IAWA BULLETIN

Contents

Front cover: Transverse section of *Lagerstroemia indica* L. (Lythraceae). The banded pattern in this and some other *Lagerstroemia* species is due to fibre dimorphism and not to parenchyma differentiation (cf. P. Baas & R.C.V.J. Zweypfenning: Wood anatomy of the Lythraceae: Acta Botanica Neerlandica 28 (2/3): 117–155. 1979).

IAWA BULLETIN 1979/4

International Association of Wood Anatomists

EDITORIAL

This unusually bulky single issue of the IAWA Bulletin is most probably the last one of this grand but rather space-consuming format. Your editors are at present exploring the possibilities of changing to a more manageable c. 16 x 24 cm format for the future volumes of the Bulletin, so that librarians and IAWA Members will not have further trouble in fitting our periodical on their book shelves. At the same time it will be attempted to accommodate about twice as much scientific and news items in a single issue than in the customary 20 page issues, which you have been receiving over the past 3 years. We should admit that this change implies something of a hazardous adventure. It is based on the optimistic assumption that the recent increase in submitted manuscripts is not a temporary phenomenon and that the availability of generous facilities at the Rijksherbarium will not be jeopardized in the near future. Doubling the available amount of printing space also implies that we will enter a period in which our financial reserves will be reduced rather than increased. You may wonder why we are prepared to face all these risks and draw-backs.

In our opinion the change from the present large format to a more normal one, is only one step in the coming of age of our IAWA Bulletin as an international journal of wood anatomy. The increase in published scientific papers should also be seen in this light. In this era of overspecialization, with a multitude of scientific periodicals, the attempt to raise the status of our friendly periodical which primarily served as a news vehicle in the recent past may encounter understandable criticism. Yet we are convinced that there is scope for and even an urgent need for a specialized wood anatomy journal as the IAWA Bulletin. This is not to enter competition with any of the botanical and forestry or wood technology oriented journals which have accommodated most wood anatomical publications in the past, but to offer a forum where these diverse aspects of wood (and bark) anatomy are brought together. Thanks to an organization like IAWA and its Bulletin extremely diverged wood anatomists pursuing such specializations as systematic wood anatomy, cambial phenomena and wood technology can still understand and inspire each other, and expanding the IAWA Bulletin and improving its status can only help to promote further contacts. This reason alone would suffice to motivate our plans for the future. Yet there are other reasons. As editors we are trying to serve the interests of our authors, and thus we must safeguard future accessibility of the IAWA Bulletin in institutional libraries. Obviously librarians, even if short of money, will prefer a manageable format containing twice as much scientific information to the present Bulletins, however attractive they may seem. Thus our policy is also aimed at increasing the circulation of the new style IAWA Bulletin. Here you can help by enrolling your institution to subscribe and by stimulating colleagues to apply for IAWA membership. This is also of direct advantage to all members personally because an increased circulation implies an increase in our income, thus delaying the moment that membership dues have to be increased.

The development of the IAWA 'News Bulletin' to a widely distributed scientific journal 'IAWA Bulletin, New Series' should never entail the loss of our columns containing news, requests, association affairs and the like. These were and are essential for our past, present and future as an international community of colleagues in the field of wood anatomy. It is also up to you to expand the quantity of this informal, yet highly essential category of communication.

These lines are written some weeks after the highly inspiring wood anatomy congress in Amsterdam, where our disciplin appeared to be alive and capable of vigorous growth and diversification. Such a disciplin deserves an active Association and a worthy scientific journal, to ensure that diverging branches will remain firmly attached to the main trunk through which they are to receive their supply of invigorating xylem sap!

Pieter Baas
Peter B. Laming

OBITUARY

Dr. Laurence Chalk 1895–1979

With the death of Laurence Chalk in Oxford on May 6th 1979, the Association lost one of its founder members, a former secretary-treasurer and a staunch supporter; the art and science of wood anatomy lost a researcher who brought an outstanding intellect and scientific discipline to the description, interpretation and classification of anatomical development in woody plants.

Dr. Chalk was born in Crowborough, Sussex, on April 7th 1895. He served in France in the Royal Berkshire Regiment during the 1914–1918 War. He was seriously injured in a mine explosion on the Somme and spent a period of recuperative service in Dublin, Eire. After the War he went up to University College, Oxford, where he took a bachelor's degree with distinction in Forestry in 1921 (and his MA in 1926). In 1921 he married Kathleen Charlotte Sidey (who died in 1971) and joined the Forest Department in Uganda where he first demonstrated his interest in the structure of tropical woods. He collected widely, travelling on a motor cycle since the only car in the Protectorate then belonged to the Governor. His wife's malaria forced them back to England where he was appointed Lecturer in Wood Anatomy in 1924. He took his doctorate in 1929 with research on the relationship between tree growth, wood anatomy and mechanical wood properties. It was in this period that a long collaboration was established with Dr. B.J. Rendle who worked initially at Oxford while awaiting the construction of the Forest Products Research Laboratory at Princes Risborough. He eventually became University Reader in Wood Anatomy and a Lecturer of University College. In 1936–37 he was commissioned to make a world tour and report on the status of forestry in the Commonwealth; undoubtedly the interest engendered by this tour led to donations of Commonwealth timbers as well as funds for the new Commonwealth Forestry Institute (which was eventually built after the 1939–1945 War). Dr. Chalk frequently acted as head of the Institute in the absence of Professor H.G. Champion.

In addition to his professional activities Dr. Chalk had many hobbies and sporting interests; he played tennis and cricket, he rowed, and he enjoyed what at the time were unusual sports for the English, gliding and skiing. He loved books, painting and music being a capable violinist himself. To the end of his life he was a keen gardener.

However, above all, he lived for his chosen science; from his first publication in 1927 until his retirement in 1966 he surveyed and described the wood anatomy of individual trees, species and families. He wrote many individual research articles and, using simple optical microscopes, displayed an understanding of the structure of wood that is beyond the powers of many scientists aided by such modern aids as scanning electron microscopes. His major contribution was with Dr. C.R. Metcalfe in the monumental and standard work "Anatomy of the Dicotyledons". Dr. Chalk was working on a revision of the second volume of "The Dicots" until a few days before his death; it is hoped that staff at Kew and Oxford will assist Dr. Metcalfe to finish the revision as a fitting tribute to one of the major contributors to our present knowledge of wood anatomy.

J. Burley, Oxford, May 1979
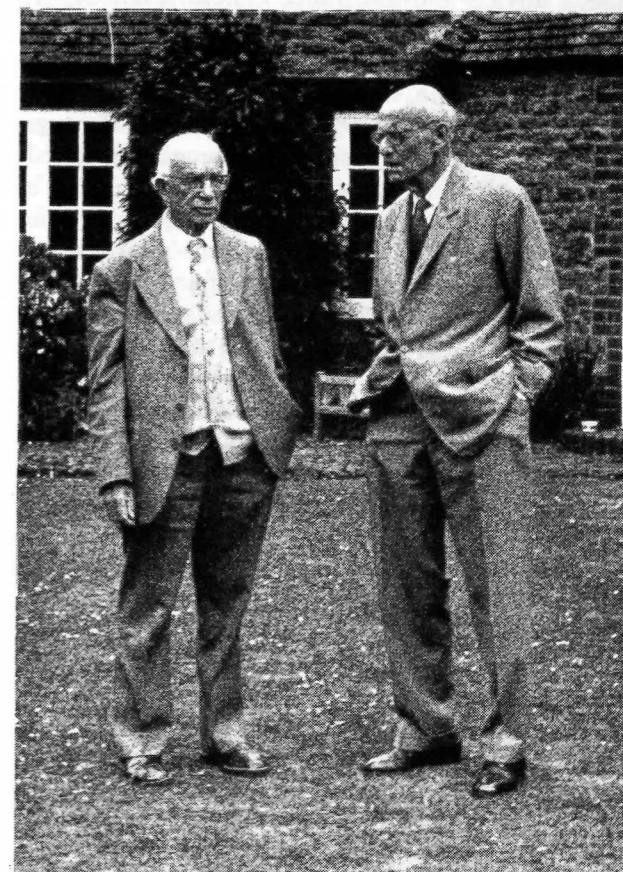
Dr. L. Chalk (right) with Dr. C.R. Metcalfe in Oxford, June 1978.

No account of Dr. Chalk's life would be complete without further reference to the important part he played in founding the International Association of Wood Anatomists, and our joint collaboration in writing "Anatomy of the Dicotyledons". The foundation of the I.A.W.A. was largely initiated by Dr. Chalk in collaboration with B.J. Rendle (then at Oxford and later at Princes Risborough) and Professor Samuel J. Record of Yale University. These three very energetic scientists, with the support of the organising committee, worked indefatigably during the 1930 International Botanical Congress that was held at Cambridge (England). The Association was formally constituted on July 2nd 1931, during the 'Congrès international du bois et de la sylviculture' held in Paris. Members from 16 countries were enrolled. Dr. Chalk was subsequently Executive Secretary of the I.A.W.A. from 1938—1947 and he played an important part in producing the "Multilingual glossary of terms used in describing wood".

My own collaboration with Dr. Chalk began in 1930 when I joined the staff of the Royal Botanic Gardens, Kew, where I was in charge of the then very small Jodrell Laboratory. Since my duties included timber identification, about which I knew very little at the time, it was natural to seek Dr. Chalk's advice and assistance. These small beginnings marked the start of a long period of friendly and fruitful co-operation which culminated in the publication of the first edition of "Anatomy of the Dicotyledons" in 1950. I was the first to suggest that we might conjointly produce an updated version of the English translation of Solereder's "Systematic Anatomy of the Dicotyledons". The suggestion met with the immediate approval of Sir Arthur Hill who was then the Director of Kew. Other leading British botanists were also consulted through the medium of my senior colleague Dr. W.B. Turrill. While their views were not unanimous, Sir Albert Seward, Professor of Botany at Cambridge, gave his wholehearted backing to the scheme and he and Sir Arthur Hill were largely responsible for organising the necessary

support. The main problem was to find a publisher, as it was expected that the demand for the book would be limited and nobody was anxious to accept the financial risk. Luckily Sir Arthur Hill was on friendly terms with Mr. Kenneth Sisam, a former, very distinguished Secretary to the Delegates of the Oxford University Press and, through him, an understanding was reached that the book would be published at Oxford. Even Mr. Sisam was dubious about the financial aspects of the venture but he was always very kind to us and he was in fact responsible for the style of descriptive writing that we adopted.

Dr. Chalk and I between us wrote the whole of the text, apart from a few brief passages, but this could not have been done without the wholehearted assistance of the technicians in our respective departments who made the innumerable microscope slides on which our observations were based. Also we enjoyed a special relationship with Professor Record at Yale University which was of special assistance to Dr. Chalk. Indeed Dr. Margaret Chattaway from Oxford spent some time at Yale collecting data for the book that were not available at Oxford.

Our friendship and co-operation continued until the end of Dr. Chalk's life, as we worked on the second edition of our book. My only regret is that he did not live to see the publication of even the first volume. Luckily it is now widely accepted that systematic anatomy is one of a number of disciplines that serve as integral parts of the present day taxonomy of the dicotyledons. This being so it is my fervent hope and expectation that the second edition of our work will ultimately be finished. I am encouraged in this hope by the interest and support of our younger colleagues in many parts of the world.

Laurence Chalk's life was many-sided. Although the study of wood structure must have been one of his deepest interests, he was far from being a narrow specialist, and he will for long be remembered by those in many walks of life who had the good fortune to know him.

C.R. Metcalfe, Kew, May 1979

TAXONOMIC SIGNIFICANCE OF SCLERIFIED TISSUE IN THE BARKS OF LAURACEAE

by

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Summary

A preliminary study of the anatomy of barks of some species of Lauraceae has shown that the occurrence and characteristics of the sclerified tissue, that is fibres, sclereids and sclerified longitudinal parenchyma, are of taxonomic significance. Differences in the nature of the sclerified tissue in this family supports the classification by Pax into the subfamilies Persoideae and Lauroideae.

Introduction

Comparatively few systematic investigations of bark anatomy have been made. Detailed reviews of the literature on bark anatomy by Srivastava (1964) and Esau (1969) do not reveal the systematic pattern of anatomical characteristics known to exist in wood.

Only the sieve elements in bark appear to have phylogenetic significance. Sieve elements are the conductive cells of the phloem. In conifers they are known as sieve cells and are long, slender cells with specialised conductive zones, the sieve areas, in their walls. They are the counterparts of the tracheids of conifer wood. The conducting cells of dicotyledonous barks are the sieve tubes and are generally shorter and wider than sieve cells and their ends abut adjacent sieve elements so as to form longitudinal strands which connect by means of sieve plates. They are the counterparts of the vessels of dicotyledon wood.

The fundamental differences between sieve cells and sieve tubes were first described by Hartig in 1837 (see Esau, 1969). A general relationship has been shown between sieve tube length and degree of evolutionary specialisation but this relationship is disturbed in some taxa by the occurrence of divisions in the sieve tube initials which results in a shortening of the cells (Esau, 1969).

The potential taxonomic significance of bark anatomy has been demonstrated in a range of genera by Chattaway (1953, 1955 a, b, c, d, e, 1959), Chang (1954 a, b), Bamber (1959, 1962) and Den Outer (1967). Such studies, however, cover only a minor portion of tree species.

Lauraceae constitute a large and commercially important family. Many of the species are difficult to identify in the forest, in the log and as timber. This study has been made to determine the broad patterns of variation in the bark anatomy and taxonomic significance of bark anatomy in this family. While a number of general studies of the Lauraceae woods have been made (Metcalfe & Chalk, 1950) no such information is available for the barks.

Preliminary examination of representative material from Lauraceae indicated that the most obvious differences in the taxa were in the characteristics of the sclerified tissue. The observations in this paper refer principally to this tissue.

Materials and Methods

The species examined together with their sources are listed in Table 1. The materials consisted of both green and dried barks. Small blocks ranging in size from 2 x 2 x 6 mm to 4 x 4 x 6 mm were cut with a sharp razor blade. Green specimens were fixed in 70% ethanol. Dried specimens were boiled in water for 1—6 hours to expand the tissue before commencing embedding procedures.

The blocks were dehydrated in a graded series of ethanol or acetone and embedded in a mixture of methacrylate and styrene according to the method of Mohr & Cocking (1968). Transverse and radial longitudinal sections were cut either on a sledge microtome at 6—12 μm or an ultramicrotome at 2 μm in thickness.

Results and Discussion

Sclerified tissue was found to occur in two general forms, tissue formed directly from the cambium and that formed in the outer (probably non-active) phloem. The cambially-derived sclerenchyma consisted either of rectangular fibres or of polygonal fibres in association with sclereids (referred to hereafter as fibre/sclereid aggregates). Likewise the phloem-derived sclerenchyma occurred in two forms, sclereids and sclerified longitudinal parenchyma.

Rectangular fibres. — In transverse section the rectangular fibres range from almost square to distinctly flattened in the radial direction (Fig. 1). They may occur singly or in longitudinal strands of tangentially oriented bands one to three seriate in width (Figs. 1, 2).

Table 1. The type[1] of sclerified tissue in the phloem of some species of Lauraceae trees.

