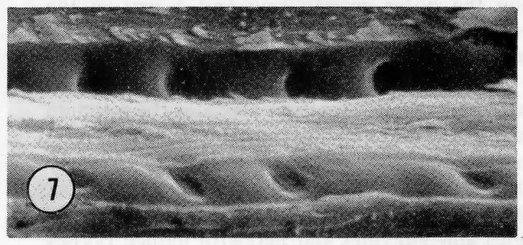












Discussion

The xylem is a unity of several different tissues. Chattaway (1950) and Braun (1970) recognized the axial and radial system. For the genus *Quercus* (Fig. 8) the axial system comprises vessels, tracheids, fibres, axial parenchyma, and the radial system the parenchyma of the rays. Braun classified the rays according to their ontogenetic development. In the seedling xylem only uniseriate rays exist, which, when they border on the vessels are all in contact by means of large pit pairs. All rays in this stage are composed of contact cells. On gradually reaching maturity, the rays show a second type of ray cells: the isolation cells, without pits to the vessels (Fig. 9). Between isolation cells radial intercellular spaces exist, which are absent between the contact cells. From the isolation cells blind pits lead to the intercellular spaces. Uniseriate rays, entirely consisting of isolation cells coalesce during ontogeny and form the wide multiseriate rays, which give oak wood the decorative radial surface. The parenchyma of the axial system is often closely connected with the vessels via large contact pit-pairs. Tyloses are formed in the vessels by outgrowths of the contact cells through the large pit-pairs. Therefore, tyloses formation theoretically can take place in the very first growth ring. However, in the red oak group the occurrence of tyloses is abnormal, even in the heartwood. Hence tyloses formation in infected red oak seedlings is remarkable. In the white oak group tyloses formation in the heartwood is a common feature as it is in European and Japanese oak. In the white oak branch tyloses cannot be expected as yet.

Sauter (1972) reported an increased respiratory and phosphatase activity at the site of the pit membranes of the contact cells to the vessels in *Betula* and *Populus*. He suggested that these contact cells are involved in an active secretion of sugar into the vessels. Sauter *et al.* (1973) found the contact cells to be the specific site of a metabolically controlled sucrose release into the vessels of *Acer saccharum* (sugar maple). Braun (1970) mentioned carbohydrate release at the contact cells of the rays into the vessels of *Quercus robur* (European oak). It is therefore reasonable to assume, that in American oaks an analogous trend exists with regard to the carbohydrate release. The uptake of water in oak occurs only along the outer growth ring and a part of the former one (Braun, 1970; Fig. 8). Probably, phosphatase activity is found in these parts. Tyloses are normally formed near the beginning of the heartwood. Their formation precedes the ultimate death of the parenchyma cells. The fungal hyphae invade by preference the outer growth ring and cause the abnormal growth of tyloses. They most likely release toxic substances together with hormones and enzymes and herewith induce tyloses formation, which ultimately leads to the death of the living tissue. The growth rings inside the outer, water conducting cylinder still contain living parenchyma cells, which may not contribute to the carbohydrate release, because water transport has been blocked here. Of the multiseriate rays it is known (Braun, 1970) that they contain large amounts of starch and are capable of radial transport.

Wilson (1961) found in the rays infected by fungi also hyphal invasion of the middle lamellae. Unfortunately he did not distinguish between the different types of ray cells. It is quite different whether hyphae invade the middle lamellae between contact cells or between isolation cells, with their radial intercellular spaces. Fungi tend to grow where they find the least resistance, as shown in spruce (Jutte and Sachs, 1976). Wilson, however, found hyphae growing through the cell walls instead of through the pit membranes, which shows the ability of the fungus to penetrate lignified barriers.

Water ascends in oak not only through the vessels, but also through the tracheids. Therefore, when the vessels are eliminated by tyloses formation, the tracheids are left, in which no tyloses develop, only 'gum' and debris, through which water may readily penetrate. Vessels and tracheids appear to form a unity together with the parenchyma, of which the individual elements do not act separately. The parenchyma probably plays an important and active, although less spectacular part. It is therefore not sufficient to look into the phenomenon of 'plugging' of vessels nor to that of the invasion of parenchyma cells by hyphae only. The coordination of the above tissues in water transport should be taken into account. This will be the subject of further studies. The anatomy of the leaves and the internodes are very important as well to help to elucidate the wilt problems, but it would lead too far to focus on these special aspects in this article.

Acknowledgements

This research was supported by the College of Agricultural and Life Sciences, Station Project 2265; by the Research Committee of Graduate School Project 170429, and by the U.S. Forest Service. The seedlings were inoculated by Mr. David Pengelly, grad. res. assistant. Appreciation is expressed to Mr. Russell Spear for his skillful assistance in the preparation of certain materials and illustrations, and in operating the scanning electron microscope.

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BOOK REVIEW

Anatomy of Papua New Guinea Wood. T. Furuno, 192 pp., 104 plates. Reprint from Research Report of Foreign Wood No. 6, 1977. Price unknown.

This book describes and pictures the wood anatomy of Papua New Guinea tree species. Although the text is in Japanese, extensive tables with headings in English enable the wood anatomist who is not conversant with this language (including the present reviewer) to have access to much anatomical information. The plates, showing a low magnification incident light photograph of a transverse surface and photomicrographs of transverse, radial and tangential sections at higher magnifications for each species also speak an international language.

Besides representatives of fairly well-known timber producing genera, numerous wood anatomically poorly known genera are described and pictured. This addition to the descriptive wood anatomical literature will be of great use in wood identification of timbers from this increasingly important region for the international timber market. The easily retrievable data will be of use to all students of comparative wood anatomy.

Pieter Baas

New date for Pan American Regional Group Meeting

The forthcoming joint meeting of the Botanical Society of America and the Pan American Regional Group of IAWA, to be held at Virginia Polytechnical Institute and State University (VPI) in Blacksburg, Virginia will be from June 25–30, 1978. The previous date was in August. This change was to make it easier for University people to attend. In addition to the Botanical Society of America section meetings, the American Society of Plant Physiologists will be meeting in Blacksburg the same week. This means that an attendee can attend several of their technical sessions in addition to the joint BSA-IAWA sessions. Dr. W.C. Dickison (Dept. of Botany, University of North Carolina, Chapel Hill) and Dr. J.G. Isebrands (Inst. of Forest Genetics, Rhinelander, Wisconsin) are actively engaged in the organization of the meetings and can be contacted for further information.

Award for 'Wood Structure and Identification'

The manual on Wood Structure and Identification by H.A. Core, W.A. Côté, and A.C. Day (see review in IAWA Bulletin 1977/3: 60) has won an award for production and design in the Graphic Arts Awards Competition of the Printing Industries of America. The authors are congratulated with this distinguished honour. It is gratifying to see how wood anatomical publications, if well designed and illustrated can please and impress specialists from other fields, in this case from graphic artists.

Jobs

Jobs in wood anatomy, like in any other field of Science are few and difficult to find at present. Yet numerous graduate students receive a highly qualified training in this field and hope to earn a living while engaged in research or teaching of this fascinating subject. On the other hand, situations may arise in certain centers of research where vacancies arise for wood scientists without an obvious candidate nearby to fill it. It might be feasible to use the Office of the IAWA as a data bank keeping record of job hunters as well as of current and forthcoming vacancies. Wood Anatomy is an international disciplin; IAWA can perhaps help some young promising wood anatomists to cross borders and find a future compatible with their scientific ambitions. Any suggestions or information on this subject will be welcomed by the Executive Secretary.

IUFRO conference on Tropical Woods

A conference on 'Wood Quality and the Utilization of Tropical Species' will be held October 28–November 3, 1978 at Kuala Lumpur, Malaysia. The conference is being sponsored by IUFRO Division 5, Forest Products Subject Group on Wood Quality and Project Group on Properties and Utilization of Tropical Woods in cooperation with the Malaysian Department of Forestry. It will immediately follow the 8th World Congress, October 16–28, 1978 in Jakarta, Indonesia. The proposed agenda includes sessions on anatomical characteristics and wood properties, on wood quality problems associated with utilization, on identifying wood properties required for processing and marketing, on evaluating tropical species to meet wood quality requirements for processing and marketing, and on improving wood quality and final recovery of tropical species by silviculture, forest operations, and utilization practices. For those who would like to either present papers or request further information on the conference, please contact: Dr. Philip R. Larson, North Central Forest Experiment Station, Box 898, Rhinelander, Wisconsin 54501.

IUFRO participation in 1979 meeting

IUFRO Division 5, Wood Quality Subject Group will participate in the joint meeting of the Afro-European regional IAWA group and the Royal Dutch Botanical Society scheduled for 1979 in Amsterdam. IAWA members in Europe and Africa are reminded to return the questionnaire sent to them recently as soon as possible.

Request for exchange of wood samples

Our new member, Mr. Wilhelm Mayer, Röselfeldstrasse 5, A 4400 Steyr, Austria, is interested in an exchange of wood samples. The following species are at his disposal for exchange: *Abies pectinata, Acer compestre, Aesculus hippacastanum, Alnus glutinosa, Betula verrucosa, Carpinus betulus, Chaenomeles japonica, Clemata vitalba, Corylus avellana, Deutzia scaba, Evonymus verrucosa, Fagus silvatica, Forsythia suspensa, Fraxinus excelsior, Juglans regia, Larix europaea, Ligustrum vulgare, Malus pumila, Philadelphus coronarius, Picea excelsa, Pinus silvestris, Pirus comunis, Populus nigra, Prunus avinus, Prunus domestica, Ptelea trifoliata, Quercus robur, Robinia pseudoacacia, Salix babylonia, Salix caprea, Sambucus nigra, Syringa vulgaris, Taxus baccata, Tilia cordata, viburnum opulus, Weigelia florida.*

INTERNATIONAL ASSOCIATION OF WOOD ANATOMISTS

Constitution*

Name of the Association:

Article I. The Association shall be called the International Association of Wood Anatomists.

Organization:

Article II. Governance of the Association shall be vested in an elected Council whose directions shall be implemented by an Executive Secretary and a Deputy Executive Secretary.

Object:

Article III. The object of the Association shall be to advance the knowledge of wood anatomy in all its aspects.