Species	Source[2]	No. of Samples	Type of tissue[1]		
			Rectangular fibres	Fibre/sclereid aggregates	Sclerified longitudinal parenchyma
Persoideae[3]					
Cinnamomum					
camphora T. Nees & Eberm.	N	1	+	−	−
laubatii F. Muell.	Q	1	+	−	−
mindanaense Elmer	P,N	2	+	−	−
oliveri F.M. Bailey	N,Q	3	+	−	−
verum J.S. Presl	N	1	+	−	±
virens R. Br.	N	1	+	−	−
Dehaasia					
triandra Merrill	P	1	+	−	−
Litsea					
ferruginea Blume	Q	1	+	−	−
garciae Vidal	P	1	+	−	−
leefeana Merrill	Q	1	+	−	−
perrottetii F.-Vill.	P	1	+	−	−
reticulata (Meissn.) F. Muell.	N	2	+	−	−
zeylanica C. & T. Nees	N	2	+	−	−
Neolitsea					
dealbata (R. Br.) Merrill	Q,N	2	+	−	−
involucrata Alston	Q	1	+	−	−
Nothaphoebe					
malabonga (Blanco) Merrill	P	1	+	−	−
Persea					
americana Mill.	P	1	+	−	−
Lauroideae[3]					
Beilschmiedia					
elliptica C.T. White	N,Q	3	−	+	+
obtusifolia F.M. Bailey	N,Q	4	−	+	+
Cryptocarya					
ampla Merrill	P	1	−	+	+
angulata C.T. White	Q	1	−	+	+
cinnamomifolia Bentham	Q	1	−	+	+
corrugata C.T. White & Francis	Q	1	−	+	+
foveolata C.T. White & Francis	N	1	−	+	+
glaucescens Hassk.	N,Q	3	−	+	+
hypospodia F. Muell.	Q	1	−	+	+
laevigata var. bavei (Hook.) Kosterm.	N,Q	1	−	+	+
mackinnoniana F. Muell.	Q	1	−	+	+
meissneri F. Muell.	N	1	−	+	+
microneura Meissn.	N,Q	3	−	+	+
oblata F.M. Bailey	Q	1	−	+	+
obovata R. Br.	N	1	−	+	+
patentinervis F. Muell.	N,Q	3	−	+	±
pleurosperma C.T. White & Francis	Q	1	−	+	+
rigida Meissn.	N	1	−	+	+
triplinervis R. Br.	N,Q	1	−	+	+
Endiandra					
cowleyana F.M. Bailey	Q	1	−	+	+
crassiflora F.M. Bailey	Q	1	−	+	+
dichrophylla F. Muell.	Q	1	−	+	+
discolor Bentham	N	1	−	+	−
globosa Maiden & Betche	N	1	−	+	
introrsa C.T. White	N	2	−	+	+
longipedicellata C.T. White	Q	1	−	+	+
muelleri Meissn.	N,Q	3	−	+	+
sieberi Nees	N	1	−	+	−
tooram F.M. Bailey	Q	1	−	+	+
virens F. Muell.	N	2	−	+	+

[1] See text for description of sclerified tissue.
[2] N, New South Wales; P, Philippines; Q, Queensland.
[3] Classification according to Pax (1891).

Fibre/sclereid aggregates. — In transverse section the fibres of the fibre/sclereid aggregates are polygonal and isodiametric (Figs. 3, 4). The fibres and the sclereids are frequently crystalliferous (Figs. 4, 5). The aggregates are formed of longitudinal strands of cells ranging from small groups of two to three cells, to distinctly elliptical groups of from ten to thirty cells or rarely tangential bands.

Sclereids. — The sclereids which arise in the outer phloem are generally ball-like aggregates of cells (Fig. 6). These sclereids may be crystalliferous. In some species the sclereids form a continuous sheath adjacent, but adaxial, to the periderm. The sclereids rarely are radially elongated. —

Sclerified longitudinal parenchyma. — Sclerified parenchyma forms during the transition from functioning to non-functioning phloem by the deposition in the axial parenchyma of secondary walls which become lignified (Fig. 7). The ray parenchyma does not undergo this change although sclereids can arise in this tissue. The lack of sclerification in the ray parenchyma allows the phloem to accommodate the increasing tree circumference by the formation of parenchyma wedges.

The occurrence of these different types of sclerified tissue in the members of the Lauraceae family examined is shown in Table 1. Sclereids (phloem-derived) are excluded from the table as they occur in most genera and are irregular in occurrence. It can be seen that the rectangular fibres are confined to the genera *Cinnamomum, Dehaasia, Litsea, Neolitsea, Nothaphoebe* and *Persea*. Fibre/sclereid aggregates and sclerified parenchyma are confined to *Beilschmiedia, Cryptocarya* and *Endiandra*.

This separation into two distinct groups on the basis of bark anatomy coincides with Pax's (1891) subfamilies of Persoideae and Lauroideae. Support for such a grouping has been put forward on the basis of wood anatomy by Dadswell & Eckersley (1940) and Janssonius (1906–36). The recent revision of the family by Kostermans (see Willis, 1966) cuts directly across this grouping placing *Persea, Dehaasia, Beilschmiedia* and *Endiandra* together in one subgroup. The strong agreement between both bark and wood characters and Pax's classification, however, suggests that a re-examination of the family incorporating both bark and wood characters is required.

The fundamental differences in sclerenchyma type which have been found in Lauraceae confirm the observation of Esau (1964) in respect to bark of the dicotyledons that 'the sclerenchyma cells give a particularly characteristic aspect to the secondary phloem.' Although the presence of phloem fibres as distinct from cambially-derived sclereids in *Cinnamomum* has been reported by Santos (see Metcalfe & Chalk, 1950) and Birnsteil (see Met-

calfe & Chalk, 1950) the taxonomic significance of phloem sclerenchyma in Lauraceae does not appear to have been reported. Zahur's study (1959) indicated that sclerenchyma was very variable in development in Persoideae; he did not, however, recognise the fundamental differences in the cambially-derived sclerenchyma types in Persoideae and Lauroideae. His reference to variable development of sclerenchyma could possibly be due to the effect of bark age, for example Esau (1964) comments that older phloem shows more intensive sclerification than younger.

The range of species examined in this study covers only a small proportion of the Lauraceae of the south-west Pacific region. Although the anatomical differences in the barks are substantial and consistent it is clearly desirable to extend this study so as to include representative material from the whole family before bark characters be used as a criterion for a taxonomic revision.

The relationship between the characteristics of sclerified tissue in barks and taxonomic classification has been demonstrated in *Eucalyptus* and *Eugenia* species by Chattaway (1953, 1955 a–e, 1959), in Leptospermoideae by Bamber (1962) and in the Coniferae by Chang (1954 a, b) and Den Outer (1967). The results in this paper emphasise the importance in taxonomy both of this feature in particular and of bark anatomy in general.

Although individual descriptions have not been attempted in this study it is obvious that in a number of species, specific differences, which would be of value in identification, exist. For example the fibre/sclereid aggregates in *Beilschmiedia elliptica* are arranged in tangential bands whereas in the other members of Lauroideae examined they are arranged in elliptical bundles. Likewise in Persoideae only *Cinnamomum camphora* had radially elongated sclereids. A significant difference was also found between Persoideae and Lauroideae in respect to crystal form. The crystals in the phloem parenchyma of Persoideae are mostly needle-like whereas in Lauroideae they tend to be rectangular to rhomboidal.

The only features which were common to all genera examined were the sieve tubes type (Zahur's, classification Type III), and oil cells. Oil cells it should be noted are also characteristic of many Lauraceae woods.

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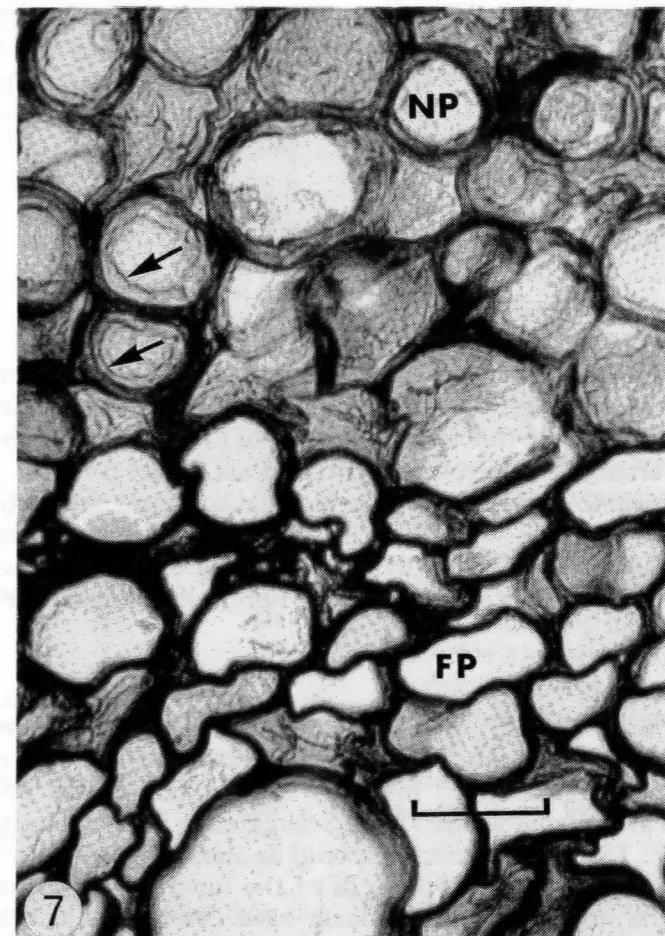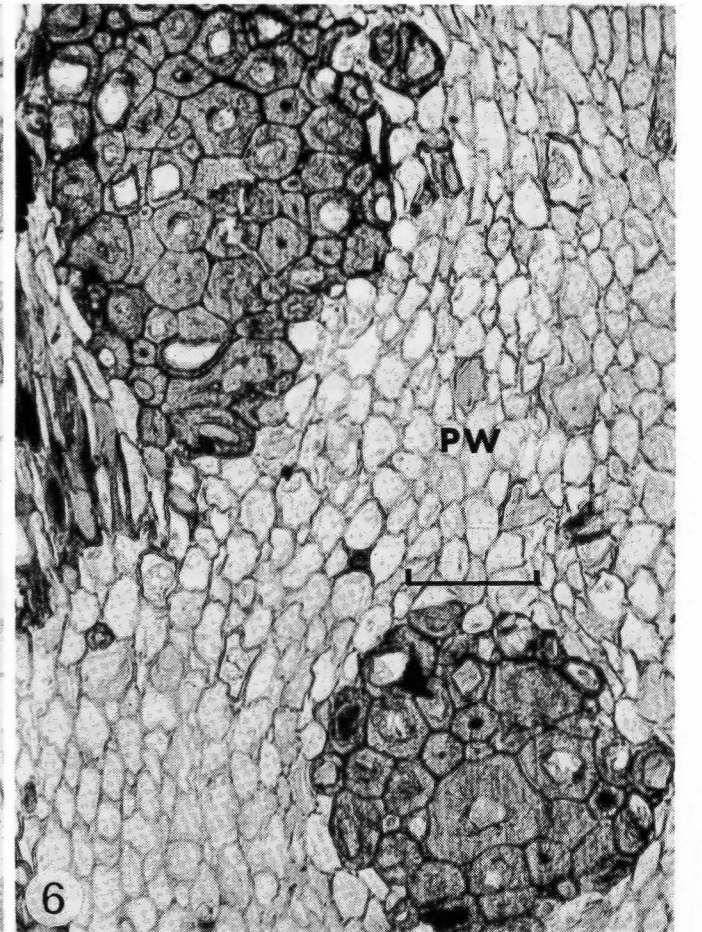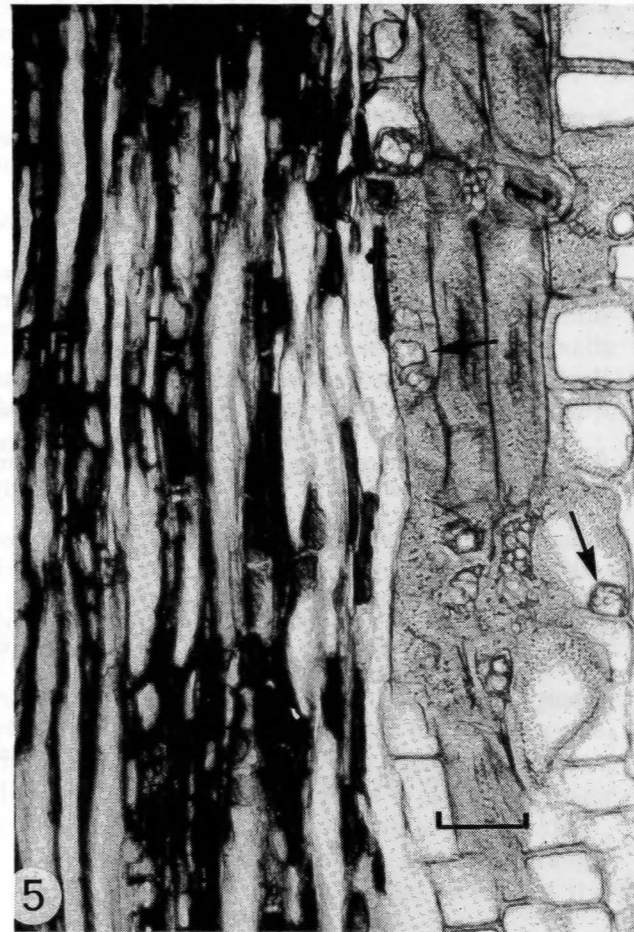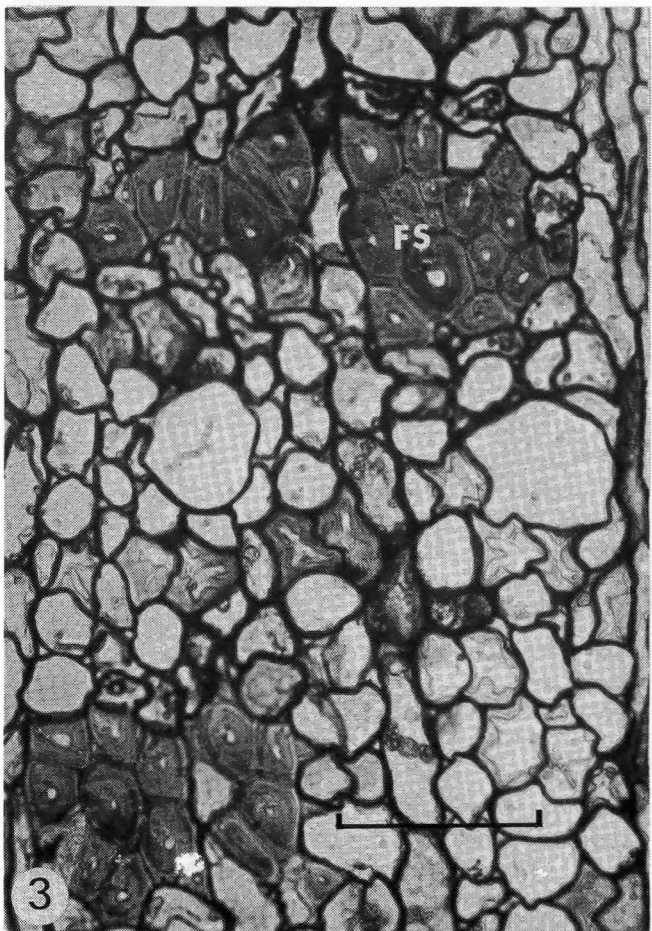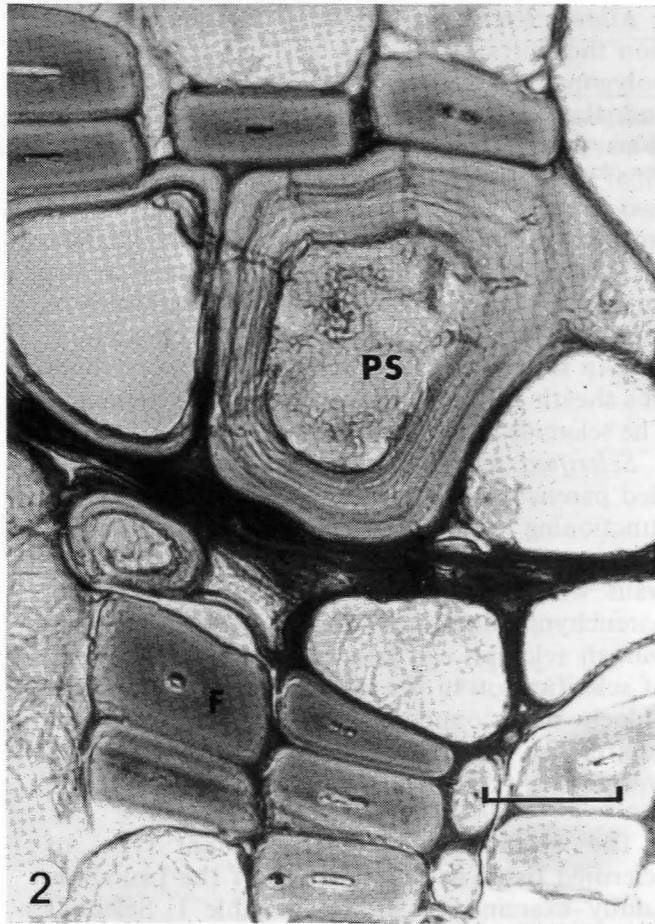
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Figs. 1—7. Sections of phloem tissue showing types of sclerified tissue in the family Lauraceae. Figs. 1, 2, 7 stained with Toluidine blue 0, Figs. 3, 4, 5, 6 stained with safranin and fast green. Brightfield. —— Fig. 1. Transverse section (TS) of the functioning phloem of *Cinnamomum camphora*. The fibres (F) are rectangular in section and arranged in narrow tangential bands. Scale: 0.1 mm. —— Fig. 2. TS of the non-functioning phloem of *Cinnamomum verum*. The rectangular fibres are distinctly flattened. Phloem-derived sclereid (PS). Scale: 0.03 mm. —— Fig. 3. TS of the functioning phloem of *Beilschmiedia obtusifolia*. Fibre/sclereid aggregate (FS). Scale: 0.1 mm. —— Fig. 4. TS of the functioning phloem of *Endiandra dichrophylla*. Crystalliferous sclereids of the fibre/sclereid aggregate arrowed. Scale: 0.1 mm.

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Fig. 5. Radial longitudinal section (RLS) of the functioning phloem of *Cryptocarya ampla*. Both fibres and sclereids of the fibre/sclereid aggregate contain crystals (arrowed). The sclereids on the left hand side are in the developmental stage. Scale: 0.15 mm. —— Fig. 6. RLS of the non-functioning phloem of *Cryptocarya hypospodia*. Parenchyma wedge (PW). Sclereids are in characteristic ball-like arrangement. Scale: 0.21 mm. —— Fig. 7. TS of *Endiandra dichrophylla* showing transition from functioning (FP) to non-functioning phloem (NP). The parenchyma cells of the functioning phloem are without thickening. The parenchyma cells in the non-functioning phloem have developed thickened (sclerified) walls (arrowed). Scale: 0.05 mm.

LONGITUDINAL PARENCHYMA AND RESIN PLUGS IN ARAUCARIACEAE WOOD

by

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Longitudinal parenchyma is generally not abundant in conifer wood. Its distribution is normally random, even in those species in which longitudinal parenchyma is common such as *Callitris* spp. and *Thuja plicata* D. Don.

In the family Araucariaceae evidence is somewhat contradictory in regard to the occurrence of longitudinal parenchyma. Although described as being scarce to absent by the majority of authors (Baker & Smith, 1910; Record & Mell, 1924; Record & Hess, 1943; Phillips, 1948; Jacquiot, 1955; and Entrican *et al.*, 1957) it is recorded as being abundant in *Agathis australis* by Carlquist (1975) and commonly abundant in several species of *Agathis* by Greguss (1955). Greguss, however, does indicate that in general it is absent to sparse in *Araucaria* but occasionally found in *Agathis*.

Because Araucariaceae are an important family both from forestry and botanical viewpoint it is considered necessary to make an accurate assessment of the occurrence of longitudinal parenchyma in the wood particularly as Greguss (1955) uses this character in distinguishing the genera *Agathis* and *Araucaria*.

In this study the abundance of longitudinal parenchyma in the wood of representative material of the Araucariaceae has been evaluated.

The evaluation was made by microscopic examination of radial longitudinal sections, in which all the longitudinal cells in the sections were examined. The results are shown in Table 1.

From Table 1 it can be seen that longitudinal parenchyma is indeed rare in Araucariaceae, being absent in the material examined from the genus *Araucaria* and only rarely found in the material of *Agathis*. It should not be concluded, however, that it is absent from *Araucaria* in general as a number of species were not available for examination. The highest proportion of longitudinal parenchyma was found in *Agathis robusta* in which this tissue made up 0.2 % of the total number of longitudinal cells.

The consistent rare occurrence of longitudinal parenchyma found in this study suggests that this tissue may have been incorrectly identified in some studies of members of this family. A common feature of Araucariaceae wood which could be the source of such an incorrect identification is resin plugs. Resin plugs are formed in the longitudinal tracheids during the transition from sapwood to heartwood apparently from material secreted by the ray parenchyma cells (Figs. 1, 2, 3). The resin plugs are quite insoluble in the normal solvents used in microscopy and therefore become a permanent feature of the tracheids in microscope slides. Where the plugs are thin they can easily be mistaken in longitudinal section for horizontal end walls in the tracheids thus giving the tracheids the appearance of longitudinal parenchyma cells (Fig. 4). In transverse section the plugs have the appearance of the deposits often found in the longitudinal parenchyma of such woods as *Callitris* and *Thuja* thus making the tracheids appear like parenchyma cells in this plane.

Carlquist (1975) refers to longitudinal parenchyma cells being abundant and appearing at the ray margins in *Agathis australis*. These cells are clearly tracheids with resin plugs and their occur-

Table 1. The amount* of longitudinal parenchyma in the wood of Araucariaceae.

Species	Number of specimens examined	Amount of longitudinal parenchyma (%)
Agathis		
australis (D. Don) Salisb.	3	nil
beccarii Warb.	1	nil
borneensis Warb.	3	nil
dammara (Lambert) Rich.	4	nil
labillardieri Warb.	3	nil
lanceolata (Pancher) Warb.	3	nil
microstachya F.M. Bailey & C.T. White	3	0.1
moorei (Lindl.) Mast.	1	nil
palmerstoni F. Muell.	9	nil
robusta (C. Moore) F.M. Bailey	3	0.2
vitiensis (Seemann) Drake	4	0.1
Araucaria		
angustifolia (Bertil.) O. Kuntze	3	nil
araucana (Molina) C. Koch	1	nil
bidwillii Hook.	7	nil
columnaris (Forster) Hook.	3	nil
cunninghamii Sweet	7	nil
heterophylla (Salisb.) Franco	1	nil
klinkii Lauterbach	7	nil

* Percentage of total number of longitudinal cells observed in radial longitudinal sections.
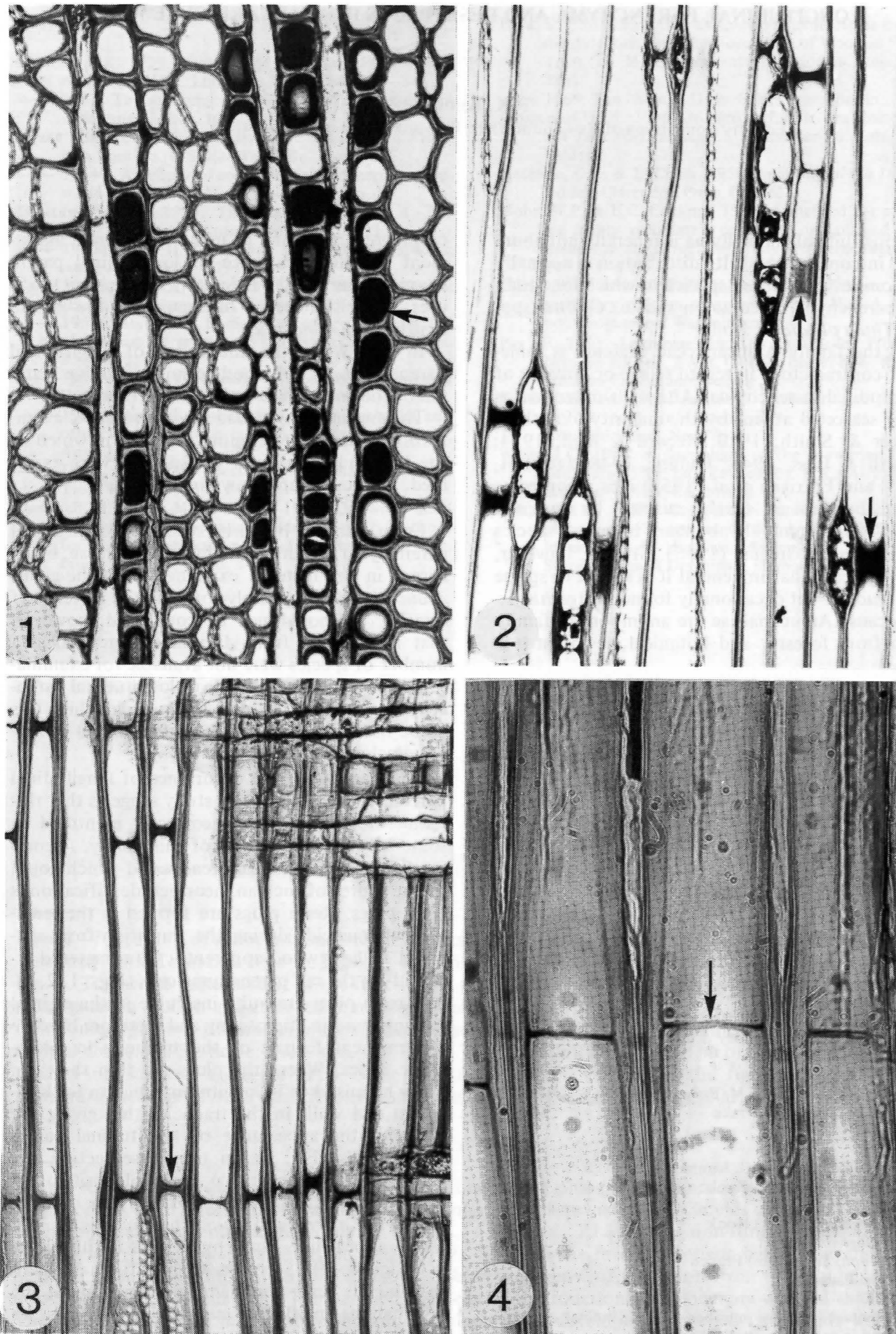
ture to abundant longitudinal parenchyma in Araucariaceae are not correct and have arisen due to confusion with resin plugs in the longitudinal tracheids. It is confirmed however that the incidence of longitudinal parenchyma is greater in *Agathis* than in *Araucaria* although its absence in the majority of sections examined precludes its use as an identification feature, except on the rare occasions when it is present.

The frequency of resin plugs has been used as a feature for the separation of the Australian species of *Agathis* and *Araucaria* by Dadswell and Eckersley (1935). These authors indicate that resin plugs are infrequent in *Araucaria* and frequent in *Agathis*. While there may be a tendency this way in the Australian material it cannot be applied generally as resin plugs are frequently found in a number of the extra-Australian species of *Araucaria*. In addition this feature only applies to heartwood, resin plugs being absent from the sapwood. As sapwood and heartwood in this family are often difficult to distinguish, the absence of resin plugs may simply indicate that the wood is sapwood.

rence adjacent to the rays due to the origin of this material from the rays (Figs. 1—3).

It is concluded that the references in the litera-

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Fig. 1—4. Photomicrographs of sections of Araucariaceae woods stained with safranin. — Fig. 1. Transverse section of *Agathis palmerstoni*. Resin plugs (arrowed) occur in the tracheids adjacent to the rays; x 250. — Fig. 2. Tangential longitudinal section of *Agathis vitiensis*. Resin plugs (arrowed) appear to be formed from material secreted into the tracheids by the rays; x 250. — Fig. 3. Radial longitudinal section of *Agathis vitiensis* showing radial distribution of resin plugs parallel with rays; x 250. — Fig. 4. Tangential longitudinal section of *Araucaria klinkii*. Shows thin septa-like resin plugs (arrowed); x 600.

Wood anatomy of Neotropical Sapotaceae I–VII. I. Bumelia, II. Mastichodendron, III. Dipholis, IV. Achrouteria, V. Calocarpum, VI. Chloroluma, VII. Chrysophyllum. B.F. Kukachka, Research Papers FPL 325–331, 1978. – Available from the U.S. Dept. Agriculture, Forest Products Laboratory, Madison, Wisconsin 53705, U.S.A.

Sapotaceae constitute a notoriously difficult family with respect to classification and generic delimitation. Airy Shaw starts his summary of the family in Willis' Dictionary with the unusual statement that there are "35–75 (!) ill-defined genera".

It requires courage to tackle the wood anatomy of a large family, the taxonomy and nomenclature of which are in such a muddle. Yet there is an urgent need for information on especially neotropical Sapotaceae because the family represents a high proportion of the timber volume and in the (deplorable) whole-sale felling of the tropical forests much of it is probably wasted or put to inefficient use through shear lack of knowledge of the identity of the species and genera.

The botanical and wood technological population is much indebted to Dr. B.F. Kukachka from the Forest Products Laboratory at Madison for taking up the challenge and devoting many years to obtain an intricate knowledge of the wood structural diversity within the group. The individual research papers on separate genera are the first public results of this immense research project. Six more are to follow this year, and it is intended to assemble all data into a single comprehensive unit at the termination of the series.

Each paper has an introduction giving crucial taxonomic background information as well as the author's views on taxonomic delimitation inspired by the wood anatomical evidence. The descriptive parts are comprehensive and based on a wealth of specimens. If appropriate, there are additional notes on infrageneric, specific and/or infraspecific variation.

The author generously puts the papers at the disposal of IAWA members on request. A series of papers like this, published individually outside the range of widely circulated journals, is likely to be overlooked by part of the public to which it is of vital interest. It is therefore hoped that not only individual wood scientists but also librarians of botanical and forest products institutions will make sure that copies are available on their premises for future reference. The author is to be congratulated with this fine series, which should be taken as a prelude to a break-through in Sapotaceae taxonomy and wood identification.

Pieter Baas

Anatomy of Papua New Guinea Woods (Continued). T. Furuno. 148 pp., 67 plates. Reprint from Research Report of Foreign Wood No. 8, 1979. – A restricted number of copies is available from the author, Faculty of Agriculture, Shimane University, Matsue, Shimane, Japan.

This is the second instalment of an atlas of Papua New Guinea wood micrographs, accompanied by descriptions in Japanese and a table of diagnostic characters with legends in English. Together with the species described in the first volume (see review in IAWA Bull. 1977/4: 81) a total of 172 woods from the Papua New Guinea flora has now been treated.

I found one intriguing mistake: *Sonneratia* ('Mangrove') is pictured and tabulated by a set of characters which do not belong to this coastal genus, but almost certainly to *Kokoona* of the Celastraceae. This might imply the first record of this genus for New Guinea, because the known distribution area of *Kokoona* is further West (Malaya, Borneo, Sumatra, Sri Lanka and S.E. Asia).

Pieter Baas

Wood Anatomy of the Combretaceae. G.J.C.M. van Vliet, in Blumea 25 (1): 141–223. 1979.

This paper describes in detail the wood anatomy of 19 genera of the Combretaceae as based on a study of 120 wood samples representing 90 species. In addition data from the literature are comprehensively reviewed. Synoptical keys to the woods of the genera as well as to 43 species of the economically important genus *Terminalia* are included as well as a discussion of the individual wood anatomical characters in relation to diagnostic and taxonomic value and ecological significance. A very restricted number of reprints is available from the author (present address: Hortus Botanicus, Plantage Middenlaan 2, Amsterdam, The Netherlands). Libraries may need to purchase the entire Blumea issue (319 pp.) from the Rijksherbarium (Schelpenkade 6, Leiden) at the appreciable cost of Dfl. 105.00.

ANATOMY OF SECONDARY PHLOEM OF WESTERN HEMLOCK TSUGA HETEROPHYLLA (RAF.) SARG.

by

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Abstract

The anatomy of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) secondary phloem is described and illustrated in detail. The relative abundance of sieve cells, axial parenchyma, ray cells and sclereids was measured from serial tangential sections. On the average, sieve cells together with axial parenchyma cells in similar proportion make up approximately 75 % of the total tissue. The remaining tissue is half ray tissue and half sclereid groups. The proportions were found to vary from the cambium outwards.