Activities:

Article IV. The activities of the Association shall be:

1. To create an awareness of the place of wood anatomy in science, technology, and conservation of natural resources, for the public good.
2. To interchange ideas and information through correspondence and meetings.
3. To facilitate the collection, storage, and exchange of research materials.
4. To provide rational bases for consistent terminology and descriptions, to work toward these ends, and to cooperate with others having similar aims in other related fields of plant anatomy.
5. To stimulate the publication of scientific articles.
6. To encourage and assist the study and teaching of wood anatomy and related fields.
7. To promote research in wood anatomy and related fields and to engage in any other activity consistent with the objects of the Assocation.

Membership:

Article V. The Association shall consist of Members and Honorary Members.

1. Members shall be persons who are interested in the study of wood structure.
2. Honorary Members shall be persons who, in the opinion of the Council have rendered notable service to the advancement of knowledge of wood anatomy.

Members shall be assessed dues or subscriptions and shall be entitled to receive all official communications of the Association, to attend member's meetings, and to be eligible for other Association benefits.
Honorary Members shall have the same privilages as members but shall not be assessed.

* *Adopted at Paris, July 4, 1931; Amended April 6, 1963; Amended Sept. 1, 1970; Amended July 1, 1972; Amended August 1, 1977.*

Admission to Membership or Change of Status:

Article VI. Application for admission by potential Members may be made in writing directly to the Executive Secretary. Candidates for Honorary Membership shall either be nominated in writing by two members of the Association and admission to this category of membership in this manner shall be controlled by the Council, or such candidates may be considered for membership at international open meetings of the Association where a majority vote shall be considered binding.

Council:

Article VII. The Association, by a majority vote of the Members, shall elect a Council consisting of not more than twelve (12) Members, of whom not more than three (3) shall be subjects or citizens of the same country. Members of the Council shall hold office for three (3) years and may retain that office for no more than two consecutive three-year terms. Following a lapse of Council membership for one three-year term, Members may be elected again for two more consecutive three-year terms. Any vacancy occurring during the term of office of the Council shall be filled by the Council.

Members of the Council and the Executive Secretary shall take office at the beginning of the calendar year following their election.

Business of the Council shall regularly be conducted by correspondence, but the Executive Secretary shall endeavor to arrange meetings of the Council when suitable opportunities arise. Council shall be empowered to conduct business at any such meeting by majortiy vote of the Council members present, providing that at least half of the Council members attend the meeting.

The Council shall elect an Executive Secretary who shall be directly responsible to the Council.

The Council shall, by a vote of two-thirds of its members, have the power to suspend or expel any member whose subscription or dues is two years in arrears or whose conduct is deemed by the Council to be prejudicial to the object or to the integrity and good name of the Association. Names of persons to be considered by Council for the actions cited above may be brought to the attention of the Council by the Executive Secretary, by a Member, or by an Honorary Member, but only through the office of the Executive Secretary, and supported by a dossier of charges.

All actions of the Council shall be by simple majority vote, except where specifically stated otherwise in the Constitution.

Executive Secretary:

Article VIII. The term of office of the Executive Secretary shall be three (3) years. The duties and responsibilities of the Executive Secretary shall be as follows:

1. To maintain the day-to-day operation and to conduct the business of the Association.
2. To preside at meetings of the Council and of Members.
3. To receive and process forthwith all proper applications for Membership.
4. To advise Council of nominations for Honorary Membership and to arrange for Council to consider all such candidates.
5. To collect, bank, and disburse Association funds as prescribed in the by-laws.
6. To maintain all Association records and archives and to cull these periodically of unessential materials.
7. To provide a clearing house for information of interest to members and to promulgate this information by formal or informal means, by circular letter, newsletter, or by other form of communication.
8. To appoint members to standing or ad hoc committees with the approval of the Council.
9. To call for and arrange business meetings of the Council and Members at such times and places as may be necessary and convenient.
10. To call for and arrange scientific meetings under the auspices of the Association.
11. To refer to Council for resolution, all matters not specifically covered by the Constitution or By-Laws.
12. To appoint the Deputy Executive Secretary with the approval of the Council.
13. To delegate certain duties and responsibilities to the Deputy Executive Secretary or to other Members of the Association.

Deputy Executive Secretary:

Article IX. The term of office of the Deputy Executive Secretary shall parallel that of the Executive Secretary. The duties and responsibilities of the Deputy Executive Secretary shall be as follows:

1. To perform the duties of the Executive Secretary in the event of his disability.
2. To provide advice, counsel, and help to the Executive Secretary.
3. To preside at meetings of Council or Members in the absence of the Executive Secretary.

Finances:

Article X. The income of the Association shall be derived from dues or subscriptions of Members, from voluntary contributions, or from sale of Association publications. The amount of dues or subscriptions shall be reviewed by the Council upon recommendation of the Executive Secretary. Ordinary expenditures of funds shall be vested in the Executive Secretary. Proposals for extraordinary expenditures shall be submitted to Council for review and recommendation prior to actual disbursement.

By-Laws:

Article XI. The Council shall have power to formulate by-laws for carrying into operation the terms of the Constitution and to alter such by-laws from time to time.

Alterations to the Constitution:

Article XII. The Constitution shall not be altered or amended except by a majority vote of the Members of the Association.

Regional Groups:

Article XIII. Within the Association regional Groups may be established to promote the aims of the Association in a specific part of the World. Such regional groups shall be administered by Regional Committees of at least two Association Members, who will report all major activities to the Executive Secretary.
Names of Regional Committee Members shall be proposed to the Council by Association Members of the region concerned. Their appointment can only follow approval by the Council.
Scientific meetings organized by a Regional Committee shall be open to all Members of the Association, and shall be announced at a reasonable time before the meeting in the Bulletin of the Association.

INTERNATIONAL ASSOCIATION OF WOOD ANATOMISTS

Office of the Executive Secretary
Rijksherbarium
Schelpenkade 6, Leiden
The Netherlands
Tel. 071 - 130541

DIRECTORY OF MEMBERS

MAY 1977

PREAMBLE

The 1977 Directory of Members is in a new form. It now includes some details of members' research interests and professional activities. To reduce costs these details are presented in an abbreviated form. A list of these abbreviations is given on page 3. We apologise for any ambiguities, errors or omissions which may have arisen due to the abbreviations. Members are also listed by country.

If the new Directory meets with members' approval, it is planned that it will be re-issued in this form at regular intervals, say every 2 years. Your comments are invited. A limited number of extra copies are available at a cost of Dfl.6.00 per copy.

The assistance of the Forestry Commission of New South Wales, Australia, in arranging for the printing and circulation of the Directory Questionnaire is acknowledged. We also wish to thank Ms Rosanne Summerville, Technical Officer of the Forestry Commission of N.S.W. for the invaluable assistance in the collation of the information.

ASSOCIATE MEMBERS

Audenaert, W.N.
Ayuque Anccasi, C.
Bissing, D.R.
Cheng, W.W.
Gibson, M.
Giebel, K.P.
Harris, R.A.
Hayden, W.J.
Lee, M.R.
Litvay, J.D.
Ozdemirden, T.
Peterson, M.D.
Rury, P.M.
Saka, S.
Styer, C.H.
Tabirih, P.K.
Taylor, S.
Wheat, D.

HONORARY MEMBERS*

Bannan, M.W.
Chalk, L.
Chattaway, Margaret M.
Côté, W.A.
Frey-Wyssling, A.
Metcalfe, C.R.
Phillips, E.W.J.
Rendle, B.J.
Wetmore, R.H.

RETIRED MEMBERS**

Beakbane, A.B.
Chowdhury, K.A.
Collardet, J.
Greguss, P.
Isenberg, I.
Marts, R.O.
Panshin, A.J.
Parham, B.E.V.
Reid, J.S.

* Honorary members do not pay dues.

** Retired members do not pay dues nor have voting privileges.

COUNCIL MEMBERS

Dr. P. Baas
Dr. R.K. Bamber
Dr. D.F. Cutler
Dr. C.H. de Zeeuw
Eng. M.P. Ferreirinha
Dr. H. Gottwald
Dr. S.M. Jutte
Dr. R.W. Kennedy
Mr. A. Mariaux
Dr. K. Shimaji
Prof. Dr. L. Susmel
Prof. A.A. Yatsenko-Khmelevsky

REGIONAL GROUPS - COMMITTEE MEMBERS

Americas:	Dr. J.G. Isebrands; Dr. W.C. Dickison
Eastern Europe:	Dr. V. Necesany
Pacific:	Dr. B.G. Butterfield; Dr. B.A. Meylan
Western Europe:	Dr. P. Baas; Dr. A.N.W. Mennega

ABBREVIATIONS USED IN ALPHABETICAL LIST OF MEMBERS

act	activity	prop	property (ies)
anat	anatomy	qual	quality
bk	bark	pw	primary wall
camb	cambium	react w	reaction wood
cw	compression wood	rel	relationship
cur	curator, wood collection	ret	retired member
coun	councillor	sapw	sapwood
dens	density	sem	scanning electron microscopy
dend	dendrochronology	str	structure
eco	ecological	sw	softwood
fb	fibre	sys	systematic
form	formation	tem	transmission electron microscopy
foss	fossil (woods)	tens w	tension wood
hrtw	heartwood	temp	temperature
hon	honorary member	tch	teaching
hw	hardwood	tr	trees
id	identification	trop	tropical
lf	leaf, leaves	var	variation
perm	permeability	ultr	ultructure
phl	phloem	w	wood
lign	lignification		

A number of conventions have been used in summarizing the information on members activities. Factors whose inter-relationships are being investigated are separated by a virgule (sloping line), for example,'the relationship of growth, anatomy and wood properties' is shown as 'growth/anat/w prop'.

The hyphen is used to separate the subject from the nature of the investigation, for example,'the systematics, phylogenetics and ecological anatomy of wood and leaves' becomes 'w,leaves- sys,phylogenetics, ecol anat'. Families are abbreviated thus, Lythraceae -Lythr, while generic names are not altered. Taxa under investigation are enclosed in brackets.