Résumé

Le présent article décrit et illustre en détail l'anatomie du phloème secondaire de la Pruche occidentale, *Tsuga heterophylla* (Raf.) Sarg. L'abondance relative des cellules criblées, du parenchyme axial, des cellules de rayons et des sclérites a été mesurée à partir des sections tangentielles. En moyenne, les cellules criblées associées aux cellules parenchymes en proportions similaires forment approximativement 75 % du tissu total. Le reste du tissu se compose à parts égales de tissu de rayons et de sclérites. On a observé que les proportions varient à partir du cambium vers l'extérieur.

Introduction

Light microscope studies of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) secondary phloem have been reported by Chang (1954a & b). Den Outer (1967) has provided a comprehensive description of the phloem anatomy of eastern hemlock (*Tsuga canadensis* (L.) Carr.). The developmental aspects of secondary phloem of gymnosperms have been exhaustively described by Chattaway (1953), Strivastava (1963), Esau (1969) and others.

The purpose of this paper is to describe the anatomy and report the relative abundance of each cell type present in the secondary phloem of western hemlock using scanning and transmission electron microscopy in addition to light microscopy.

Terminology used will be that accepted by the Committee on Nomenclature, International Association of Wood Anatomists (1964).

Secondary phloem of western hemlock is comprised of the following cell types: sieve cells, ray parenchyma cells, axial parenchyma cells, and sclereids (Fig. 1, 2). Termination of the phloem is defined by the periderm. Each cell type will be described and illustrated.

Materials and Methods

The material for this study was selected from that collected and reported by Bramhall *et al.* (1977). Light microscope observations were made from hand sections of fresh frozen material, from sliding microtome sections of material embedded according to Wilcox (1964), and from ultramicrotome sections approximately 1 micron thick of material embedded in Spurr's low-viscosity embedding resin. Some sections were stained with safranin and fast green, Sudan IV, or alkaline methylene blue for light microscopy. Ultrathin transmission electron microscopy sections were post-stained with potassium permanganate or uranyl acetate and lead citrate.
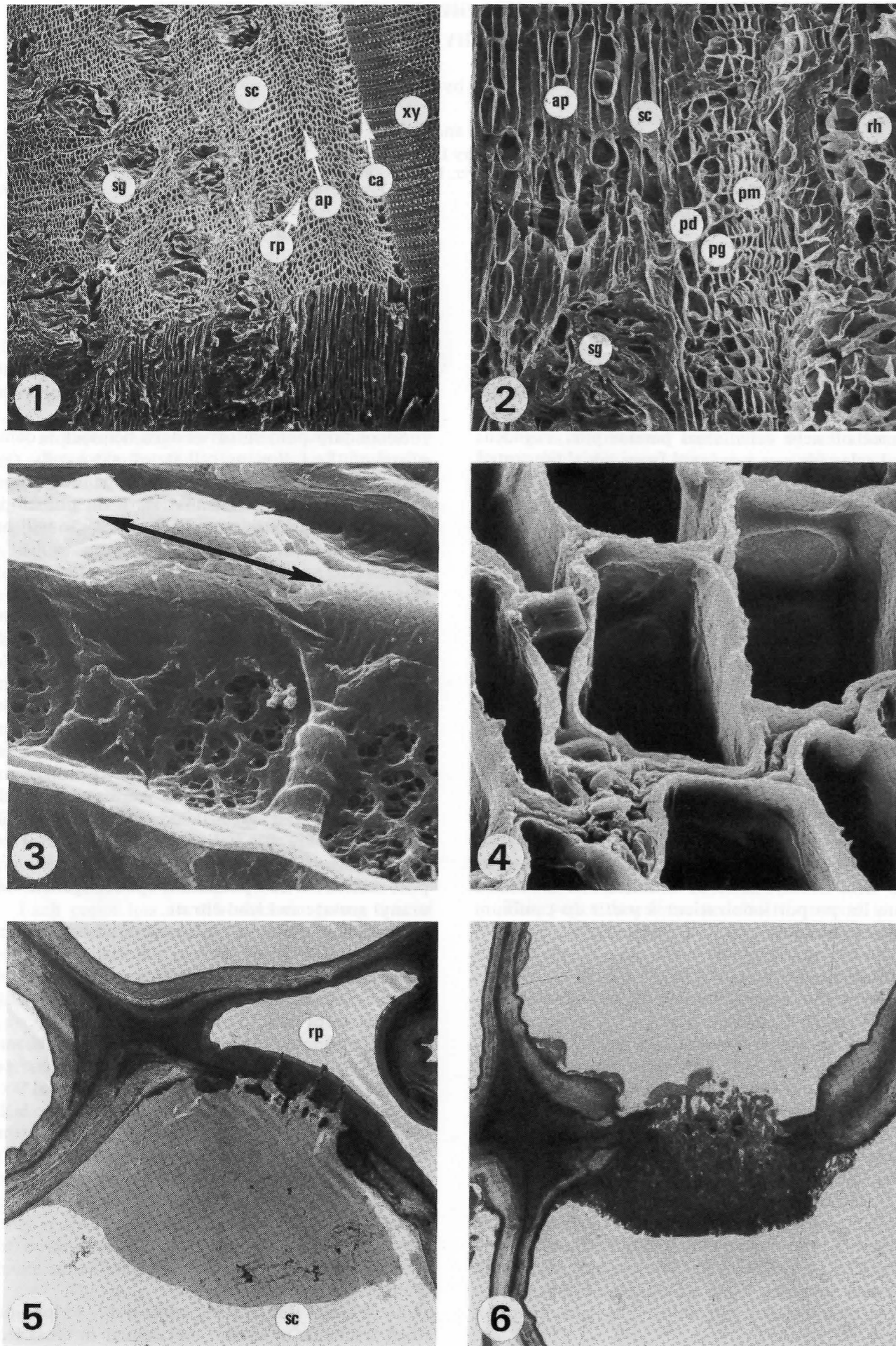
Scanning electron microscope observations were made of fresh frozen material which had been either air dried, solvent-exchange dried or critical-point dried and subsequently coated with a thin layer of gold to promote conductivity.

Evaluation of relative abundance of cells was made from data obtained from light microscope observations of unstained 25-μm tangential sections, cut serially from the cambium to the last-formed periderm, using a Carl Zeiss integration eye piece with 25 measuring points. Counts were made of three areas from each section; groups of 10 serial sections were averaged.

Observations and Results

Microscopic Structure

Sieve cells: Radial files, comparable to longitudinal tracheids in xylem, rectangular in cross sec-

tion; collapsing radially farther from cambium. Sieve areas on radial walls commonly in single rows, occasionally in pairs; pit contact on radial walls with ray tissue; no tangential pitting. Cell wall thickness variable, unlignified and lamellar.

Axial parenchyma: Strands in tangential bands, singly or in twos approximately every four or five rows of sieve cells. Rectangular in cross section; similar in dimension to sieve cells except expanding farther from cambium. Simple pit contact on radial walls with each other and with ray tissue. No direct contact with sieve cells. Generally with cell contents, such as starch particles or frequently crystalliferous with styloid crystals; cell walls unlignified; thicker walled farther from cambium. Crystalliferous cells may be suberized. Crystals enclosed in sheath of cell wall-like material.

Rays: Semi-heterogeneous, uniseriate. Procumbent parenchyma thin-walled; simple pitting between ray parenchyma and axial parenchyma. Pitting between sieve cells and ray parenchyma similar to half-bordered pits in xylem; expanding farther from cambium partially accommodating girth of system. Marginal upright cells, considered to be albuminous cells; thin-walled with simple pits. Air-filled intercellular spaces adjacent to all ray parenchyma cells.

Sclereids: Randomly located throughout secondary phloem, in groups of intrusively grown individual cells, thick-walled, lamellar, lignified with numerous simple pits; pit canals and lumens frequently filled with extraneous material.

Relative Abundance of Cells

Counts made on serial tangential sections of two secondary phloem samples from the cambium to the last-formed periderm yielded the information contained in Table 1. Overall percentages suggest that sieve cells, together with axial parenchyma cells in similar proportion, make up approximately 75 % of the total tissue, the remaining tissue being half ray tissue and half sclereid groups. However, the proportions vary from the cambium outward. Near the cambium, the sieve cells comprise more than half of the total, decreasing to one-third near the periderm. Axial parenchyma cells maintain a proportion near 30 % throughout one sample, while increasing to about 45 % in the other. Rays increase three to four times from the cambium to the periderm. Sclereids show no trend.

Discussion

Sieve cells predominate in the newly formed secondary phloem, arising from the cambium in radial files, comparable to xylary tracheids. Sieve cells comprise about 40 % of the total tissue from the cambium to the last-formed periderm. Pit contact occurs in more or less circular sieve areas confined to radial walls. The pores of one sieve area do not necessarily match perfectly with those of adjacent cells (Fig. 3), as is generally the case with bordered-pit pairs in xylary tracheids. However, no completely blind pit areas were observed.

Near the cambial zone, pores of sieve cells are frequently plugged with callose (Fig. 4 & 5) and, in some instances, show streaming of cell material through the pores (Fig. 6). Farther from the cambial area sieve cells are clean and the pores open (Fig. 7).

Sieve cell walls are lamellar in construction (Fig. 8) and show random variation in thickness. Ultimately these cells, no longer functioning in transport, will collapse under the pressure of expanding parenchyma and sclereid tissue.

Axial parenchyma strands contribute to a greater part of the phloem tissue than in xylem, making up 36 % of this tissue. Crystalliferous parenchyma develops a thicker cell wall which becomes suberized in some cases (Fig. 9) and also sheathes the crystal in a wall-like material (Fig. 10). Wattendorf (1969) described the occurrence of this crystal sheath in the bark of European larch (*Larix decidua* Mill.). The abundance of distinctive styloid crystals in hemlock bark is a characteristic recommended by Rem & Wilcox (1976) to separate the wood of white fir (*Abies sp.*) from hemlock (*Tsuga sp.*) produced in California.

Fig. 1. Scanning electron micrograph (SEM) of radial and transverse surfaces of secondary phloem with xylem attached. Identified are cambial area (ca), xylem (xy), sieve cells in radial files (sc), axial parenchyma in tangential bands (ap), ray parenchyma (rp), and randomly dispersed groups of sclereid cells (sg); x 42. –– Fig. 2. SEM of radial surface of secondary phloem showing axial parenchyma (ap), sieve cells (sc), a sclereid group (sg), phelloderm cells (pd), phellogen area (pg), phellem or cork cells (pm) and rhytidome (rh); x 100. –– Fig. 3. SEM of a radial surface of a sieve cell. Arrow indicates axis of cell. The circular sieve area shows individual pores in small clusters. Pores do not align perfectly with adjacent pores as with pits in xylem; x 3200. –– Fig. 4. SEM of transverse section of sieve cells showing sieve areas totally occluded; x 1280. –– Fig. 5. Transmission electron micrograph (TEM) of a cross section of adjacent sieve (sc) and ray parenchyma (rp) cells showing sieve area occluded with callose; x 8130. –– Fig. 6. TEM of cross section of sieve area between adjacent sieve cells showing cell contents streaming through the sieve area pores; x 4350.
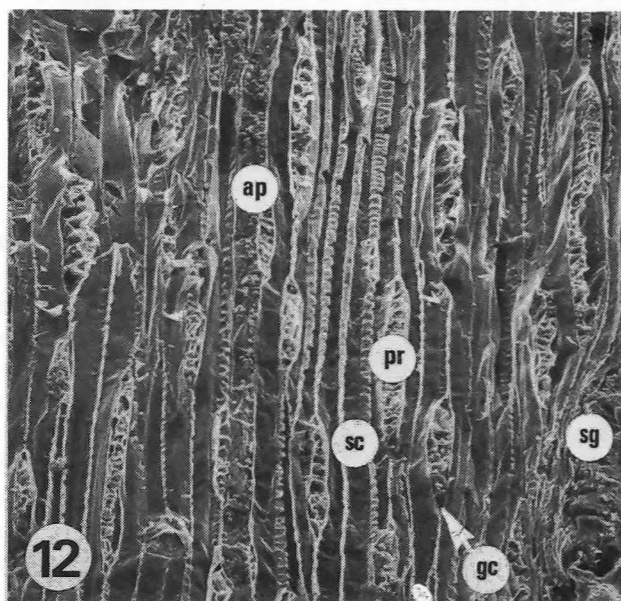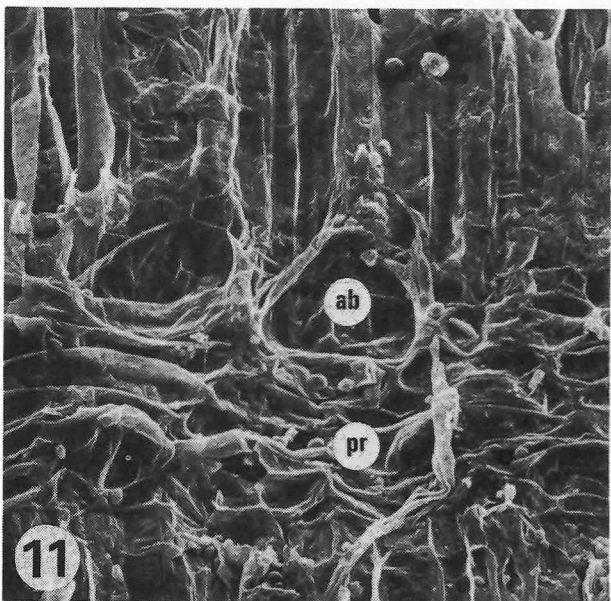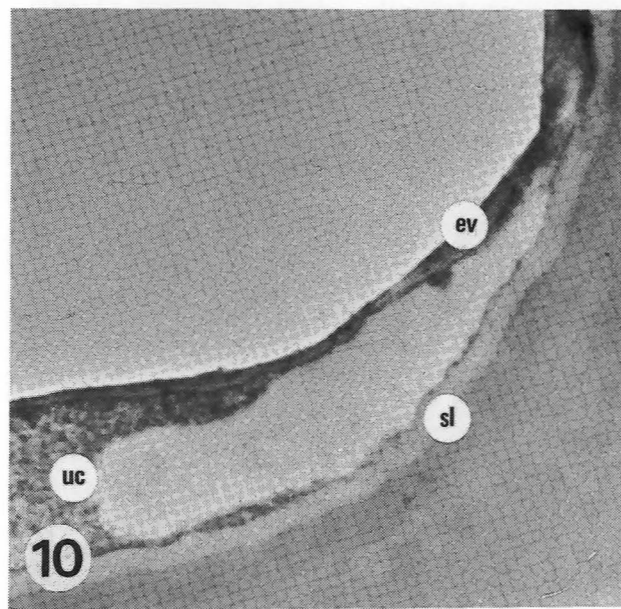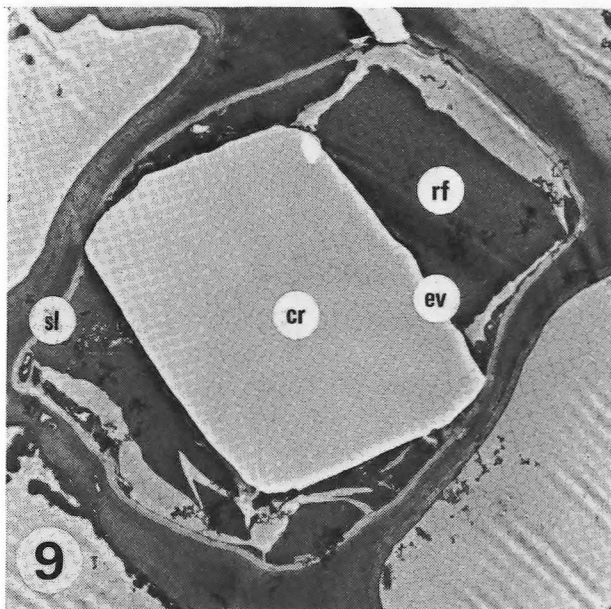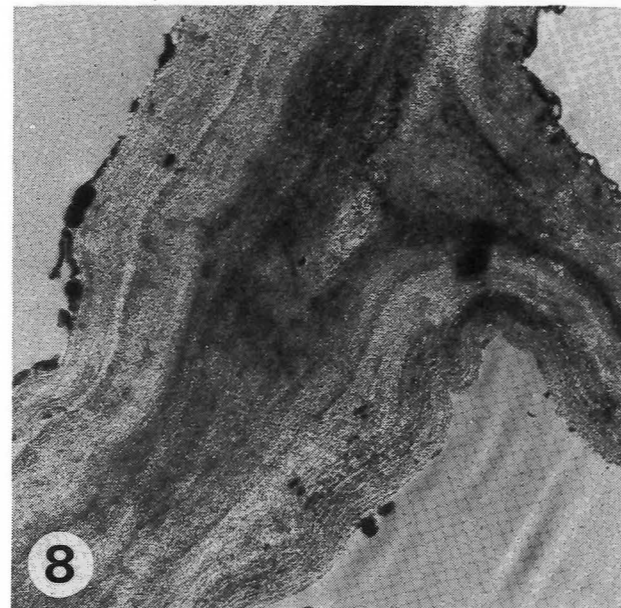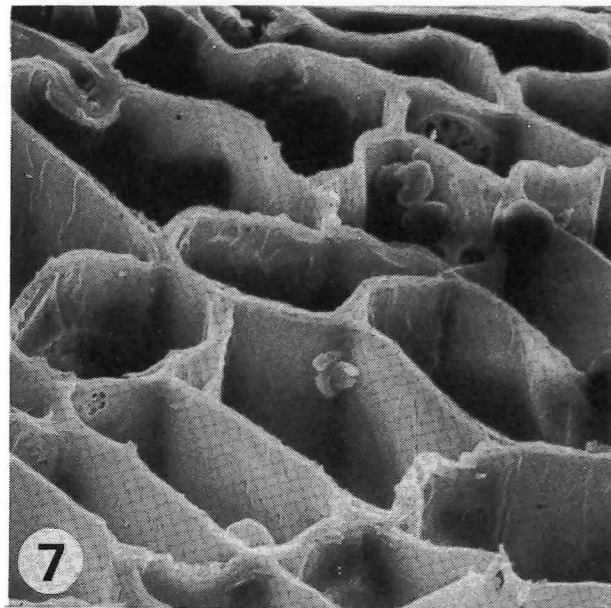
Table 1. Relative percentage of cell types in two samples (1 and 2) of western hemlock secondary phloem