Mr. F.W. Addo-Ashong
Forest Products Research Institute
University
P.O. Box 63
Kumasi, Ghana
w qual (plantation hw,
Terminalia ivorensis)

Mr. Haraldur Agústsson
Miklubraut 9
Reykjavik, Iceland
cur, tch, Icelandic glossary

Dr. Clement C. Amobi
Dept of Botany
University of Nigeria
Nsukka, Nigeria.
camb act (trop spp.)
day length, temp/w form

Professor Raymond Antoine
Laboratoire Forestier de l'Université
de Louvain
Place Croit du Sud 2
1348 Louvain-la-Neuve, Belgium
w ultr; mineral nutrition tr

Mr. William N. Audenaert
P.O. Box 4203
Mississippi State, Mississippi 39762
U.S.A.
rays, tens w (Fagus)

Dr. Edward S. Ayensu
Department of Botany
Smithsonian Institution
Washington, D.C. 20560
U.S.A.
pl anat (Monocots); trop w;
revision "Commercial Timbers of W.Africa"

Mr. Clodoaldo Ayuque Anccasi
Avenida San Juan Evangelista
510 Huancavelica, Peru

Dr. Pieter Baas
Rijksherbarium
Schelpenkade 6
Leiden, Netherlands
w, leaves - sys, phylogenetic,
ecol anat (Lythr. Punic. Paracryphia);cur

Dr. R.K. Bamber
Forestry Commission of N.S.W.
Wood Technology Division
P.O. Box 100
Beecroft, N.S.W. 2119
Australia
sapw, hrtw; w anat/properties; bk
anat/taxonomy; leaf anat

Dr. U.C. Banerjee
22 Divinity Avenue
Harvard University
Cambridge, Massachusetts 02138
U.S.A.
w ultr - sem, tem; foss w; trop w;
palms; cur; ident

Dr. M.W. Bannan
68 Edenbridge Drive
Islington, Ontario, Canada M9A 3G2
ret (non active); camb activity/cell
characteristics; hon

Miss Josefina Barajas Morales
Inst. de Biologia U.N.A.M.
Ap. Postal 70-233
Mexico 20. DF., Mexico

Dr. A.C. Barefoot
3401 Hampton Road
Raleigh, North Carolina 27607
U.S.A.
dend-Winchester, UK (Quercus);preparing
textbook-w anat (with FW Hankins)

Dr. Tine Baretta-Kuipers
Institute of Systematic Botany
Transitorium 2
Heidelberglaan 2
Utrecht, Netherlands
sys anat (Mimos.Caesalp. Papil.)

Dr. E.S. Barghoorn, Jr.
Biological Lab.
Harvard University
Cambridge, Massachusetts 02138
U.S.A.
tertiary w; w silicification

Dr. M. Bariska
Inst. fur Mikrotechnologische
Holzforschung
Eldg. Technische Hochschule
Binzstrasse 39, 8045
Zurich, Switzerland
physical, chemical, mechanical prop,
perm sorption, w (Fagus, Abies)

Dr. H. Michael Barnes
Forest Products Utilization Laboratory
Mississippi State University
P.O. Drawer FP
Mississippi State, Mississippi 39762
U.S.A.

Dr. John R. Barnett
Department of Botany
Plant Science Laboratories
University of Reading
Whiteknights Reading
United Kingdom
ultr camb; w form (Pinus radiata)

Mr. Thomas S. Bartholin
Laboratory of Quaternary Biology
Tornavägan 13
S-223 63 Lund,
Sweden
w, charcoal id -paleoecology
(European spp.); dend

Prof. Dr. Josef Bauch
Ordinariat für Holzbiologie der
Universität Hamburg
Leuschnerstrasse 91d
205 Hamburg 80,
Germany
hrtw form; lign; dend
(various spp.)

Dr. A.B. Beakbane
27 Bower Mount Road
Maidstone
Kent ME16 8AX
United Kingdom
ret

Dr. F.C. Beall
University of Toronto
203 College Street
Toronto, Ontario,
Canada M5S 1A1
thermal degradation w

Dr. Helmut Bednar
Rebenweg 1/19
A-1170 Vienna
Austria

Dr. Dwight W. Bensend
Department of Forestry
245 Bessey Hall
Iowa State University
Ames, Iowa 50010
U.S.A.
syst anat; react w (Populus,
Alnus, Acer) tch

Dr. Graeme P. Berlyn
Yale University School of Forestry
and Environmental Studies
Greeley Laboratory
370 Prospect Street
New Haven, Connecticut 06511
U.S.A.
growth, development, cytochemistry-
woody plant cell wall; tissue culture
somatic hybridization woody plants

Mr. Donald R. Bissing
Rancho Santa Ana Botanic Garden
Claremont, California 91711
U.S.A.

Mr. Alan J. Bolton
Department of Forestry and Wood Science
University College of North Wales
Bangor, N. Wales
United Kingdom
w anat-perm, physical prop; anat, ultr-
pits vessels, walls (Pinac, Arauc, hw)

Professor Dr. Karl Borgin
Dept. of Chemistry
Univ. of Nairobi
P.O. Box 30197 Nairobi,
Kenya
anat, ultr - archeological w; fb
resources-Kenya, E.Africa

Prof. Dr. H.H. Bosshard
Institut für Mikrotechnologische
Holzforschung, E.T.H.
CH-8092, Zurich, E.T.H. - Zentrum
Switzerland
camb act; w anat/function;
aging in tr

Professor E. Boureau
Laboratoire de Botanique-Paléobotanique
12 Rue Cuvier
75005 Paris
France
sys anat; palaeoxylology; id

Dr. Julius Boutelje
Avdelningen för Träteknik
Svenska Träforskningsinstitutet
Box 5604
S-114 86 Stockholm
Sweden
distribution of lignin; w perm - water
storage; technical handbook

Dr. Jack D. Boyd
Forest Products Laboratory
Division of Building Research,CSIRO
P.O. Box 56, Highett, 3190
Victoria, Australia
growth in leaning trees; microfibril
configuration - pw; fb morphology/growth
stresses; prop of normal, reaction wood

Mrs. Arlene E. Bramhall
Western Forest Products Laboratory
6620 N.W. Marine Drive
Vancouver, BC. V6T 1X2
Canada
phl,w - ultr (Pinac)

Prof. Dr. H.J. Braun
Institut für Biologische Holzforschung
der Universität Freiburg
Bertoldstrasse 17
78 Freiburg i. Br.,
Germany
anat, physiology, pathology - tr

Mr. J.D. Brazier
Princes Risborough Laboratory
Building Research Establishment
Princes Risborough, Aylesbury
Buckinghamshire HP17 9PX
United Kingdom
growth/anat/prop; cur; id

Mr. Brian Bullock
8 Longcliffe Gardens
Nanpantan
Loughborough, Leicestershire
United Kingdom
tch; id; photomicrography

Dr. Pieter D. Burggraaf
Franz Lisztlaan 28
Voorschoten, Holland
camb act; anat; ultr (Fraxinus excelsior)

Dr. Jeffrey Burley
Dept. of Forestry
Oxford University
South Parks Road, Oxford
United Kingdom
anat, chemical, pulping prop w -
genetic var (trop pines, eucalypts)

Dr. Brian G. Butterfield
Department of Botany
University of Canterbury
Private Bag
Christchurch. New Zealand
w anat/function; ultr vessel, fb
(NZ app.) co-author 3 texts w anat
(with B.A. Meylan)

Dr. James E. Canright
Department of Botany
Arizona State University
Tempe, Arizona 85281
U.S.A.

Dr. Sherwin Carlquist
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, California 91711
U.S.A.
w anat - ecol, physiological inter-
pretation; w anat (Pittospor, Brun,
Gyrostemon, etc)
wr; author texts w anat

Dr. habil, Gerhard Casperson
Institut fur Phlanzenschutzforschung
DDR-1532 Kleinmachnow

Dr. Daniel Cassens
Dept of Forestry & Natural Resources
Purdue University
W. Lafayette 47907
U.S.A.
w anat (Pithecellobium complex)

Professeur Anne Marie Catesson
Laboratoire de Botanique
24 Rue Lhomond
75231 Paris Cedex 05
France
camb; w differentiation, lign; anat
vascular wilt; cytochemistry, ultr;
(Acer, Robinia, Populus)

Miss Dorothy M. Catling
Metropolitan Police Forensic
Science Laboratory
10g Lambeth Road
London S.E. 1
United Kingdom

Dr. Samuel C. Chafe
C/- J.J. Ryan
11 Tucker Street
Fawkner, Victoria 3060
Australia

Dr. L. Chalk
38 Ritchie Court
380 Banbury Road
Oxford, OX 2 7PW
United Kingdom
Ret, active; sys w anat; hon

Miss Wendy Cheng
International Paper Co.,
Forest Research Route 3,
Box 46-A
Natchez, Miss., 39120
U.S.A.
cell wall - ultr; tens w; tr physiology

Mr. Kwan Yun Chow
148 North Sathern Road
Bangkok, Thailand

Prof. K.A. Chowdhury
Raipura Lodge
Dodpur
Aligarh, India
ret; sys, ecol anat; prehistoric
pretohistoric forest economy;
trop w

Dr. Wiraj Chunwarin
College of Forestry
Kasetsart University
Bangken
Bangkok 9, Thailand
w anat; anat/prop (mangrove spp.)

Dr. R.A. Cockrell
Department of Forestry
University of California
Berkeley, California 94720
U.S.A.

Prof. Jean Collardet
Centre Technique du Bois
10 avenue de Saint-Mandé
Paris 12 ème
France
ret

Dr. Harold A. Core
Dept. of Forestry, College of Agric.
Univ. of Tennessee,
P.O. Box 1071
Knoxville, Tenn. 37901
U.S.A.
w qual/growth; w anat; trop w,
id, utilization

Ing. Fer. Harry Corothie
Avenida Moheeane No. 19
Urbanización La Castellana
Caracas, Venezuela

Dr. Wilfred A. Côté
Director, N.C. Brown Center for
Ultrastructure Studies
S.U.N.Y. College of Environmental
Science & Forestry
Syracuse, New York 13210
U.S.A.
w ultr; coatings, adhesives/wood
substrate; perm - ultr; hon

Dr. Salvator J. Cudia
Biology Department
State University College
Fredonia, New York 14063
U.S.A.