Serial Section No.	Sieve cells		Axial parenchyma		Ray cells		Sclereids	
	1	2	1	2	1	2	1	2
Cambium								
1–10	52.4	61.4	31.2	28.8	5.5	3.4	10.9	6.3
11–20	44.6	44.5	32.8	33.1	10.9	8.3	11.8	14.1
21–30	45.4	30.1	32.9	44.8	9.8	12.8	11.9	12.3
31–40	36.0	25.6	33.2	45.4	11.9	15.8	18.9	13.2
41–50	33.3	29.2	31.4	48.4	14.6	15.7	20.6	6.6
51 +	34.2	22.1	31.1	45.5	16.2	17.7	18.5	14.7
Periderm								
Weighted average	41.3	37.0	32.2	40.5	11.2	11.7	15.3	10.8
Overall average	39.1		36.4		11.4		13.0	

Ray tissue of the phloem differs from that of the xylem. In the phloem, the procumbent parenchyma cells expand to accommodate the increasing girth of the stem. Albuminous or upright ray parenchyma cells occur sporadically in heterogeneous rays (Fig. 11). They do not have a counterpart in the xylem of any gymnosperms. Radial air-filled intercellular spaces accompany all ray parenchyma cells (Fig. 12 & 13). However, there are no resin canals or resin ducts, either axially or radially.

Sclereids are the only cell type which show lignification in the secondary phloem. These distinctively shaped cells, which have been described previously by Goldschmid & Folsom (1975), are cigar-shaped clusters of highly irregularly shaped cells (Fig. 14 & 15). Because they have thick walls, the pit canals are long. These canals were found to be either occluded with resinous material (Fig. 16) or clean and open (Fig. 17).

Summary and Conclusions

The secondary phloem of western hemlock is comprised of well-ordered radial files of sieve cells and axial parenchyma strands interspersed with groups of sclereid cells.

Intrusive growth of sclereid cells, expansion of axial parenchyma cells and radial ray parenchyma cells and consequent collapse of sieve cells causes a change in relative abundance of other cell types. The phloem is terminated with the formation of the periderm layer.

Fig. 7. SEM of transverse section showing sieve cell pores open; x 1020. — Fig. 8. TEM transverse section of sieve cell walls. Sample extracted with alcohol-benzene and hot water before embedding and post staining with KMnO4. The numerous lamellae of sieve cell walls and irregular wall thickening are shown; x 11700. — Fig. 9. TEM of transverse section of a crystalliferous parenchyma cell showing large crystal (cr) in the center of the cell, an envelope around the cell (ev) and resinous material which has fractured under sectioning (rf). The bright unstained zone in the cell wall indicates suberization of this layer (sl); x 3730. — Fig. 10. TEM of transverse section of crystalliferous parenchyma cell showing suberized layer (sl), unidentified cell contents (uc) and an envelope of wall-like material surrounding the central crystal (ev); x 32500. — Fig. 11. SEM of radial split surface of secondary phloem showing procumbent ray parenchyma (pr) and erect albuminous cells (ab); x 260. — Fig. 12. SEM of tangential surface of secondary phloem showing phloem rays (pr), sieve cells (sc), axial parenchyma (ap) and a sclereid group (sg). Intercellular spaces (gc) can be observed associated with each ray; x 96.
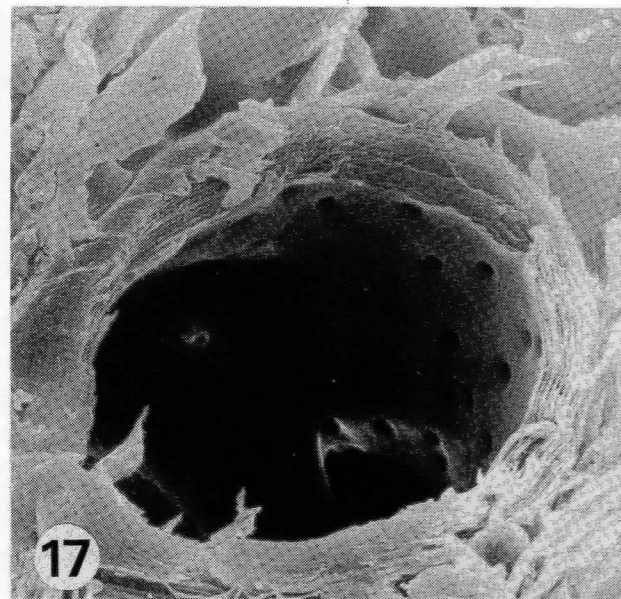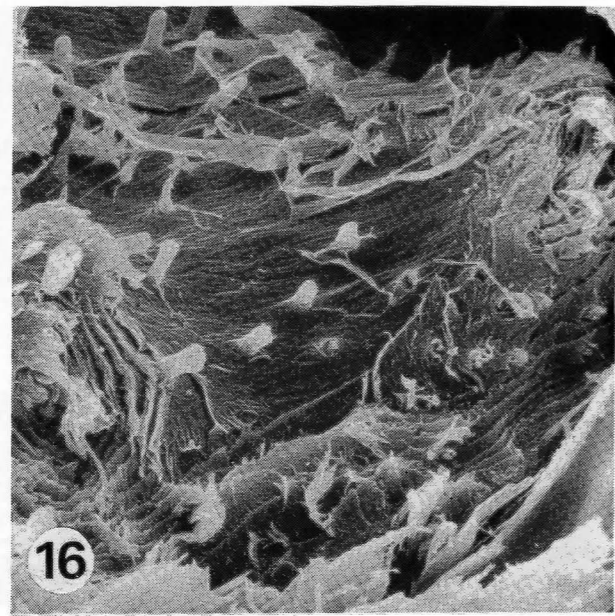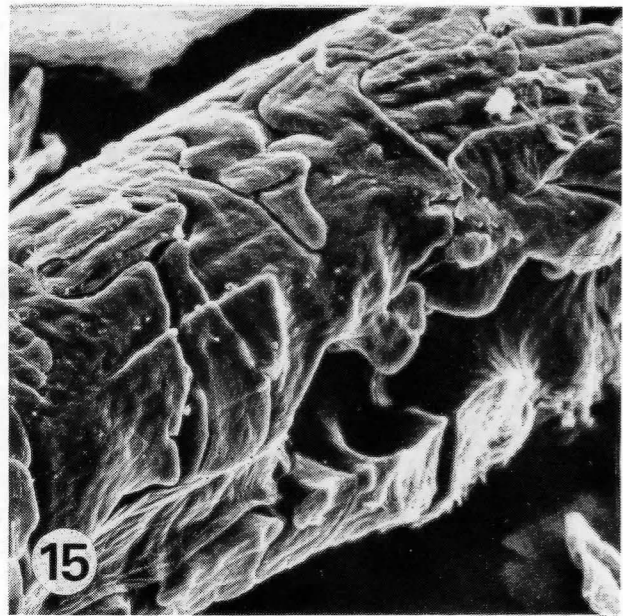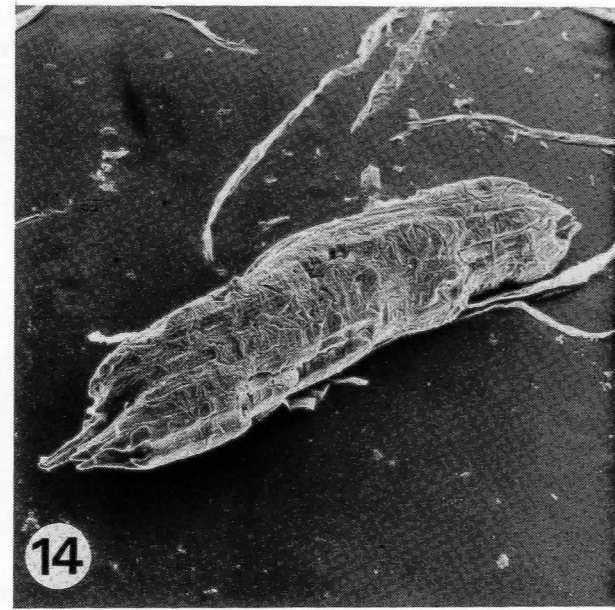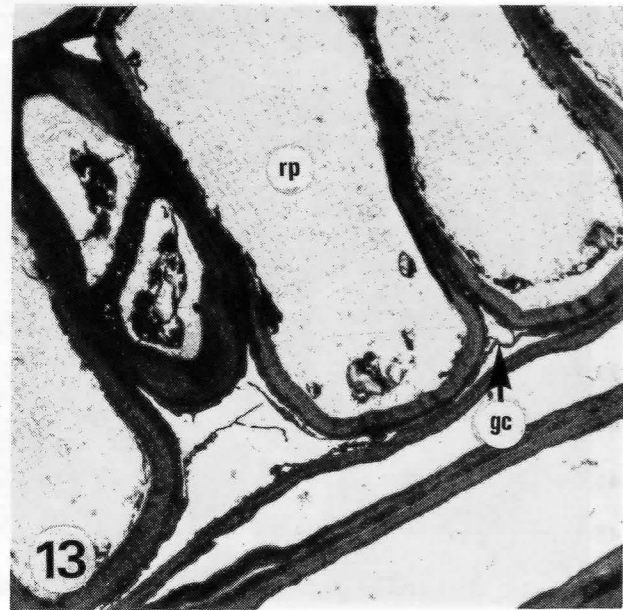
With the exception of the sclereid cells, all cell types are parenchymatous, in some instances with wall thickening but no lignification. Suberization occurs in some crystalliferous parenchyma. There is no tangential pitting between axial elements. All pitting is simple with the exception of sieve cells which have clusters of pores.

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Fig. 13. TEM of tangential section of secondary phloem ray showing intercellular spaces (gc) in association with ray parenchyma (rp); x 2000. —— Fig. 14. SEM of typical cigar-shaped cluster of sclereids; x 57. —— Fig. 15. SEM of a cluster of sclereids showing highly irregular shape of individual cells and the results of their intrusive growth. Cavity in lower right is where one cell has been pulled out during dissecting; x 280. —— Fig. 16. SEM of fractured sclereid cell showing resinous pit plugs remaining after cell wall layers have fractured away; x 2000. —— Fig. 17. SEM of lumen of a single sclereid cell with pits appearing clear of any resinous material; x 1260.

A STRUCTURAL PECULIARITY OF ANTIARIS AFRICANA ENGL.

by

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More or less clearly visible structural defects can repeatedly be noticed in peeled veneer from *Antiaris africana* Engl. (Ako). These are longitudinal, stripy, synclinal formations of about 3 cm length and 2 mm width that cause an increased roughness of the veneer surface. Figures 1 and 2 show that this is a wood defect resulting from an essentially different fibre direction since in the defective zone fibres and rays are almost in horizontal direction. It is striking that in these places there are no vessels; the rays seem to be shorter and wider and have secretory ducts, and the fibres are shorter and often lack the characteristic septa. The cause of this structural peculiarity is not yet understood.
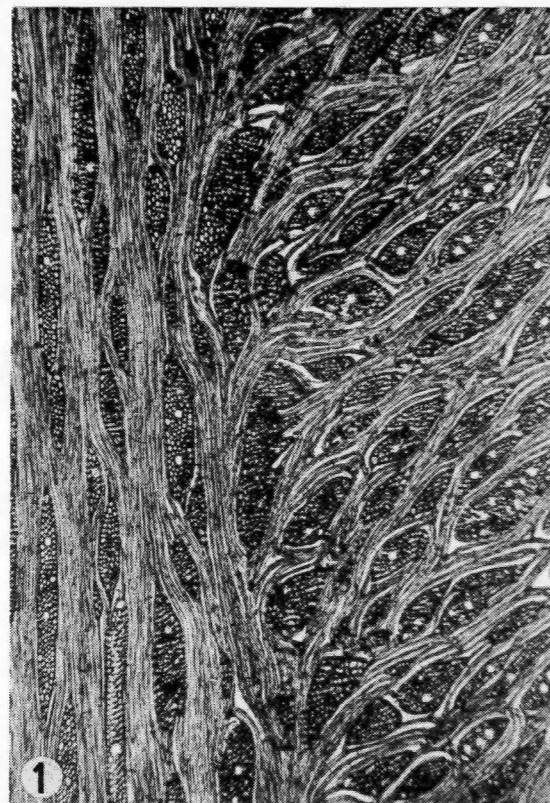

Fig. 1. On the left: normal zone, on the right: defective zone, diagonal–horizontal direction of fibres and rays, horizontal rays shorter and wider than vertical ones, rays with secretory ducts. Tangential section x 20.

Fig. 2. Section of the defective zone, fibres short and without septa. Tangential section x 60.

CRYSTAL–CONTAINING WALLS OF SPICULAR CELLS IN WELWITSCHIA

by

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In the course of our studies on the fine structure of polylamellate walls (Parameswaran, 1975; Parameswaran & Liese, 1976; Parameswaran & Sinner, 1979) the so-called spicular cells of *Welwitschia mirabilis* were also examined. These cells are characterized by the presence of crystals in their walls (cf. Martens, 1971). Since no fine structural details on the spicular cells are available, our observations on these from the wood and bark of air-dried material are presented in the following.

The genus *Welwitschia* is unique in possessing fibre-like cells in wood, bark, palisade parenchyma of leaves, reproductive branches and cone scales, whereby they are mostly elongated showing anastomosis and oriented parallel to the stem axis. In connection with his studies on the occurrence of calcium oxalate crystals in plant cell walls Solms-Laubach (1871) mentions *Welwitschia* in some detail: the name spicular cell was conceived by J.D. Hooker (1863) for this peculiar cell type, even though he attributed a silica nature to the crystals; later Hofmeister established their calcium oxalate nature. In describing the leaf anatomy of *Welwitschia* Rodin (1958) expands on the development of 'sclereids', as he calls these cells. The crystals are said to be deposited at an early stage of cell development and the secondary wall is suggested to be formed subsequently.

Our observations confirm the occurrence of numerous prismatic crystals of various sizes within the wall of the spicular cells. On the basis of morphology these cells can be interpreted as modified sclerotic fibres comparable to those found in the Douglas-fir bark (Parameswaran & Liese, in preparation). In scanning electron micrographs of the fractured surfaces of stems the nature of these crystals as well as their distribution become clearly revealed (Fig. 1, 2). The crystals are exposed due to the removal of the outermost wall layers. The spaces occupied by them are left over as well-formed depressions in the wall (Fig. 3). In observing a transversely broken cell it is apparent that the crystals are restricted to the peripheral zone of the cell (Fig. 2). Their exact localization within the cell wall can at best be observed in thin sections. Transmission electron micrographs re-veal that the crystal spaces are in the outermost region of the lamellated secondary wall. They appear sunken in the secondary wall and partly even covered all around. In certain cases however some crystals protrude outside the secondary wall into the primary wall region (Fig. 4). This implies that the formation of crystals takes place at a very early stage in the development of the secondary wall. In contrast to the finding of Rodin (1958) the innermost layer of the secondary wall becomes highly lignified. The pits of the sclerotic spicular cells are distributed between the crystals (Fig. 4) and resemble pit canals in sclereids.

The nature of the crystals can at best be described as corresponding to the primitive hendyoeder (Holzner, 1864), as suggested by Solms-Laubach (1871); the klinorhombic form can also be well documented in the scanning electron micrographs. The calcium oxalate nature of the crystals was confirmed both by histochemistry and x-ray microanalysis; an x-ray micro-distribution map for calcium in the crystals as well as a secondary electron image are given in Figures 5 and 6.

Similar crystal-containing walls of sclerotic cells are said to be characteristic for *Araucaria* (Bleisch, 1891; Griffith, 1950; Napp-Zinn, 1966), *Nymphaea, Nuphar* (cf. Napp-Zinn, 1973), *Illicium, Schisandra* and *Kadsura* (Bailey & Nast, 1948; Lemesle, 1953), Cupressaceae barks (Sinz, 1925; Wattendorff & Meier, 1970). The occurrence of crystals within the walls of the so-called crystalliferous sclereids of *Schisandra* has been denied by Jalan (1968), who reports their presence only in the lumen. In this connection it must also be emphasized that the term 'spicular cell' (Spikularzellen) has been employed as identical to sclereids without the possession of crystals within the walls (Napp-Zinn, 1973; see also Metcalfe & Chalk, 1950). Perhaps it is to be recommended for the future to use only a homogeneous term like 'spicular cell' for cells with crystals in their walls without the danger of synonymy with sclereids and related cells.
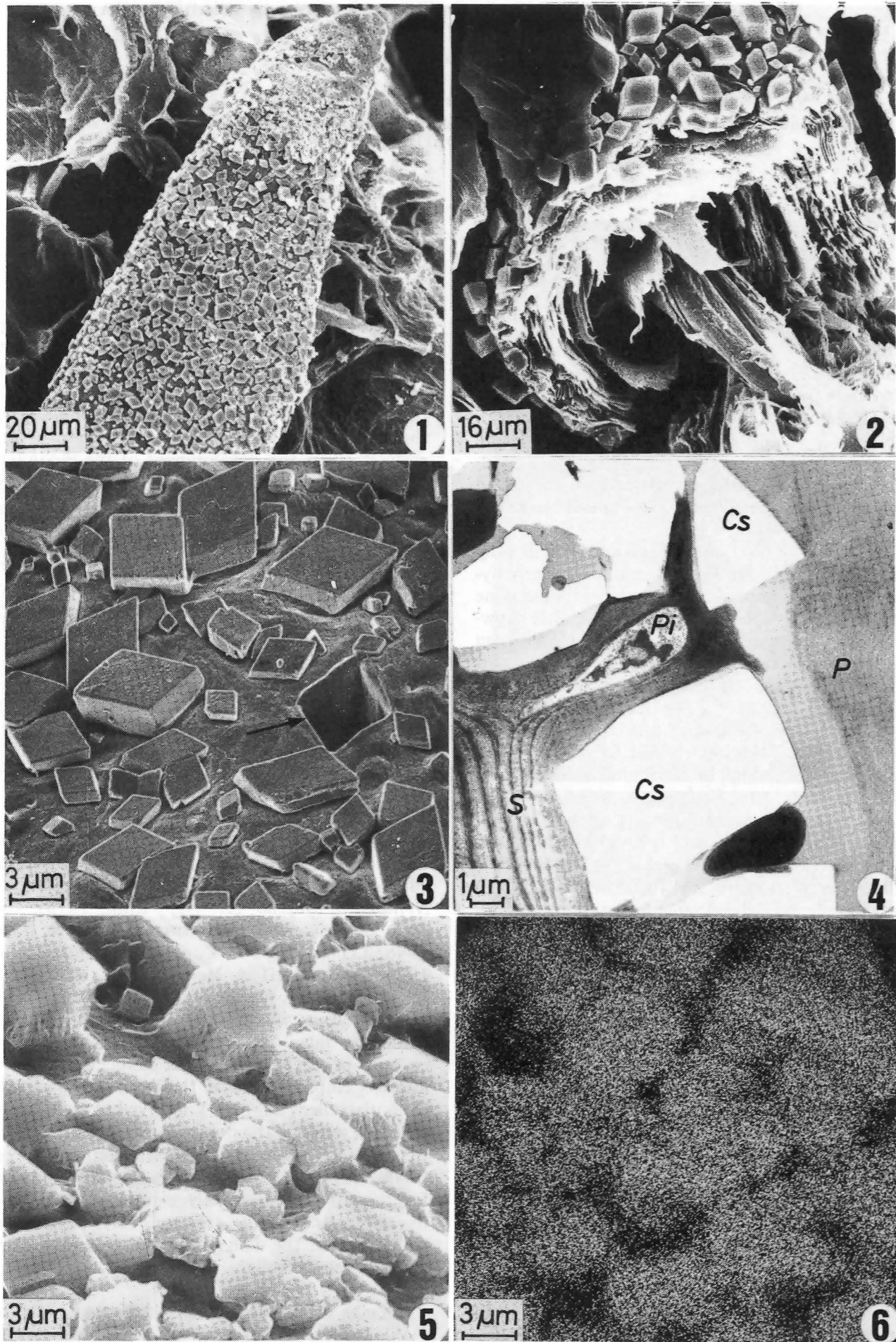
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Fig. 1. Fractured surface of the stem with an exposed spicular cell covered with crystals. SEM. —— Fig. 2. Transversely broken spicular cell showing the multilamellate nature of the wall and the distribution of crystals in the outermost wall region. SEM. —— Fig. 3. Enlarged view of the wall surface of a spicular cell demonstrating crystal form; note depression (arrow) in wall due to removal of crystal during preparation. SEM. —— Fig. 4. Cross section through the wall of a delignified spicular cell with crystal spaces (Cs) — crystals removed during preparation — partly protruding from the secondary wall (S) into the primary wall region (P); pit canal (Pi) between crystals. TEM. —— Figs. 5 & 6: 5. Secondary electron image of crystals on the wall of the spicular cell, and 6. The x-ray map for the distribution of calcium. SEM.

The Picea-Larix problem

Dear Sir,

With regard to the article in the issue of IAWA Bulletin 1979/1 by Thomas Bartholin, I would like to draw your attention to his statement in the first paragraph of the abstract: "The woods of *Larix* and *Picea* hitherto thought to be indistinguishable".

I find it difficult to accept that statement. The author fails to either mention or refute the information contained in widely used keys for wood identification such as those found in the well recognized textbooks by Panshin and de Zeeuw or Tsoumis. These keys suggest several features as useful in separating wood of the genus *Picea* from that of *Larix*. The first is the frequent occurrence of two rows of bordered pits on the radial walls of tracheids in the genus *Larix* compared with the very rare occurrence of more than one row in the genus *Picea*. This feature plus the relative abruptness of the transition from earlywood to latewood in my mind are irrefutable as diagnostic features.

I take no exception to the observations Mr. Bartholin has made and convincingly presented, I merely wish to point out that over many years as a species analyst I have identified literally thousands of samples of spruce and larch from British Columbia and Alberta and cannot accept that prior to Mr. Bartholin's work I should have considered them indistinguishable.

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Dear Sir,

Mr. Rowe is completely right in opposing the statement: "The woods of *Larix* and *Picea* hitherto thought to be indistinguishable" in the abstract of my article "The Picea-Larix Problem" in this bulletin 1979/1. He is right, because the statement could be taken to mean that I want to show the only possible solution to the problem, and that is of course not the case!

The two well-known characters for distinguishing between *Picea* and *Larix*, used by Mr. Rowe: "Two rows of bordered pits on the radial walls of tracheids, and the relative abruptness of the transition from earlywood to latewood" are mentioned by the two authors quoted by me (Petersen 1901 and Huber 1970) as not satisfactory for a reliable identification. I am of the same opinion: Two rows of bordered pits often occur in *Picea*, especially in broad tree-rings and in roots. The transition from earlywood to latewood cannot normally be seen in wood found in the earth because of decay.

In my article I gave a number of examples of how crucial it is to make a reliable identification of *Larix* and *Picea*, particularly here in Europe, where, besides, special conditions often make it necessary to perform identifications only on very small pieces of wood.

I believe that I have established a character, the bordered pits in ray tracheids, which can contribute essentially to the distinguishing between *Picea* and *Larix*, particularly when used together with other characters. The many positive reactions received to my article indicate the possibility of getting quite near to a reliable identification, even if one can only examine the ray tracheids.

Mr. Editor, in my article I invited a debate on the subject, and I still do, hoping that you will put the IAWA Bulletin at disposal for possible future contributions.

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Note from the Editor

The above debate adds much to the flavour of our Bulletin, and it is hoped that in the future other classical identification problems will be the subject of similar discussions. When Mr. Bartholin submitted his manuscript to the IAWA Bulletin, the fairly extensive collection of *Picea* and *Larix* slides of the Rijksherbarium was consulted to check the validity of the ray-tracheid pit character, and it was immediately clear how useful and practicable a character to separate the two genera Mr. Bartholin had found. This also held true for several species not included in his paper.

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by

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Summary

Wood chips, cut in radial and tangential directions were cooked by the sulphate process to different Kappa numbers. A fresh radial or tangential surface for observation was then prepared by cleavage of the still intact chip and the specimen was dehydrated by solvent exchange. Since the cementing middle lamella is largely removed from between the cells, their surface features can easily be studied in the SEM. The cells are still in their original positions in the wood tissue.

Introduction

The two important aids in studying the anatomy of wood with a microscope are microtome sectioning of wood samples in the three directions — radial, tangential and cross-sectional — and maceration of wood to isolate the different cells.

With scanning electron microscopy, the thin sectioning of wood samples with a microtome can be replaced by the preparation of small blocks or chips of wood. In the case of blocks with radial, tangential and transverse surfaces, the three-dimensional wood structure can be displayed. A very useful description of this technique was published by McMillin (1977).

The blocks or chips can be cut on a microtome or by hand with a carefully cleaned single-edged razor blade (Exley *et al.*, 1974). It is recommended that the razor blade be sharpened on a mirror glass with aluminium oxide polishing powder suspended in a detergent. In some cases the cutting can be replaced by cleavage.

The pretreatment prior to the preparation of the wood sample depends on the condition of the material (green wood or dried logs) and on the hardness of dense wood. In most cases, boiling the sample in water for about one hour may be sufficient. For refractory woods, Kukachka (1978) has recently described a softening technique using 4% ethylene diamine solution. As a posttreatment Exley *et al.* (1974) recommend cleaning with 20% sodium hypochlorite solution.

Many methods exist for macerating wood (Kommert & Wienhaus, 1973). A fairly mild procedure involves a maceration by triethylene glycol (Burkart, 1966) followed by hypochlorite treatment.

In both cases, the material has to be dried without the introduction of artifacts. Very often, solvent exchange (alcohol series, followed by propylene oxide, ether or the like and pentane (Collet, 1976) is quite sufficient. In difficult cases, dehydration (sometimes after fixation) with 2,2-dimethoxypropane (DMP) may be preferable (Muller & Jacks, 1975; Johnson *et al.*, 1976). DMP can also be used as an intermediate liquid for critical point drying with CO_2.

In radial or tangential sections, most of the cells are cut open and the cell wall structure is seen in the SEM from the lumen side. Some cells are cut somewhere in the S_2, but cell wall features on the outer cell wall (P or S_1) can usually not be observed. The chance of seeing the outer surface of the cells is of course much higher if the wood is split by cleavage but the fissure is rather irregular and many artifacts affect the observation. All cells are visible from the outer surface after maceration but details of any special orientation of the surface or of the location of the cell in the xylem tissue are lost and certain surfaces may never be in a proper position for observation due to the shape of the cells. Besides, it is much more difficult to make a good preparation for SEM investigations from macerated material than to arrange a wet preparation for light microscopy.

A new method ?