Professor Billy G. Cumbie
Division of Biological Sciences
411 Tucker Hall
University of Missouri
Columbia Missouri 65201
U.S.A.
camb act; w development (Hibiscus,
Leguminos)

Dr. D.F. Cutler
Jedrell Laboratory
Royal Botanic Gardens
Kew,
United Kingdom
sys anat (Liliaceae); id archeological w,
plants root w anat; contributing to
"Anatomy of the Monocotyledons"
(ed. C.R. Metcalfe); coun

Dr. Yvette Czaninski
Ecole Normale Supérieure
Laboratoire de Botanique
24, rue Lhomond
75231 Paris Cedex 05
France
w diff, lign; anat vascular wilt;
cytochemistry, ultr; (various spp.)

Mr. Dilip Kumar Das
Divisional Officer
Botany Division
Forest Research Institute
P.O. Box No. 273
Chittagong
Bangladesh

Dr. P.C. Datta
Reader in Botany
University of Calcutta
35, Ballygunge Circular Road
Calcutta-700019, India
sys anat; camb activity; wood culture;
(various spp.); id medicinal w

Dr. Chris Davidson
Los Angeles County Museum of Natural
History
900 Exposition Boulevard
Los Angeles, California 90007
U.S.A.
w anat (Piper, Caric, Berbered, Marograv)
anat tr butresses; sys ecol anat; Peru,
Bolivia w

Mr. Larry E. DeBuhr
Rancho Santa Ana Botanic Garden
Claremont, California 91711
U.S.A.
sys, ecol anat (Sarracenia, Dresera)

Mr. Albino Alves Pereira de Carvalho
Estaçae de Experimentaçae Florestal
Alcebaça, Portugal

Mr. Roger Dechamps
Service d'Anatomie des Bois Tropicaux
Musée Royal de l'Afrique Centrale
B-1980 Tervuren, Belgique
w anat - trop. Africa; id African w
carvings African foss w - Tertiary,
Quarternary; our

Dr. M. Patricia Denne
Dept of Forestry & Wood Science
University College of North Wales
Banger, Gwynedd, N. Wales
United Kingdom
camb act; w differention; rel environment,
w anat; (Picea, Pinus, Fraxinus
Triplochiton); Chairperson, IUFRO Xylem
Phsiology Working Party

Prof. Dr. L.S.V. de Seabra
Inst. Superior de Agronomia
Rua Proj. Av. Ilha da Madeira Np.1-5º
Portugal

Dr. C.H. Zeeuw
Wood Products Engineering Department
S.U.N.Y. College of Environmental
Science and Forestry
Syracuse, New York 13210
U.S.A.
sys anat; w var; anat/prop; (Lecythid,
Chaen); our; coun

Dr. W.C. Dickison
Department of Botany
University of North Carolina
Chapel Hill, North Carolina 27514
U.S.A.
sys anat, plant, flower (Dillen, Cunon, Connar)

Dr. J.M. Dinwoodie
Princes Risborough Laboratory
Building Reseach Establishment
Princes Risborough, Aylesbury
Buckinghamshire HP17 9PX
United Kingdom
w fracture morphology; chipboard - anat, adhesive distribution; w anat/prop; sw id

Dr. Ingegerd Dormling
The Phytotron
Royal College of Forestry
S 104 05 Stockholm 50,
Sweden

Mrs Mary Viik Dyer
School of Forest Resources
University of Maine
Orono, Maine 04473
U.S.A.

Dr. Ramón Echenique-Manrique
H. Colegio Militar No. 7
Xalapa, Veracruz
Mexico
w anat/prop; id; (trop, temperate commercial Mexican spp.)

Dr. Robert M. Echols
411 Skyline Drive
Harrison, Arkansas, 72601
U.S.A.
ret active; x-ray, electronic techniques in w research

Dr. Dieter Eckstein
Ordinariat für Holzbiologie
Leuschnerstrasse 91d
205 Hamburg 80,
Germany
tr-ring analysis; dend; ecol w anat/ man induced changes; (various spp.)

Mr. Aloysius Ifeanyi Ekweanua
Dept of Forestry & Wood Science
University College of North Wales
Bangor, Gwynnedd, N. Wales
United Kingdom
w physiology

Dr. G.K. Elliott
University College of North Wales
Dept of Forestry & Wood Science
Bangor, Caernarvonshire, North Wales
United Kingdom
w anat/prop; anat changes in processed w (commercial spp. UK Europe); tch

Dr. M. Lotfy M. El-Osta
Department of Forestry
Faculty of Agriculture
Alexandria University
Alexandria
Egypt
w anat hw/prop (Eucalyptus, Casuarina, Populus)

Prof. A. Fahn
Department of Botany
The Hebrew University of Jerusalem
Jerusalem
Israel
plant anat; anat resin ducts; author textbook plant anat

Eng. M.P. Ferreirinha
Presidente do Instituto dos Produtos Florestais
Rue Filipe Folque
10-J
Lisboa-1 Portugal
sys anat; id (trop African spp.); coun

Dr. Geoffrey W.D. Findlay
4, Bells Cottages
Farnham
Nr. Bishops Stortford
Herts.
United Kingdom

Ing. Jorge L. Flaman
ICATEC, S.A., Consultores
Minería No. 145
México 18, D.F.
México

The President
Forest Research Institute & Colleges
Government of India
P.O. New Forest
Dehra Dun,

India

Miss Mary-Lou Florian
Conservation Processes Res
Canadian Conservation Inst.
1030 Innes Road
Ottawa K1A 0M8
Canada
wooden archeological artefacts

Prof. Dr. A. Frey-Wyssling
Prof. Emeritus
Department of General Botany ETH
Universitätstrasse 2
8006 Zürich, Switzerland
ultr plants, w/cell wall, cytoplasmic organelles; author several texts ultr; hon

Mr. M. Fujita
Dept of Wood Science & Technol
Faculty of Agriculture
Kyoto University
Sakyo-Ku, Kyoto, Japan
cell wall form

Mr. J.M. Fundter
Roghorst 275 Wageningen,
The Netherlands
w anat, prop (New Guinea spp.; Dipterocarp., Pacific zone) cur, id

Mr. Takeshi Furuno
Foreign Wood Laboratory
Faculty of Agriculture
Shimane University
Nishikawatsu-cho
Matsue City, Shimane Prefecture
Japan
w anat (trop. spp.) anat w polymer interface

Dr. G. Gardner
ARctic & Sub-Arctic Research Services
Université du Québec a Montréal
P.O. Box 8889
Montreal H3C 3P8
Canada
growth characteristics (cold climate tr)

Mr. Mark D. Gibson
56 N.W. 33rd Street
Corvallis, Oregon 97330
U.S.A.
particle board - anat, fracture (Pseudotsuga menziesii, Tsuga heterophylla)

Mrs Kristen Phend Giebel
Department of Botany
University of North Carolina
Chapel Hill, North Carolina
27514
U.S.A.
sys anat (Clethr, Cyrill, Actin)

Dr. Bernadette Giraud
Laboratoire de Paléobotanique
12 Rue Cuvier
Paris Cedex 75005
France
w anat - statistical var (Entandrophragma utile)

Dr. James F. Goggans
Department of Forestry
Auburn University
Auburn, Alabama 36830
U.S.A.

Wiss. Rat. H. Gottwald
Bundesforchungsanstalt für Forstund Holzwirtschaft
Leuschnerstrasse 91d
205 Hamburg 80,
Germany
anat w; Tertiary foss; (Diptero, Magnol, Eban, Myrist); coun

Dr. Richard L. Gray
Tropical Timber Information Center
S.U.N.Y. College of Environmental Science and Forestry
Syracuse, New York 13210
U.S.A.
w anat; var w prop; general w prop; (Vitex;French Guinea spp.)

Dr. Robert A. Gregory
Northeastern Forest Experiment Station
P.O. Box 968
Burlington, Vermont 05401
U.S.A.
growth, development - forest tr (Acer)

Em. Professor Dr. Pál Greguss
Jozsef Attila University
Botanical Department
6722 Szeged
Egyetem u. 2.,
Hungary
w, foss anat; phylogenetics; author texts descriptive 2 anat

Dr. Dietger Grosser
Institut für Holzforschung und Holztechnik der Universität Munchen
Winzererstrasse 45
D-8 Munchen 40, Germany
sys w anat; foss; w defects; w destroying agents (temperate mediterranean spp) cur; id

Dr. George A. Grozdits
Eastern Forest Products Laboratory
Canadian Forestry Service
800 Montreal Road
Ottawa, Ontario, Canada K1A 0W5
deformation mechanism - transverse compression; anat/glue wood interface; bk anat;

Dr. M. Nabil El Hadidi
The Herbarium
Faculty of Science
Cairo University
Giza, Egypt

Mr. J.D. Hale
28 Seymour Avenue
Ottawa, Ontario, Canada K2E 6P2

Prof. John W. Hall
Department of Botany
University of Minnesota
St. Paul, Minnesota 55101
U.S.A.
paleobotany; morphology vascular plants; (Salvinia)

Dr. William V. Hancock
6436 121 A Street
Surrey, British Columbia,
Canada

Mr. Frank W. Hankins
Sept-March: P.O. Box 478
Alpine, Texas 79830
U.S.A.
April-Aug: P.O. Box E
Collegeville,
Pennsylvania 19426,
U.S.A.
id w; Tertiary w; preparing text - id of modern and Tertiary w (with A.C. Barefoot)

Dr. Robert B. Hanna
Department of Neurosciences
Rose Kennedy Center
AECOM
1410 Pelham Parkway
Bronx, New York 10461
U.S.A.

Prof. Dr. H. Harada
Department of Wood Science & Technology
Faculty of Agriculture
Kyoto University
Kyoto, Japan
cell wall organisation, development w

Mr. Robert A. Harris
Room 210 Cheatham Hall
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061
U.S.A.
anat react w (Pinus echinata)

Dr. John H. Hart
Department of Botany & Plant Pathology
Michigan State University
East Lansing, Michigan 48824
U.S.A.

Prof. Dr. G. Hartwig
Faculty of Forestry
University of Stellenbosch
Stellenbosch, South Africa
id (South African spp.); w anat-SEM

Mr. Walter J. Hayden
3424 Tulane Drive 34
Hyattsville, Maryland 20783
U.S.A.
Sys anat (Euphorbia)

Dr. James Henrickson
Department of Biology
California State University
5151 State University Drive
Los Angeles, California 90032
U.S.A.
comparative anat (Mexican spp.); taxonomy

Mr. Robert W. Hess
5730 Tall Pine Lane, No. 4
Jacksonville, Florida 32211
U.S.A.
ret - non active

Miss Charlotte H. Hiller
Division TUR
U.S. Forest Products Laboratory
Madison, Wisconsin 53705
U.S.A.