A way of overcoming these difficulties, which introduces an additional method in wood anatomy studies, is to prepare wood chips in both radial and tangential directions, e.g. of the approximate size 10 x 4 x 30 mm, and to cook the chips using the sulphate process to different Kappa-numbers. It is important to handle the chips with a minimum of mechanical action and to ensure that the cooking does not reach the point where the chips disintegrate easily with only slight mechanical action. On the other hand, the delignification should have proceeded to the stage where cleavage in the middle lamellae is achieved easily with a minimum of artifact formation. In general, cooking is stopped in the region of the defibration point but in some cases, as some of our examples show, the defibration point can be noticeably exceeded.
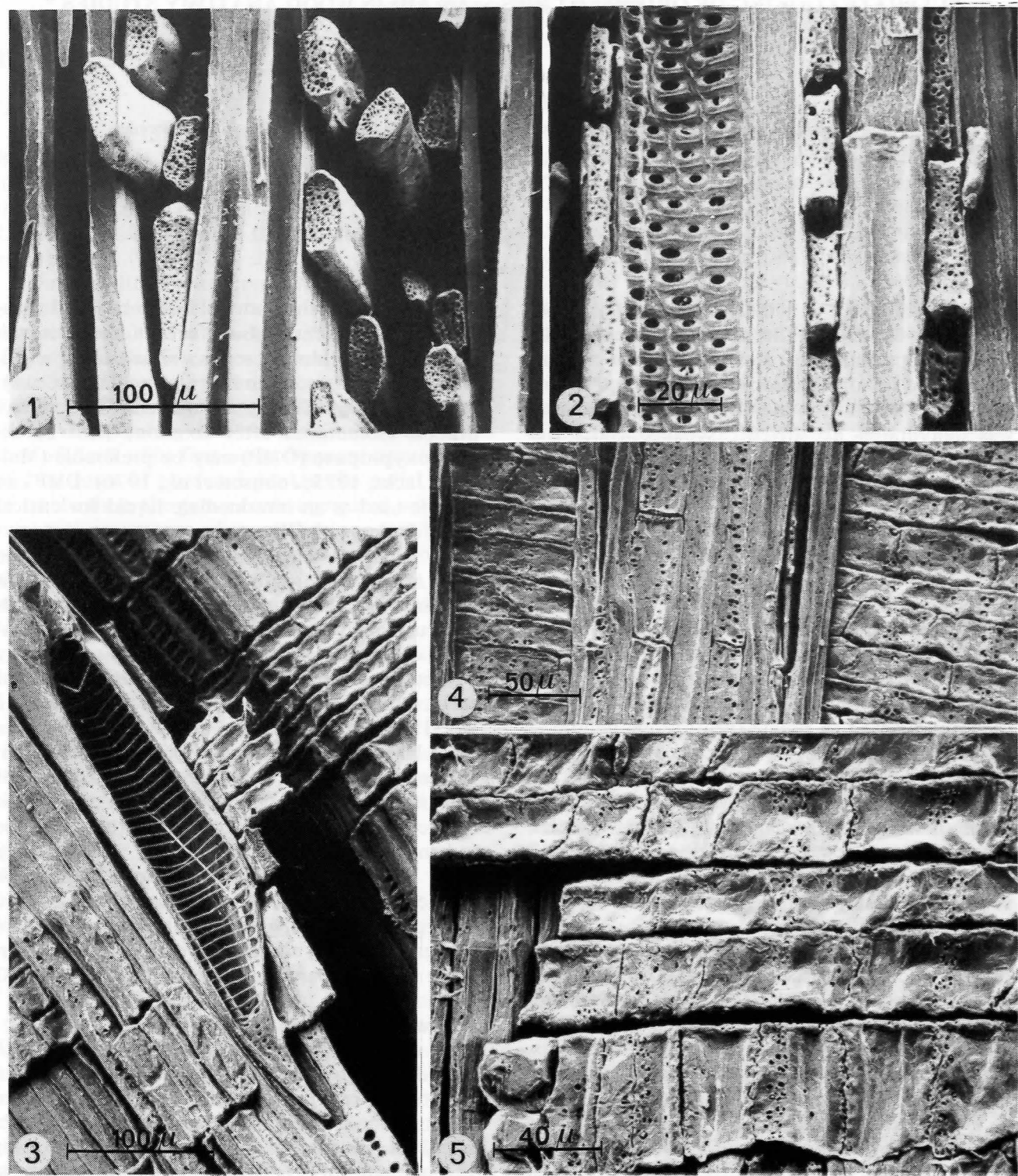
Fig. 1. Tangential section of *Pycnanthus angolensis* (Ilomba or Eteng), showing parenchyma rays (multi-seriate rays) and wood fibres (libriform cells). —— Fig. 2. Tangential section of *Strombosia glaucescens* (Mbangmbazoa), showing ray cells, libriform cells and a vessel. —— Fig. 3. Radial section of *Diogoa zenkeri* (Olombang) with parenchyma cells and a vessel member. The scalariform vessel perforation is clearly visible. —— Fig. 4. Vertical and radial parenchyma cells in *Grewia coriacea* (Akendeng). —— Fig. 5. Procumbent and marginal ray cells in *Diospyros conocarpa* (Osang Akurna).

The cooked chips are very carefully washed in water until all alkali and soluble coloured material are removed. A fresh radial or tangential surface for observation is then produced by cleavage with a razor blade and controlled in a stereomicroscope. If the surface appears to be in the correct direction and affected by a minimum of distortion, the chip may be trimmed to the appropriate size and the solvent exchange started. A practical scheme for the first step consists of an alcohol series consisting of 30, 50, 70 and 100% ethanol. An antistatic agent is added to the 50% mixture. After all water has been replaced by ethanol, the ethanol is exchanged with propylene oxide and finally with isopentane or cyclohexane. After the hydrocarbon has been evaporated in air (room temperature or 60° C), the objects are glued onto the aluminium stub and coated with gold in a sputter apparatus.

Results

The micrographs in Figures 1—5 show some results obtained with tropical deciduous woods. Since the cementing lignin substance is largely removed from between the cells, the (intersecting) endwalls with their pitting in the rays are clearly seen in the tangential view (Fig. 1 & 2). A microtome section in this case would preferentially have cut the ray cells and only their cross-sections would have been observable.

If layers of different cells in the radial surface are partially removed and cells in the xylem tissue are partially separated, the corresponding pitting between the procumbent and upright ray cells and the tracheary elements is easily seen (Fig. 3, & 5).

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VARIATION OF WOOD ANATOMY OF GMELINA ARBOREA ROXB. IN NIGERIAN PLANTATIONS[1]

by

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Abstract

Plantations of *Gmelina arborea* Roxb. were established in five States within the Rain Forest Zone of Nigeria using seed from earlier plantations in two States but believed to be of the same natural origin in India. After seven years five trees were sampled in both of two plots at each of four sites and in plots of four planting espacements at the fifth site. From each tree samples were removed at four height levels and four wood features were examined in earlywood and latewood of each annual ring along two random radii. Data were subjected to orthogonal and anorthogonal analyses of variance to examine the importance of up to 27 main effects and interactions.

Planting espacement and cardinal direction had no significant effect on wood features. The four principal sites varied only for fibre length (1.13–1.26 mm) and no variation was attributable to plots within sites. Tree mean values differed considerably for all traits – fibre length (1.08–1.47 mm), fibre proportion (57.3–78.3%), vessel proportion (9.0–22.5%) and parenchyma proportion (11.3–25.5%). These were not related to tree growth parameters.

Within individual trees the effect of sampling height was unimportant except for parenchyma proportion (18.3% at the lowest level to 13.0% at the highest). However, considerable variations occurred between earlywood and latewood within annual rings; earlywood had shorter fibres, a higher proportion of fibres and lower proportion of vessels and parenchyma. Radial variation existed also between annual rings 1–7 mainly for fibre length (0.87–1.36 mm) and vessel proportion (11.8–16.7%).

Although there was considerable confounding between climate, geology, management and seed history of the four principal sites the results have important implications for wood use (mainly pulp production) and for studies of ecological anatomy.

Introduction

Many of the published studies of 'ecological wood anatomy' have demonstrated (within a given species) anatomical variation that is related to environmental variation in the natural range of occurrence (see e.g. Baas, 1973, 1976; Carlquist, 1975; van der Graaff & Baas, 1974; den Outer & Veenendaal, 1976); such studies are commonly conducted by classical anatomists with botanical and phylogenetic interests and tend to overlook the confounded effects of the environmental variation *per se* and the genetic variation between populations caused by the selective effects of the different environments.

Foresters attempt to estimate population genetic differences by growing (in one comparative experiment or provenance trial) samples from seeds of different origins but such experiments are rarely replicated in the several different environments that are necessary to determine the extent of environmental effects and the presence of genotype-environment interactions; further, the forester is usually more interested in those anatomical features that have a direct influence on wood use than in those that have alleged adaptive significance.

Ideally the present report would describe variation in adaptive characters in seedlings from many natural populations planted on several sites; however, in fact it is concerned with characters that have both adaptive and utilization importance measured in seedling material believed to be of common origin (in India) though of different provenance in Nigeria, having been subject to some environmental and silvicultural selection in two plantation areas (Anambra and Bendel States) and grown in a range of environmental conditions within the Rain Forest Zone of southern Nigeria.

The species chosen is *Gmelina arborea* Roxb. (Verbenaceae). It occurs naturally from the lower Himalayas in Pakistan through India, Nepal, Bangladesh, Sri Lanka, Burma, Thailand, Laos, Cambodia, Vietnam and the southern provinces of China. It is used widely as an exotic plantation species in many countries of the lowland tropical zone because of its ability to survive, grow fast, coppice and yield seed early in a variety of environments (Lamb, 1968). Studies of chemical and semi-chemical pulping processes show that *Gmelina* has high yield compared with other hardwoods; it pulps easily and the pulp can be used to manufacture many types of paper and board (Lamb, 1968; Ballon *et al.*, 1971; Estudillo *et al.*, 1972; Palmer, 1973, Palmer & Gibbs, 1974; Doat, 1976).

In Nigeria *Gmelina* plantations are being established on a large scale to supply raw material to various wood-using industries especially for pulp and paper, panel products, matches, poles and occasionally saw-timber. The establishment of three pulp mills is either completed or in progress. It is thus essential to study the features of Nigerian *Gmelina* to ensure its quality is correct for the intended end use and to determine the potential for improvement of wood quality through choice of site, silviculture or genetic selection.

Materials and methods

Samples were collected from five plantations within those southern Rain Forest areas of Nigeria where *Gmelina* has been extensively planted and is likely to be planted in future. The plantations were seven years old; at this age Nigerian *Gmelina* is believed suitable for pulping. The locations are illustrated in Figure 1 and listed with details of the vegetation type, rainfall and seed provenance in Table 1. Temperatures are similar for all plantations. The Ore samples represented a trial of planting espacements (1.37, 2.44, 3.35 and 4.73 m square spacing). The sources of seed for these plantations were earlier plantations in Anambra and Bendel States; the natural Indian origin for both was believed to be the same but exact details are not available. Even if they were of the same origin a small amount of population genetic variation could have occurred under the influence of somewhat different environments and managements in Anambra and Bendel. If such provenance variation occurred it would be confounded with the site differences between our sampled plantations.

Within each of the first four areas two plots were selected and in each plot five trees were chosen at random; within the fifth area three freely growing trees were selected at random in each of the four espacements. In each tree discs 7.5 cm thick were taken at the levels of 2, 25, 45 and 65 % of total tree height. Two radial strips were removed in random cardinal directions from each disc.

Slivers of wood parallel to the grain were taken from the inner and outer portions of each annual growth ring (equivalent to earlywood and latewood). They were macerated in equal volumes of 100 per cent glacial acetic acid and 100 volume hydrogen peroxide for 24 hours. Fibre length was determined on projections of microscope slides at x 100 magnification and recorded with a digitised mapping wheel interfaced with a data logger and tape punch.
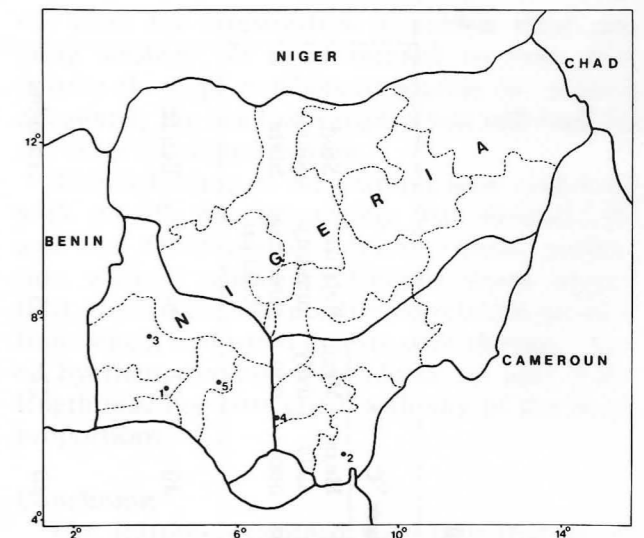

Fig. 1. Map of Nigeria showing State boundaries and location of five sample areas.

The proportions of fibres, vessels and parenchyma in each annual ring were determined with a modification of Ladell's (1959) point sampling and randomized dot counting method. A total of 25 points were classified in each wood type annual ring on planed, solid, radial samples.

Data from the first four sites were subjected to several orthogonal and anorthogonal analyses of variance according to a mixed model with the main effects of sites, levels, rings and woods ("earlywood" *vs* "latewood") considered fixed and factorial while plots, trees and radii were random and hierarchical. For the fifth site spacing effects were considered fixed.

Results and discussion

For each of the first four sites analysis of variance with 27 sources of variation (main effects and interactions) showed a non-significant effect of height levels in the vertical sequence for all characters except parenchyma proportion (13–18 %). The data were therefore pooled over levels with 18 sources of variation; although high levels of statistical significance occurred, often because of the large numbers degrees of freedom associated with the mean squares, the practical importance of most factors and interactions was low, as shown by the variance components listed as percentages of total variation in Table 2.

Sites had a significant effect solely on fibre length (1.19, 1.26, 1.19 and 1.13 mm for sites 1–4 respectively with the shortest fibres occurring on the worst site) and then accounted for only 3.8 % of the total variation. Differences between sites were not significant for fibre proportion (63–70 %), vessel proportion (13–15 %) or parenchyma proportion (16–20 %). The effect of plots within sites was negligible for all characters.

Table 1. Locations of seven-year old *Gmelina* plantations in Nigeria

State where plantation sampled	Forest Reserve	Vegetation type	Altitude above mean sea level (meters)	Latitude	Longitude	Mean annual rainfall (mm)	Temperature °C				Relative humidity percentage 10.00 hrs	Seed source State
							Annual mean 10.00 hrs	Annual mean 16.00 hrs	Mean daily max.	Mean daily min.		
1. Ogun	Omo Forest Reserve Ajebandele	High forest	61	6°51'N	04°23'E	2159	25	29	30	22	84	Bendel
2. Cross River	Oban Forest Reserve Awi	High secondary forest	229	5°19'N	08°34'E	4026	26	29	30	22	85	Anambra
3. Oyo	Olla Hill at Odanbon near Ogbomosho	Derived savanna woodland	562	8°08'N	04°15'E	1270	26	31	32	21	80	Bendel
4. Anambra	Akpaka Forest Reserve Onitsha	Degraded derived savanna woodland	61	6°09'N	6°47'E	2178	26	29	32	23	84	Anambra
5. Ondo	Ore Forest Reserve	High forest	91	6°44'N	4°52'E	1495	26	30	32	22	80	Bendel

The major consistent source of variation was the tree effect accounting for 13–24.7 % of variation with the following ranges of values:

Fibre length	1.08–1.47 mm
Fibre proportion	57.3 –78.3 %
Vessel proportion	9.0 –22.5 %
Parenchyma proportion	11.3 –25.5 %

These tree mean values were not correlated with any parameters of external stem or crown growth and morphology. Although tree values are affected by both the micro-environment and genetic composition of the individual, the lack of macro-environmental variation (sites and plots) suggests that much of this variation is genetic (although progeny tests would be necessary to prove this unequivocally).

Such variation is of importance to both the wood user and to the tree breeder. Further it indicates that the environments in Anambra and Bendel States did not select differentially and that the environments in the four sampled plantations were not sufficiently different to cause phenotypic differentiation. Detailed and reliable climatic data were available for these sites (Table 1); such data were often not available to the authors cited in the introduction but clearly the range of our environments was much smaller than those reported in Carlquist (1975) or the several papers by Baas (1973, 1976) and Van der Graaff & Baas (1974).

In addition to variation between trees, within-tree variation is important to the wood user and the anatomist. In our material, differences between annual rings were statistically significant for all four traits but practically important only for fibre length (0.87–1.36 mm) and vessel proportion (11.8–16.7 %). This is despite the fact that the inner seven rings were sampled where the maximum rate of anatomical change could be expected. Variation with height at a common ring number from the pith was important only for parenchyma proportion (17–25 %).

Within the annual ring differences between the inner and outer portions (earlywood *vs.* latewood) were statistically significant for all traits. Rounded values were:

Fibre length	1.15–1.24 mm
Fibre proportion	71–64 %
Vessel proportion	12–16 %
Parenchyma	16–19 %

While part of the variation in proportions is explained by the common occurrence of narrow terminal bands of parenchyma, the changes reflect changing water conditions during the growing season. The variability of fibre length is of interest to the pulp miller but small in relation to inter-ring differences. Together with annual ring variation, however, such variability adds to the sampling required to obtain adequate precision for estimates of tree mean values. It emphasises the need for investigators to publish their sampling strategy. It is of interest to note that, despite the large numbers of sources of variation examined, the residual variance was still high for the three tissue proportions.

Although none of the features were correlated with growth rate (suggesting that silviculturists and tree breeders may improve volume production without adversely affecting wood properties), there was a real positive correlation between fibre length and wood density over all rings (caused by their common dependence on age). Fibre length was not correlated with any of the tissue proportions.

Conclusion

The features examined were four that are of direct interest to a hardwood pulp miller; they may also be expected to have ecological adaptive significance and therefore to be modified by natural or artificial selection as well as by the current environment. Separation of environmental and genetic components can only be achieved unequivocally by progeny testing but these preliminary results from plantations of allegedly the same seed origin show that macro-environmental differences were small (between sites and sample plots) in comparison with individual tree differences within plots.