Dr. William E. Hillis
Division of Building Research
CSIRO
P.O. Box 56
Highett, Victoria, 3190
Australia
w anat/prop; w chemistry/ prop (Eucalyptus, Syncarpia, tropical spp.)

Dr. R.B. Hoadley
Wood Science & Technology
University of Massachusetts
Amherst, Mass. 01002,
U.S.A.
str/w prop

Dr. W. Höll
Institut für Botanik
Technische Hochschole München
Arcisstrasse 21
8 Munchen-2, B.R.D.
nature, distribution, physiology storage materials (Robinia, Tilia, Picea)

Mr. Waldemir J. Hora
Rua Rodrigo Silva, 224
Apt. 22
Santos-SP-(11100)
Brazil

Dr. Hans-Rolf Höster
Institut für Landschaftspflege und Naturschutz
Technische Universitat Hannover
D-3 Hannover, West Germany
Herrenhäuser Str. 2
camb act; ecological anat (urban tr)

Mr. R.H. Hudson
38 Arnold Avenue
Coventry
West Midlands, CV3 5LX,
United Kingdom

Dr. Fay Hyland
Department of Botany & Plant Pathology
Deering Hall University of Maine
Orono, Maine 04473
U.S.A.

Dr. Geza Ifju
Department of Forestry & Forest Products
Virginia Polytechnic Institute & State University
Blacksburg, Virginia 24061
U.S.A.

Mr. Jugoslav Ilic
C.S.I.R.O. Building Research
P.O. Box 56
Highett, 3190
Australia
prop/w anat (fast grown Eucalyptus)
w cell statistics; id; cur

Mr. H.D. Ingle
C.S.I.R.O. P.O. Box 310
South Melbourne, Victoria
Australia
ret; w taxonomy - Pacific zone

Dr. Judson G. Isebrands
Institute of Forest Genetics
North Central Forest Experiment Station
Star Route 2
Rhinelander, Wisconsin 54501
U.S.A.
w anat/prop (Populus); anat fast grown w; co-chairman IAWA (American region)

Dr. Irving H. Isenberg
529 N. Linwood Avenue
Appleton, Wisconsin 54911
U.S.A.
ret; w anat; fb morphology, analysis pulp, paper (North American pulpwoods)

Professor Shigeo Ishida
Department of Forest Products
Hokkaido University
Sapporo, Hokkaido,
Japan

Prof. Dz. Ing. Jacquiot
Laboratoire de Biologie Végétale
Route de la Tour Dénecourt
77300 Fontaine bleau, France
camb tissue culture anat; cytology; (Fagac, Prunus, Populus)

Mr. C.T. Johnson
Department of Botany
University of Western Cape
Bag X 17, Belville 7530
Republic of South Africa
(tempory until 1.1.1978);
Rijksherbarium
Schelpenkade 6
Leiden. The Netherlands.
sys anat (Leptospermum)

Dr. Susanna M. Jutte
Department of Plant Pathology
University of Wisconsin
1630 Linden Drive
Madison, Wisconsin, 53706
U.S.A.
w anat/micro organisms; coun

Dr. El Sayed A. Ezzat Kandeel
Wood Scientist
c/- UNDP/FAO
P.O. 274
Monrovia, Liberia
perm trop w; a, ultr (West African spp.); w extractives, utilization research

Dr. Donald R. Kaplan
Department of Botany
University of California
Berkeley, California 94720
U.S.A.
developmental morphology; shoot/ growth; (Acacia, Pandan, Palmae)

Dr. Clayton T. Keith
Eastern Forest Products Laboratory
Department of the Environment
800 Montreal Road
Ottawa, Ontario, K1A 0W5
Canada
w anat/prop; id

Dr. R.W. Kennedy
Western Forest Products Laboratory
6620 N.W. Marine Drive
Vancouver, B.C., V6T 1X2
Canada
x-ray densitometry - tr rings (North-western American conifers); coun

Prof. T. Kishima
Wood Research Institute
University of Kyoto
Kyoto, Japan
w anat/perm

Prof. Dr. h.c.J. Kisser
Hochschule für Bodenkultur
Gregor Mendel-Strasse 33
A-1180 Wein, Austria

Mrs D. Jifke Koek-Noorman
Institute for Systematic Botany
State University of Utrecht
Transitorium II
Heidelberglaan 2, de Uithof
Utrecht, Netherlands
sys anat (Rubia, Melastomat)

Dr. Robert C. Koeppen
U.S. Forest Products
Madison, Wisconsin 53705
U.S.A.

Dr. Zoltan Koran, Professeur
Département d'Ingénierie
Univ. du Québec à Trois-Rivières
C.P. 500
Trois-Rivieres, Québec, G9A 5H7
Canada
anat, ultr w cells, fb-w, pulp, paper rel pits/perm; rel fb prop/ paper prop

Dr. Robert L. Krahmer
School of Forestry
Oregon State University
Corvallis, Oregon 97331
U.S.A.
w anat/gluing plywood, particle board (Pseudotsuga menziesii, Dipterocarp)

Dr. Jeannette M. Kryn
3710 Atwood Avenue
Madison, Wisconsin 53714
U.S.A.

Dr. Ing. Ladislav J. Kucera
Kreuzwiesen 6, 8051, Zurich
Switzerland
anat react w; anat wound tissue (Podocarp, Winter, Tax)

Dr. B.F. Kukachka
U.S.D.A. Forest Service
Forest Products Laboratory
Madison, Wisconsin, 53705
U.S.A.
sys w anat (Sapotac); id; w prop

Dr. Norman Kutscha
School of Forest Resources
University of Maine
Orono, Maine 04473
U.S.A.
anat - new w products

Mr. Chow Kwanyun
148 North Sathorn Road
Bangkok, Thailand

Dr. Peter B. Laming
Forest Products Research Institute TNO
Schoemakerstraat 97
Delft, Netherlands
interstitial spaces; bordered pit aspiration; w perm; surface coatings; cur; id

Miss Joyce W. Lanyon
The Forestry Commission of N.S.W.
Wood Techn. & Forest Research Dvn.
P.O. Box 100
Beecroft N.S.W. 2119
Australia
sys w anat (Proteaceae); cur; id; published card key for Pinus leaves, card key for New South Wales timbers

Dr. Philip R. Larson
North Central Forest Experiment Station
Box 898
Rhinelander, Wisconsin 54501
U.S.A.
w formation; primary vascularization; vascular anat, function (Populus)

Mr. Michael R. Lee
Department of Botany & Microbiology
Arizona State University
Tempe, Arizona 85281
U.S.A.

Dr. Lawrence Leny
Forest Resources AR-10
University of Washington
Seattle, Washington 98195
U.S.A.
w anat/prop; var anat-growth quality

Dr. J.F. Levy
Department of Botany
Imperial College of Science & Technology
Prince Consort Road
London S.W. 7 2BB
United Kingdom
w anat; microbiology/w; co-chairman IUFRO section 5.03.00

Prof. Dr. Walter Liese
Lehrstuhl für Holzbiologie
Universität Hamburg
Leuschnerstrasse 91d
205 Hamburg 80. Germany
ultr cell wall; environment/w anat; anat, ultr - biological degrade w; President, IUFRO

Mr. John D. Litvay
Forest Products Department
Oregon State University
Corvallis, Oregon 97331
U.S.A.

Dr. Eldar D. Lobjanidze
Paliashvili st. 49, ap. 16
Tbilisi, 380030, U.S.S.R.
ecol anat; camb act (Caucasian spp.); cur

Dr. Anders E. Lund, Director
Institute of Wood Research
Michigan Technological University
Houghton, Michigan 49931
U.S.A.

Dr. Donald R. Lundy
Bureau of Alcohol, Tobacco & Firearms
Forensic Lab.
IRS Building
1111 Constitution Avenue, N.W.
Washington, D.C. 20226
U.S.A.

Mr. Albert H. Lyter, III
2576 Merrywood Court
Woodbridge, Virginia 22192
U.S.A.
id; sem/w; id fb

Mr. Calvino Mainieri
Divisão de Madeiras
Instituto de Pesquisas Tecnológicas
Caixa Postal 7141
01000 São Paulo, Brazil
w anat; id;

Dr. Paul T. Mann
Research & Development
Food Division
J.R. Simplot Company
Caldwell, Idaho 83605
U.S.A.

Dr. Floyd G. Manwiller
Southern Forest Experiment Station
2500 Shreveport Highway
Pineville, Louisiana 71360
U.S.A.
anat, w, bk; cell dimensions; hw spp.

Mr. Alain Mariaux
Centre Technique Forestier Tropical
45 bis, Avenue de la Belle-Gabrielle
94130 Nogent Sur Marne, France
sys anat; tr rings (trop spp.)
w shrinkage; cur; id; coun

Mr. Ralph O. Marts
P.O. Box 27
Princeton, Kansas 66078
U.S.A.
ret; w anat; fluorescence microsc.

Dr. Edgar A. McGinnes, Jr.
School of Forestry, Fisheries & Wildlife
University of Missouri
Columbia, Missouri 65201
U.S.A.
form abnormal w; anat w charcoal (Quercus, Juglans)

Dr. Douglas C. McIntosh
International Paper Company
Corporate Research & Development
Division, Box 747
Tuxedo Park, New York 10987
U.S.A.
light microscopy, sem, computerized image analysis - w, fb, paper

Dr. Charles W. McMillin
Southern Forest Experiment Station
2500 Shreveport Highway
Pineville, Louisiana 71360
U.S.A.