The sites tested covered the range of the Rain Forest Zone in Nigeria and some degraded derivatives but apparently the environmental variation was not enough to modify wood structure. A wider range should be tested (using material of known seed origins). Nevertheless, although the effects of climate, soil and genetic history are confounded somewhat here, these simple observations suggest that the ecological anatomical variation reported by Baas, Carlquist and others for different natural origins of a given species or genus may indeed be due to evolved genetic differences between the populations rather than to current environmental differences.

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Table 2. Summary of analyses of variance for means of four levels showing all mean squares and the F ratios and variance components as percentages for all statistically significant effects.

Source of variation	d.f.	Fibre length m.s.	Fibre length F	Fibre length VC%	Fibre proportion m.s.	Fibre proportion F	Fibre proportion VC%	Vessel proportion m.s.	Vessel proportion F	Vessel proportion VC%	Parenchyma proportion m.s.	Parenchyma proportion F	Parenchyma proportion VC%
Sites	3	0.788	3.9*	3.8	965.5			216.1			609.4		
Plots in sites	4	0.143			62.7			176.8			287.4		
Trees in plots	32	0.212	18.1***	13.0	405.8	10.7***	24.7	187.5	4.3***	14.1	276.3	7.7***	24.2
Radii in trees	40	0.012	3.7***	1.1	37.9	2.6***	3.1	43.6	5.0***	6.8	36.0	3.3***	5.0
Rings	6	5.071	287.6***	57.4	228.1	4.6**	2.1	41.5	9.4***	6.4	326.3	11.9***	5.3
Sites x Rings	18	0.025			14.2			7.6			7.6		
Plots x Rings	24	0.016			49.5			44.4			19.5		
Trees x Rings	192	0.018	3.5***	5.8	32.7	1.4*	4.0	17.3	2.3***	3.4	28.5	2.2***	10.7
Radii x Rings	240	0.005	1.6***	1.8	24.1	1.7***	9.0	21.8	2.5***	17.8	13.3		
Woods	1	2.061	405.2***	6.7	630.0	412.3***	21.1	4671.0	407.1***	22.9	1238.0	74.6***	6.2
Sites x Woods	3	0.007			6.9			20.8			42.1		
Plots x Woods	4	0.004			3.3			3.1			8.9		
Trees x Woods	32	0.005			16.8			8.6	1.7*		17.5	1.6*	1.4
Radii x Woods	40	0.004			12.8			14.6	4.4**		8.9	4.2**	2.3
Rings x Woods	6	0.095	10.1***	2.0	71.0	4.0**	1.3	45.6		2.2	85.3		
Plots x Rings x Woods	42	0.009	2.2***	1.0	17.8			10.3		1.2	20.2		
Trees x Rings x Woods	192	0.004	1.3*	1.0	15.9			8.5			14.7	1.3*	5.2
Residual	240	0.003		5.8	14.6		27.3	8.8		24.2	11.1		31.2
Total	1119												

d.f. : degrees of freedom
m.s. : mean square
F : Fisher's variance ratio
VC% : variance component expressed as a percentage of total variation
*** : statistically significant at the 0.1% probability level
** : statistically significant at the 1.0% probability level
* : statistically significant at the 5.0% probability level

ASSOCIATION AFFAIRS

Report from the Wood Anatomy Congress in Amsterdam

The joint meeting of the Afro-European regional group of the IAWA, the wood quality subject group of IUFRO Division V, and of the plant morphology and anatomy section of the Royal Botanical Society in the Netherlands was a great success. Over 90 wood scientists from 22 countries participated.

The Congress began on Sunday, August 26 with registration and an informal social hour at the magnificent Royal Tropical Institute, the host institute. After brief introductions by Dr. W. Liese, President of IUFRO and Dr. P. Baas, Executive Secretary of IAWA and Secretary of the plant morphology and anatomy section of the Royal Botanical Society in the Netherlands, the meeting began in earnest on Monday morning. The general theme of the papers presented on Monday were comparative wood anatomy and wood identification. Tuesday was devoted to papers concerned with xylem differentiation, cambial activity and ultrastructure. Papers presented on Wednesday highlighted the use of wood anatomy in archeology, dendrochronology and forensic science, as well as the relevance of anatomical studies on so-called minor forest products as barks, palms and bamboo. The papers on Thursday included subjects on wood quality, structure and wood technology. The scope of papers from a wide variety of disciplines added a welcome flavor to the meeting. All who attended had the opportunity to learn more about the field of wood anatomy.

Since I asked the IAWA for assistance with collecting data for my computerized wood identification program, a panel discussion was held on Thursday before the close of the Congress. The panel members included A. Mariaux from CTFT, France; J. Brazier from Princes Risborough, U.K.; and myself, and was chaired by J. Burley from Oxford, U.K. After much discussion, the concensus of the attendants was to form a committee to formulate a standardized list of characters for wood identification, eventually – after scrutiny by many specialists – to be published by the IAWA together with explanations, examples and detailed illustrations. It was recommended that a committee of no more than 8 members would be formed, to be selected from major institutions involved in routine identification throughout the world by Dr. P. Baas and myself.

The meeting organizers, P. Baas, P.B. Laming, G.J.C.M. van Vliet, B.J.H. ter Welle and S.I. Wiselius fulfilled their duties and tasks at a high standard of excellence. From registration to closing, the Congress ran smoothly.

The social events were a delight and enjoyed by everyone. Special note must be made of the first performance of "Woody Wood Pecker's Oratorium" before the Congress dinner. The Leiderdorp Chamber Choir conducted by W. van Meeuwen, and led by the pen and voice of P. Baas bubbled with enthusiasm, humor and harmony to the delight of the listeners. The Congress dinner that followed was held in the main hall of the Royal Tropical Institute. The magnificent surroundings were befitting of the occasion. The speakers, including one of the former IAWA Secretary-Treasurers, Dr. A. Frey-Wyssling, were brief, charming and witty. Many toasts were proposed with flair; an evening of entertainment, superb food, drink and comradery. On Wednesday afternoon there was an excursion to the Forest Products Research

Some photographic impressions of the Amsterdam Wood Anatomy Congress. — 1. Guest of honour Dr. A. Frey-Wyssling speaking at the congress dinner. From left to right: Pieter Baas, Jifke Koek-Noorman, the speaker and Vladimír Nečesaný. — 2. The Leiderdorp Chamber Choir performing 'Woody Wood Pecker's Oratorium' to music by G.F. Händel and J.S. Bach. — 3. Part of the congress attendants on the steps of the Royal Tropical Institute following a busy day with 14 papers on wood ultrastructure and developmental aspects. — 4. Alberta M. W. Mennega and Helmut Gottwald engaged in lively conversation during the congress reception.

Institute TNO in Delft, where we saw a number of interesting research projects and testing facilities. The dinner that followed was another enjoyable evening of food, drink and lively conversations.

The organizers must be commended and the participants congratulated. Truly a fine meeting with a touch of class.

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Report from the IAWA Business Meeting held on August 30, 1979, during the Wood Anatomy Congress in Amsterdam

As first item on the agenda future meetings on wood anatomy were discussed. The IUFRO Division 5 Conference scheduled for 8—16 April 1980 in Oxford, U.K., will be a good opportunity for wood anatomists to meet again (see notice elsewhere in this issue). Apart from desirable activities by the American Regional Group for the near future, IAWA membership as a whole can look forward to the International Botanical Congress in Sydney in 1981. To celebrate the 50th anniversary of IAWA coinciding with the Congress, the Chairman of the Structural Section, Dr. A.B. Wardrop, has agreed to devote a full day symposium in the Congress Program to diverse aspects of wood anatomy. The program will consist of papers by invited speakers. The other wood anatomy contributions to the Congress program will mainly take the form of poster sessions. The Executive IAWA Secretary obtained the support from attending members to carry on negotiations with the Botanical Congress organizers to secure a good representation of wood anatomy in accordance with our long standing tradition to meet at International Botanical Congresses.

The regional Afro-European IAWA Committee underwent a change in its composition. Dr. A.M.W. Mennega who resigned from the Committee was thanked for her services and warm support of the regional group activities. Mr. B.J.H. ter Welle, also from Utrecht will take her place in the Committee of which P. Baas remains the other member.

The announcement that it is intended to change to a smaller IAWA Bulletin format, but yet double the amount of printing space per volume was welcomed enthousiastically, as was the plan to start with Volume numbering from 1980 onwards; the IAWA Bulletin will then have the qualifier added: New Series Volume 1. The desirability to have instructions for authors, and a system of external refereeing of papers was discussed. The editors will retain the right to submit any manuscript to independent referees. The instructions to authors will also be drafted in such a way that the IAWA Bulletin will meet the requirements for the International Citation Index. The strong increase in production costs of the Bulletin, resulting from the new format can be covered for the next year or two by our modest reserve capital. It was hoped that future dues and subscription rates can remain relatively low, thanks to further increases in our number of members and subscribing libraries. The active support of the whole membership was solicited for this purpose.

Amongst the items brought forward by attending members, was a proposal by Dr. A.M.W. Mennega to publish a new edition of the multilingual glossary of terms to commemorate our semi-centenary in 1981. After some discussion it was agreed that such an enormous undertaking could better wait for some years, until discussions on specific terms and proposals had been held in the Bulletin, and until agreement had been reached on a standardized list of wood characters for computerized wood identification (see general report on the Congress by R.B. Miller elsewhere in this issue). Dr. Butterfield from New Zealand mentioned the problems of his regional IAWA committee for the Pacific and Asia to organize meetings in these parts of the world with a low density of wood anatomists. These problems were appreciated by the audience, and the suggestion was made to extend the committee by a member from Japan, because the latter country shows a highly active and flourishing wood anatomical scene.

The business meeting was attended by numerous IAWA members, as well as by interested non-members. It should be stressed that proposals on general IAWA affairs are still subject to approval by the Council.

Pieter Baas
Executive Secretary

WOOD ANATOMY NEWS

IUFRO Division V Conference in Oxford welcomes wood anatomists

In his opening address at the Wood Anatomy Congress in Amsterdam, IUFRO President Dr. Walter Liese invited all IAWA members to attend the IUFRO Division 5 Conference to be held in Oxford, U.K., from 8—16 April 1980. This meeting will cover a great range of general topics related to Forest Products, and wood anatomists will be especially interested in the meetings of the wood quality subject group S5.01 on Wood formation and factors influencing its productions; Secondary wood changes; The significance of structural variation on wood properties and use; Stability of wood and wood products; Property requirements for end use; and Bark properties and utilisation. It was made clear by Division V officers present at the Amsterdam congress that other wood anatomical contributions would also be welcome.

For general information and registration, contact The Secretariat, IUFRO Division 5 Conference 1980, 142 Oxford Road, Cowley, Oxford OX4 2DZ, United Kingdom. Members intending to submit papers should directly contact John D. Brazier, BRE, Princes Risborough Laboratory, Princes Risborough, Aylesbury, Bucks. HP17 9PX, U.K. Abstracts of papers complying with strict instructions should be with the conference secretariat not later than 8 December 1979.

The wood collection at the University of California, Berkeley

There exists at the University of California, Berkeley, an important collection of woods representing over 12,000 wood specimens. The collection was initially developed in the late 1920's by Emanuel Fritz and then continued by Robert Cockrell, both of the Berkeley campus. Publicizing the existence of this collection seems worthwhile since the University of California Wood Collection appears to be the most extensive and most valuable collection in the United States west of the Mississippi River, and since it is not listed in either of the editions of Index Xylariorum (1967, 1978, the latter in Taxon 27: 233–269) compiled by William Louis Stern (this omission is not Professor Stern's oversight).

The Wood Collection on the Berkeley campus is a composite of several collections, the largest of which consists of some 10,000 wood specimens, of which 9800 are U.C.-numbered and labelled, comprising 1170 genera in 152 families. The other collections are: (1) the "Robinson Collection", a private collection of 2094 specimens (worldwide) donated by Mr. C.H. Robinson; (2) the "Project I" woods, a special Wood Technology Project concerned with assembling sets of authentic wood samples of the United States species, backed by vouchered specimens; and (3) a reference collection at nearby Forest Products Laboratory in Richmond, consisting of some 650 samples comprising 84 families and 268 genera. The entire collection is completed by slides for microscopic study and by an extensive card-index, divided into (a) a master-file in U.C.-numerical order, (b) an alphabetical family file, (c) an alphabetical genus file, (d) a common name file for local and/or trade names, and (e) a country of origin file. A fair number of the wood samples are vouchered by specimens in the University of California Herbarium. The University of California Wood Collection has important accessions in the following geographical areas, each represented by several hundred or more specimens: Philippines, Indonesia, Borneo, Australia and New Zealand, Korea and Japan, Brazil, Peru, Guyana, Puerto Rico, and, of course, the United States.

The collection is now temporarily housed in Mulford Hall, which is physically in the Department of Forestry on the Berkeley campus. Because of space considerations, it is essential that the collection be moved. Plans have been made to house the collection in a separate, specially constructed building at the Forest Products Laboratory, Richmond Field Station. The University has provided $20,000 toward the approximately $75,000 cost of the project. Efforts are being made to obtain donations of construction materials and the remaining funds needed. Construction of the facilities is expected to begin 1 October, 1979, with completion of them by early 1980.

The purpose of this note is to call attention to this most valuable collection of woods. Donations of specimens for incorporation into the new facilities would be very much appreciated. Inquiries concerning the project and any donations should be sent to Dr. Fred E. Dickinson, Director, University of California, Forest Products Laboratory, 47th St. and Hoffman Blvd., Richmond, CA 94804.

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IUFRO xylem physiology meetings

A IUFRO workshop on control of shoot growth, also highlighting aspects of cambial structure and activity will be held from July 20–24, 1980 in Fredericton, New Brunswick, Canada. Information can be obtained from Dr. C.H.A. Little, Canadian Forest Research Centre, P.O. Box 4000, Fredericton, N.B., Canada, E3B 5P7.

A workshop with limited participation will be held on age and growth rate determination in tropical trees, late winter or early spring 1980. Information: Graeme P. Berlyn and F. Herbert Bormann, Yale University School of Forestry & Environmental Studies, Greeley Lab., 370 Prospect St., New Haven, CT 06511, U.S.A.

New catalogue of SFCw collection

Curator Miss Joyce Lanyon informed us that a fully updated catalogue has been prepared for the wood collection of the Wood Technology and Forest Research Division, Forestry Commission of New South Wales (SFCw), P.O. Box 100, Beecroft, N.S.W., Australia. The new catalogue contains approximately 300 more species than the previous edition of 1975, and is available on request from Miss Lanyon.

Special offer for IAWA Members

Our member, Mr. Wilhelm Mayer, A 4400 Steyr, Rosefeldstrasse 5, Austria, informed us of the festivities of the City of Steyr on the occasion of its first millenium celebrations throughout the year 1980. IAWA members who visit the town for one of the numerous festivities will be specially received and presented with a set of 40 accurately named European woods as a souvenir of their visit. For further details please contact Mr. Mayer.

ASSOCIATION AFFAIRS

Deceased Members

Earlier this year Dr. E. Reinders, Emeritus Professor of Plant Anatomy at the Agricultural University of Wageningen, The Netherlands passed away. Professor Reinders had been a Member of IAWA for many decades.

With the death of Dr. Laurence Chalk, IAWA lost one of its founder Members and previous Secretary Treasurers as well as one of its most distinguished Honorary Members. In view of Dr. Chalk's exceptional services to wood anatomy and this Association the editors have invited Dr. C.R. Metcalfe (Kew) and Dr. J. Burley (Oxford) to write an Obituary for the IAWA Bulletin (see elsewhere in this issue).

New members

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Contents

Front cover: Transverse section of Lagerstroemia indica L. (Lythraceae). The banded pattern in this and some other Lagerstroemia species is due to fibre dimorphism and not to parenchyma differentiation (cf. P. Baas & R.C.V.J. Zweypfenning: Wood anatomy of the Lythraceae: Acta Botanica Neerlandica 28 (2/3): 117–155. 1979).