Prof. Han Meier
Institut de Biologie Végétale et de Phytochimie
Université de Fribourg
3, rue Albert Gockel
1700 Fribourg, Switzerland
departmental research: rhizongenesis; ultr suberization (Populus Acacia)

Dr. A.M.W. Mennega
Botanical Museum & Herbarium
University of Utrecht
2e Transitorium "De Uithof"
Heidelberglaan 2
Utrecht, Netherlands
sys anat (Celastr, Euphorbia Logan) id; cur

Mr. P.K. Balan Menon
School of Applied Sciences
Institute Technology MARA
Shah Alam, Selangor, Malaysia

Ing. Forest. Margarita Mesa Izquierdo
Centro de Investigaciones y Capacitacion Forestales
Calle 174, No. 1723 e/17b
Rpto. Siboney, Marianao
Havana, Cuba

Dr. C.R. Metcalfe
Jodrell Laboratory
Royal Botanic Gardens
Kew, Richmond-on-Thames
United Kingdom
ret, active; sys plant anat; revision of 'Anatomy of the Dicotyledons'; hon

Dr. Robert W. Meyer
Engineering Extension
Dana Hall
Washington State University
Pullman, Washington 99164
U.S.A.
w failure; fracture mechanics; anat/strength; cell wall prop; anat/use; editor "Wood and Fibre", "Wood Industry Abstracts"; convenor symposium 1978 "Structural use of wood in Adverse Environments:

Dr. Brian A. Meylan
Physics & Engineering Laboratory
Private Bag
Lower Hutt, New Zealand
w anat/prop; ultr/prop (New Zealand spp.) Co-author texts (B.G. Butterfield)

Prof. Fernando Romano Milanez
Universidade Estadual de Campinas
CXP. 1170 - Cidade Universitaria
Barao Geraldo, Brazil
sys anat; laticifers (Desmanthus fatuhiensis; Eremanthus)

Dr. Howard J. Miller
Plantenziektenkundige Dienst
Geertjesweg 15
Wageningen, The Netherlands

Dr. Regis B. Miller
U.S. Forest Products Laboratory
P.O. Box 5130
Madison, Wisconsin 53705
U.S.A.
sys anat; computerized w id; (Jugland, Flacourt, Boragin); id

Dr. Jette Dahl Moller
Institute of Plant Anatomy & Cytology
Solvgade 83
1307 Copenhagen K, Denmark
comparative phl anat; Tetracentron

Prof. Peter Moltesen
Royal Veterinary & Agricultural University
Department of Forestry
Thorvaldsensvej 57
DK-1871 Copenhagen V, Denmark
w qual, dens/genetics environment (Picea excelsa)

Ms Josefina Barajas Morales
Ap. Postal 70-233, Mexico 20 DF, Mexico
sys anat; cur; tch

Dr. Philip R. Morey
Department of Biological Sciences
P.O. Box 4149
Texas Tech. University
Lubbock, Texas 79409
U.S.A.
w form/herbicides; anat (Gossypium) gummoisis (Prosopis,Acacia)

Dr. M.F. Moseley, Jr.
Department of Biological Sciences
University of California, Santa Barbara
Santa Barbara, California 93106
U.S.A.
w, floral anat; ecol plant anat; (Casuar, Garry, Nymph, Nelumbon)

Ing. A. Mottet
Chef de Travaux
Institut Agronomique de l'État
Gembloux, Belgium

Dr. Lidija Murmanis
Forest Products Laboratory
Madison, Wisconsin 53705
U.S.A.

Mr. T. Nabuchi
Dept. of Wood Science & Tech.
Faculty of Agriculture
Kyoto University
Sakyo-Ku, Kyoto, Japan
heartw form

Mr. H. Nagtegaal
M.V. Clevelaan 8
Amstelveen
The Netherlands
sys anat; id

Dr. Vladimír Necesaný
State Forest Products Research Institute, Lamesks 5
CS-891 29 Bratislava, Czechoslovakia
camb act; formation ultr-cell wall; heartw; react w; sem-w; Editor "Drevasky Vyskum"

Dr. Stanley Nemec
Research Plant Pathologist
U.S. Horticulture Research Laboratory
2120 Camden Road
Orlando, Florida 32803
U.S.A.
plant pathology; w-physiology/disease (Citrus)

Prof. Dr. R.A. Noel
Dept. of Botany
University of Natal
Pietermaritzburg 3201
Republic of South Africa
plant anat; cell wall

Dr. P.H. Norberg
MODOCELL AB
Research & Development
S-891 01 Örnskoldsvik, Sweden

Monsieur Didier Normand
Maitre de Recherches (E.R.)
6 Blvd, Gambetta
94130 Nogent-sur-Marne
France
sys anat (African Leguminos, French Guyana Vochys) id; in press - text id Afrique Guineo-congolaire w

Dr. T.P. O'Brien
Botany Department
Monash University
Clayton, Vic. Australia 3168
anat/physiology; cell wall ultr/ microbiological attack; root anat; ultr. co-author (M.E. McCully) "Plant Structure and Development"

Dr. Ken Ogata
Wood Anatomy Section
Government Forest Experiment Station
Meguro, Tokyo, Japan
w anat; id; (Dipterocarp, trop Asian Pacific w)

Dr. Sadaaki Ohta
Government Forest Experiment Station
21-37-5 Shimomegura Meguro-Ku
Tokyo, Japan
growth ring analysis; anat tens w (Cupress, Pin, Taxodia, Acer, Fag, Salic)

Prof. Timothy G. O'Keefe
School of Forest Resources
Nutting Hall
University of Maine
Orono, Maine 04473
U.S.A.

Mr. P.O. Olesen
Skovbrugsinstituttet
Thorvaldsensvej 57
1871 Copenhagen, Denmark
age/w prop; dens var; (Picea abies)

Dr. Paavo J. Ollinmaa
Ristinummentie 47
04420 Ristinummi, Finland
ret; w, biological collections

Mr. H.R. Orman
Forest Research Institute
New Zealand Forest Service
P.B. Rotorua,
New Zealand
sys anat (S.W.Pacific spp.); id

Dr. R.W. den Outer
Arboretumlaan 4
Wageningen, The Netherlands
sys anat phl, w (Dichapetal, Stercul Annon)

Mr. Tezcan Özdemirden
Apt. 3
415 Stratford Street
Syracuse, New York 13210
U.S.A.
glue-lamination (Turkish white oak)

Dr. Ganesh S. Paliwal
Department of Botany
University of Delhi
Delhi 7, India

Prof. Alexis J. Panshin
2515 Arrowhead Road
Okemos, Michigan 48864
U.S.A.
ret, act; sys w anat; co-author 2 texts "Textbook of Wood Technology" "Forest Products"

Dr. N. Parameswaran
Bundesforschungsanstalt für Forstund Holzwirtschaft
Leuschnerstrasse 91d
205 Hamburg 80, Germany
bk anat, prop; EM-sound, decayed w bk; bk collection; sys anat; anat w products; (Fagus, Picea hw)

Mr. B.E.V. Parham
14 Cracroft Terrace
Christchurch 2, New Zealand

Dr. Russell A. Parham
Institute of Paper Chemistry
1039 East South River Street
Appleton, Wisconsin 54911
U.S.A.
ultr cytology, w anat; EM-paper (Nth.American spp.) tissue culture (Pinus, Pseudotsuga)

Mrs Susannah Peletier
Chopinlaan 23
Voorschoten
The Netherlands
sys w anat (Punic)

Mr. E. Perem
161 Rachel Avenue
Ottowa, Ontario
Canada K1H 6C5
ret; rel w anat/prop; id

Mr. Mark D. Peterson
International Paper Co.
P.O. Box 797 Tuxedo Park
N.Y., 10987, U.S.A.
ultr fungal attack w

Dr. Bozidar Petrić
Wood Structure & Preservation Section
Forestry Faculty
University of Zagreb
P.O. Box 178
41001 Zagreb, Yugoslavia
w anat/perm; tech; id; cur

Mr. John F. Phelps
School of Forestry, Fisheries & Wildlife
1-30 Agriculture Building
University of Missouri
Columbia, Missouri 65201
U.S.A.
anat wound response w
(Quercus Juglans)

Prof. Dr. W.R. Philipson
Department of Botany
University of Canterbury
Christchurch, New Zealand
sys anat (Cornac)

Dr. E.W.J. Phillips
Building Research Establishment
Princes Risborough Laboratory
Princes Risborough,
Aylesbury, Bucks.
United Kingdom
ret; hon

Prof. Jane Philpott
Department of Botany
Duke University
Durham, North Carolina 27706
U.S.A.
ecol plant anat; tch

Dr. Maxon Y. Pillow
3201 Stevens Street
Madison, Wisconsin 53705
U.S.A.

Dr. Thompson D. Pizzolato
North Central Forest Experiment Station
Box 898
Rhinelander, Wisconsin 54501
U.S.A.

Ms Arlette Plu
Muséum de Paris
57, rue Cuvier 75231, Paris
Cedex 05, France
cur, id

Dr. Jean Poliquin
Faculté de Foresterie et de Géodésie
Université Laval
Quebec 10, P.Q.
Canada

Dr. N. Prakash
Department of Botany
University of New England
Armidale, N.S.W. 2351
Australia
sys, ecol, anat; embryology;
(Bauera Piptocalyx, Chrysanthemoides, Eucalyptus)

Dr. S.K. Purkayastha
Wood Anatomy Branch
Forest Research Institute
P.O. New Forest
Dehra Dun, U.P. India

Dr. John T. Quirk
117 North Franklin Avenue
Madison, Wisconsin 53705
U.S.A.
acoustical microscopy; scalariform perforation plates; anat (Vochysia); techniques statistical analysis of cells

Dr. Jaromir Rak
Eastern Forest Products Laboratory
800 Montreal Road
Ottowa, Ontario,
Canada K1A OW5
w anat/perm (Nth.American spp.)

Mr. Roberto da Silva Ramalho, Dean
School of Forestry
Federal University of Vicosa
Viçosa, Minas Gerais, Brazil

Mr. K. Ramesh Rao
Senior Research & Development Officer
The Indian Plywood Mfg Co Ltd
Dandeli-581325 (N.K.), Karnataka State
India
w anat/prop; dyeing, gluing veneers/ w anat; general prop veneer plywood; id plywood spp.

Prof. F. Raposo
(Current address unknown)

Mr. J.S. Reid
160 Wadestown Road
Wellington 1, New Zealand
ret; macroscopic id

Prof. E. Reinders
Sparrenhof, Flat 616
Stationsweg 92
6100 Ede (Gld), Netherlands

Miss Nelly C. Rem
Forest Products Laboratory
University of California
1301 South 46th Street
Richmond, California 94804
U.S.A.
w path (Pacific coast spp.); id

Mr. B.J. Rendle
Glebe Cottage
Horsenden, HP17 9NF
Aylesbury (Bucks.),
United Kingdom
ret. not active; author "Fifty years of Timber Research" (FPRL Princes Risborough) Hon

Professor S.D. Richardson
Dept of Forestry & Wood Science
University College of North Wales
Bangor, North Wales,
United Kingdom

Hans Georg Richter
Wiesenweg 3A
2000 Barsbüttel/Willinghusen
West Germany
w bk anat (Laur); general w prop; id

Dr Richard T. Riding
Department of New Brunswick
Fredericton, N.B., Canada
growth, development conifers; effects of age, pollutants; (Pinus spp.)

Ir. J.F. Rijsdijk
Koninginnelaan 55
Rijswijk (Z.H.)
The Netherlands
physical prop w; w anat (Leguminos-Surinam)

Dr. A.W. Robards
Department of Biology
University of York
Heslington, York YO1 5DD
United Kingdom
root anat, function; ultr, differentiation - vascular camb, w;
(Picea, Fagus, Salix)

Dr. Barrett N. Rock
Department of Biology
Alfred University
Alfred, New York 14802
U.S.A.
sem - w anat; sys w anat; rel habit environment/ w anat

Mr. Stanley Rowe
Western Forest Products Laboratory
6620 N.W. Marine Drive
Vancouver, B.C., Canada
sys anat (Abies, Pinus) cur, id

Mr. Phillip M. Rury
Department of Botany
University of North Carolina
Chapel Hill, North Carolina 27514
U.S.A.
ecol, evolutionary, sys-plant anat;
(Hibbertia Erythroxy)

Dr. Irving B. Sachs
U.S. Forest Products Laboratory
ChemicalUtilization & Protection Research
Madison, Wisconsin 53705
U.S.A.
ultr - bordered pits; w perm; therm - mechanical pulps; adhesives; (sw spp.)

Prof. Hiroshi Saiki
Faculty of Agriculture, Kyoto University
Sakyoku, Kyoto, Japan
anat abnormal w; anat bk; w anat/prop rel id

Mr. Shiro Saka
Department of Wood & Paper Science
North Carolina State University
Box 5488
Raleigh, North Carolina 27607
U.S.A.
fb morphology - alkaline pulping
(Pinus palustris)

Mr. Krit Samapuddhi
Managing Director
Forest Industry Organization
Rajdamnernnok Avenue
Bangkok, Thailand

Prof. Dr. S. Sarkany
Institute for Applied Botany and Histogenetics
University Budapest
Budapest III
Muzeum-Körut 4/A Hungary

Mr. M.M.A. Sassen
Botaniseh Laboratorium
Universiteit van Nijmegen
Toernooiveld
Nijmegen, The Netherlands
ultr, biochemistry - cell wall

Dr. Cherla B. Sastry, Canadian Expert
Universiti Pertanian Malaysia
P.O. Box 203, Sungei Besi
Selangor, Malaysia
general wood and industry research
(Dipterocarp, Pinus oocarpa)

Prof. Dr. G. Scaramuzzi
Centro di Sperimentazione Agricola e Forestale
E.N.C.C.
C.P. 9079, 00100
Rome Italy
wood quality (Populus, Eucalyptus Pinus)

Dr. Roswitha Schmid
Botanisches Institut Technical University
Arcisstrasse 21
DB München 2, Germany
ultr w, fungi, Editor "Naturwissenschaftliche Rundschau"

Professor Rudolf Schmid
Department of Botany
University of California
Berkeley, California 94720
U.S.A.
sys, ecol anat - flowers, fruits

Professor Marc H. Schneider
Faculty of Forestry
University of New Brunswick
Fredericton, N.B. Canada E3B 5A3
w coatings, polymer interactions; sorption; microwave drying
(North East American spp.)

Dr. habil, Günther Schultze-Dewitz
X 13 Eberswalde (East Germany)
August-Bebel-Str. 4a
ecol anat; w perm (sw, Pinus,Larix)

Dr. R.A. Scott
U.S. Geological Survey
Bldg. 25, Denver Federal Center
Denver, Colorado 80225
U.S.A.

Dr. Leslie P. Sebastian
Faculty of Forestry
University of New Brunswich
P.O. Box 4400
Fredericton, N.B., Canada E3B 5A3
w perm-ultr rel (North-east American sw, hw)

Dr. Lalita Sengal
Dept of Botany, Gargi College
Lajpat Nagar IV
New Delhi-24, India
sys anat (Euphorbia)

Dr. Ken Shimaji
Wood Research Institute
Kyoto University
Uji, Japan
camb act; w formation; id; coun

Dr. Gunilla Smedman
McDoCell Research & Development
Fack, 891 01 Ornsköldsvik, Sweden
general anat (Pinus, Picea, Betula)

Mr. Wallace J. Smith
Division of Technical Services
Queensland Dept of Forestry
GPO Box 944
Brisbane, Q. 4001
Australia
w qual improvement; physiology w formation anat/prop (sw); id; cur

Prof. Dr. Zvonmir Spoljarfc
Forestry Faculty
University of Zagreb
Simunska 25
41001 Zagreb Yugoslavia
w anat/perm; w preservation; tch; id; cur

Dr. Ian A. Staff
Department of Botany
La Trobe University
Bundoora, Victoria 3083
Australia
(woody monocots, Xanthor); symbiosis - plant anat. cycads

Dr. J. Stahel, Oberförster
19 Kreisforstamt Rathaus
Gemeinderatshaus
7250 Klosters, Switzerland
camb act, growth rhythm/w qual (sw)

Dr. Erak Staka
Zovod za technologiju drevata
Omladinsko setaliste 12
71000 Sarajevo, Yugoslavia
general anat (Corylus, Abies, Fagus,Picea)

Dr. William L. Stern
Department of Botany
University of Maryland
College Park, Maryland 20742
U.S.A.
sys anat (dicotyledons)

Mr. James B. Stichka
33 Woodland Drive
Walnut Creek, California 94595
U.S.A.
anat foss w; id

Mr. Charles H. Styer
Department of Botany
University of Maryland
College Park, Maryland 20742
U.S.A.
comparative vegetative nat
(Deutzia, Philadelphus)

Dr. Syoji Sudo, Chief
Anatomy & Identification of Wood
Wood Technology Division
Government Forest Experiment Station
Meguro, Tokyo, Japan
sys anat; var tracheid length; id
trop w, sw, hw; cur

Prof. Dr. Lucio Susmel
Università Degli Studi di Padova
Instituto di Selvioltura
Via Gradenigo 6
35100 Padova, Italy
ecol anat (Eucalyptus, Quercus Picea, Pinus, coun

Dr. Edward M. Sweitzer
Division of Natural & Applied Sciences
Northern Virginia Community College
LouDoun Campus
Sterling, Virginia 22170
U.S.A.

Mr. Paul K. Tabirth
1-30 Agriculture Building
School of Forestry
University of Missouri
Columbia, Missouri 65201
U.S.A.
gamma radiation/anat trop hw; anat hw charcoals

Dr. Francisco N. Tamolang
Commissioner
FORPRIDECOM, Forestry
College Laguna E-109
Philippines

Dr. Michael A. Taras
Forestry Sciences Laboratory
Southeastern Forest Experiment Station
Carlton Street
Athens, Georgia 30602
U.S.A.
environmental anat, prop (southern pines U.S.A. hw spp.)

Dr. F.H. Taylor
Department of Botany
University of Vermont
Burlington, Vermont 05401
U.S.A.

Dr. Fred W. Taylor
Assistant Director
P.O. Box 552
Mississippi Forest Products Laboratory 39762
U.S.A.
w prop var; vessel morphology; prop, anat rays (hw spp.) Chairman SWST, Professional Referral Service

Mr. Stephen C. Taylor
6080 Holbrook Drive
Jackson, Mississippi 39206
U.S.A.
w anat

Mr. Berend J.G. ter Welle
Instituut voor Systematische Plantkunde
Trans 11
Heidelberglaan 2
Utrecht, The Netherlands
sys anat (Neotrop Melastom)

Dr. Richard J. Thomas
Department of Wood & Paper Science
School of Forest Resources
North Carolina State University
P.O. Box 5488
Raleigh, North Carolina 27607
U.S.A.
ultr bordered pits; w perm; w decay; morphology pulped fb; differentiation; id

Dr. T.E. Timell
Department of Forest Chemistry
S.U.N.Y. College of Environmental Science and Forestry
Syracuse, New York 13210
U.S.A.
cw - form, ultr; form cell walls; cytology, chemistry, ultr-pw; camb; tens w

Dr. Michail Stanislawow Todorow
Institute for Cellulose and Paper Industry
Sofia-1528, Bulgaria
ecol anat; fb prop; w anat/paper qual; effect of beating/fb
(Picea abies)

doc. Dr. Erich E. Treiber
Svenska Träforskningsinstitut
Box 5604
S-114 86 Stockholm Sweden
SEM - w, fb, products (Pinus, Picea, Betula); tch; abstracting

Madame Yvonne Trenard
Chef du Laboratoire d'Anatomie
Centre Technique due Bois
10 Avenue de Saint Mandé
75012 Paris, France
w id; w anat/prop; (temperate sw,hw)

Prof. Thomas Trübswetter
D82 Rosenheim-Mitterfeld
West Germany
Gleiwitzer STr. 7
id; cur; tch; (Shorea)

Prof. Dr. George Tsoumis
Laboratory of Forest Utilization
School of Forestry
Aristotelian University
Thessaloniki, Greece
tr growth/anat; anat/prop; cur

Dr. van der Burgh
Laboratory of Palaeobotany & Palynology
Heidelberglaan 2, De Uithof
Utrecht, The Netherlands
id foss w - Tertiary, Quaternary - NW Germany, Netherlands

Mr. G.J.C.M. van Vliet
Rijksherbarium
Schelpenkade 6
Leiden, Holland
sys w anat (Myrtales)

Dr. rer. nat. Rudi Wagenführ
Forschungsinstitut für Holztechnologie
8020 Dresden, Zellescher Weg 24
German Democratic Republic
sys, ecol anat; w products
degradation; (Melia, Dipterocarp)
cur; id.

Dr. Gary D. Wallace
Research Division
Los Angeles State & County Arboretum
301 N. Baldwin Avenue
Arcadia, California 91006
U.S.A.
ecol w anat (Arctostaphylos, Salix)

Prof. Dr. A.B. Wardrop
Professor of Botany
La Trobe University
Bundoora, Victoria 3083
Australia

Ir J.T. Wassink
Royal Tropical Institute
Dept. of Agricultural Research
Mauritskade 63
Amsterdam The Netherlands
cur; w id

Dr. Martin W. Wenham
Derwen, 68A Greenhill Road
Coalville
Leicestershire LE6 3RH
United Kingdom
mechanisms of growth and development
of w (Salix, Quercus, Chlorophora)

Prof. R.H. Wetmore
12 Francis Avenue
Cambridge, Massachusetts 02138
U.S.A.
ret active; sys anat; cataloguing
Bailey - Wetmore Collection, Harvard
Univ. hon

Mr David Wheat
Biological Laboratories
Harvard University
16 Divinity Ave. Cambridge, Mass.,
02138
U.S.A.
dev. anat; anomalous secondary
growth; sylleptic branching
(Phytolac, Nyctagin)

Dr. Elisabeth Anne Wheeler
North Carolina State University
Division of University Studies
P O Box 5971
Raleigh, North Carolina 27607
U.S.A.
foss w (Eocene w, Yellowstone National Park)

Dr. W. Wayne Wilcox
University of California Forest Products
Laboratory
1301 South 46th Street
Richmond, California 94563
U.S.A.
anat - decay, soft rot; microdistribution
of preservatives in fungus attacked w

Dr. Llewelyn Williams
514 Second Street
Randolph, Wisconsin 53956
U.S.A.

Mr. Thomas K. Wilson
Department of Botany
Miami University
Oxford Ohio 45056
U.S.A.

Mr. A. Voorrips
Albert Egges van Giffen Instituut
voor Prae - en Protohistorie
Singel 453
Amsterdam
The Netherlands
id - w, charcoals (Archeological specimens)

Prof. Kung-chi Yang
School of Forestry
Lakehead University
Thunder Bay, Ontario, Canada
sapw,heartw; pits (Betula) particle
board; solar drying; id; preparing text
"Canadian Woods"

Prof. A.A. Yatsenko-Khmelevsky
Department of Plant Anatomy and Plant
Physiology
Leningrad Forest Academy
Leningrad, 194018, U.S.S.R.
coun

Mr. Gregorio Isidro T. Zamuco, Jr.
Forest Products Research & Industries
Development Commission
College, Laguna 3720
Philippines

Dr. M.H. Zimmermann
Harvard Forest
Petersham, Massachusetts 01366
U.S.A.
long-distance transport in tr; 3-dimensional
arrangement of vascular tissue in tr-(monocots);
patterns - vascular differentiation;
functional aspects of vessel distribution in
dicot tr

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Dr. Regis B. Miller

(continues)

U.S.A. (Continued)

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Prof. R.H. Wetmore
Mr. David Wheat
Dr. Elizabeth Anne Wheeler
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Dr. Llewelyn Williams
Dr. Thomas K. Wilson
Dr. M.H. Zimmermann

U.S.S.R.

Dr. Eldar D. Lobjanidze
Prof. A.A. Yatsenko-Khmelevsky

VENEZUELA

Ing. For. Harry Corothie

WEST GERMANY

Prof. Dr. Josef Bauch
Prof. Dr. H.J. Braun
Dr. Dieter Eckstein
Miss Rat. H. Gottwald
Dr. Dieter Grosser
Dr. Wolfgang Höll
Dr. Hans-Rolf Höster
Prof. Dr. Walter Liese
Dr. N. Parameswaran
Hans Georg Richter
Dr. Roswitha Schmid
Prof. Thomas Trubswetter

YUGOSLAVIA

Dr. Božidar Petrić
Prof. Dr. Zvonimir Spoljarić
Erak Staka

ASSOCIATION AFFAIRS

New Members

Dr. Himansu Baijnath
Botany Department
University of Durban-Westville
Private Bag X54001
Durban, Natal
South Africa

Dr. Kazumi Fukazawa
Department of Forest Products
Faculty of Agriculture
Hokkaido University
Sapporo
Japan

Mr. Hitoshi Imagawa
Department of Forest Products
Faculty of Agriculture
Hokkaido University
Sapporo
Japan

Dr. Steve Manchester
Paleobotany Laboratory
Department of Plant Sciences
Jordan Hall 138
Indiana University
Bloomington, Indiana 47401
USA

Mr. Wilhelm Mayer
Röselfeldstrasse 5
A 4400 Steyr
Austria

Mr. Mukesh Kumar Seth
Seth Niwas
Comely Bank
Simla-171003
India

Mr. Jun Ohtani
Department of Forest Products
Faculty of Agriculture
Hokkaido University
Sapporo
Japan

Mr. Andrews Oteng-Amoako
Forest Products Research Institute
U.S.T. Box 63
Kumasi
Ghana

Changes of address

Dr. J.R. Barnett
Plant Science Laboratories
University of Reading
Whiteknights
Reading
England

Dr. Robert M. Echols
Department of Forestry
University of Arkansas at Monticello
Monticello, Arkansas 71655
USA

Dr. Richard L. Gray
ITT Rayonier Inc.
Olympic Research Division
HO9 East Harvard Avenue
Shelton, Washington 98584
USA

Dr. Cherla B. Sastry
Faculty of Forestry and Landscape Architecture
University of Toronto
203 College Street
Toronto M5S 1A1
Canada

Resignations

Mr. Michael R. Lee
Department of Botany & Microbiology
Arizona State University
Tempe, Arizona 85281
USA

Dr. Charles W. McMillin
Southern Forest Experiment Station
2500 Shreveport Highway
Pineville, Louisiana 71360
USA

Address unknown

Recently mail has been returned from the previous address of our Member Ing. For. H. Corothie in Caracas, Venezuela. Members who know Mr. Corothie's present address are kindly requested to inform the Executive Secretary.

IAWA BULLETIN

Contents

Front cover: Scanning electron micrograph of vestured intervessel pits (pit floors removed) in *Anogeissus acuminata* (Roxb. ex DC.) Wall. (Combretaceae). Courtesy G.J.C.M. van Vliet, Leiden.

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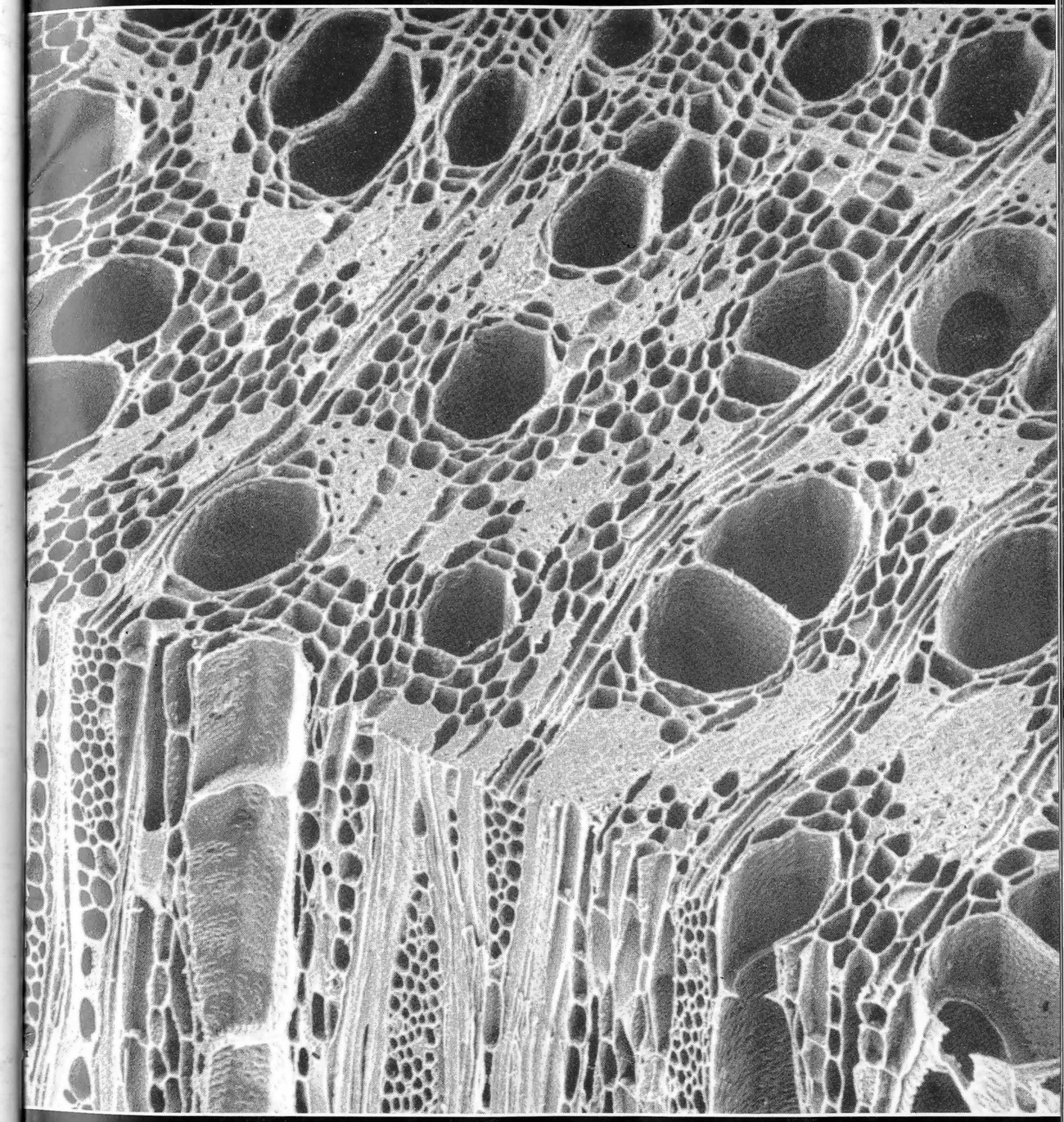

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