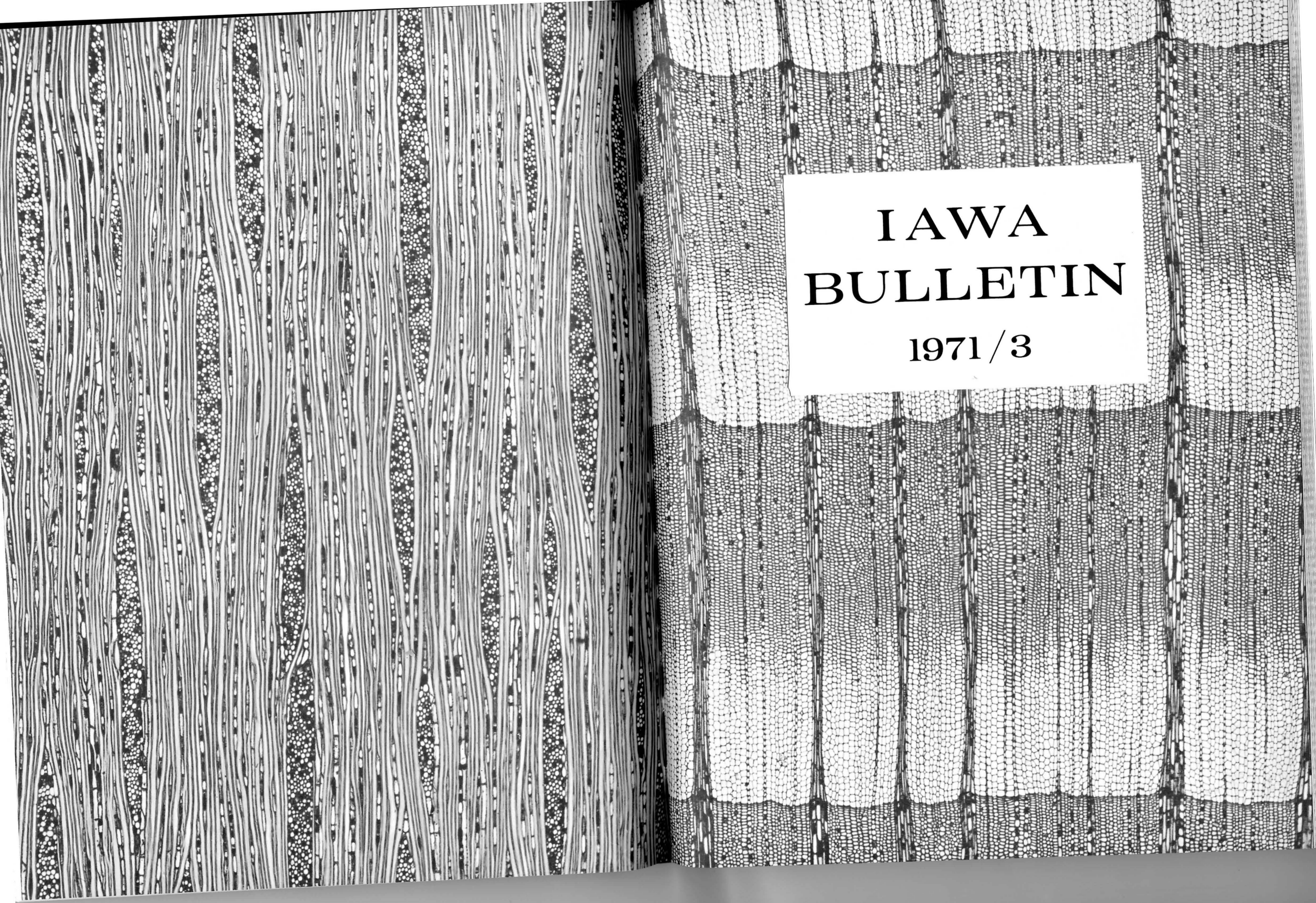

IAWA BULLETIN

1971/3

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INTERNATIONAL ASSOCIATION OF WOOD ANATOMISTS

STATE UNIVERSITY OF NEW YORK / COLLEGE OF FORESTRY / AT SYRACUSE UNIVERSITY
SYRACUSE, N.Y. 13210 / U.S.A.

OUR COVER

For 1971, the IAWA Bulletin cover consists of photomicrographs (cross- and tangential sections) of a particularly interesting wood, *Trochodendron aralioides* S. et Z., Family Trochodendraceae. The absence of vessels, and the nature of the growth increment boundaries, are significant features.

The slide and specimen (BWC_W) 5941 were borrowed from the Harry Philip Brown Memorial Wood Collection at State University of New York College of Forestry. The sample was received from M. Fujioka, Komaba, Tokyo, Japan, on October 20, 1933. Its source was given as Yamaguruma, Formosa.

EDITORIAL

Judging by the number of technical notes recently submitted for publication in the Bulletin, there appears to be a renewal of interest in IAWA and its activities. For the first time in two years we have more material than we can publish in this issue. The 1971/4 issue is being planned for October mailing and there are already enough manuscripts for that issue.

Your editors are proud to send you the current issue as well. It represents what we hope will be a trend toward a proper balance of Association business, personal notes, book reviews, technical notes, and other items of interest to members. It is something less than a journal but a bit more than a newsletter. We are particularly appreciative of the contribution made by founder member B. J. Rendle who provided the signature sheet as well as the historical notes.

Once again we make an appeal for items of general interest to IAWA members and for comments on the direction in which we are moving.

W. A. Côté

C. H. de Zeeuw

OBSERVATIONS ON THE ANATOMY AND FINE STRUCTURE OF THE TRABECULAE OF SANIO

By

C. T. Keith[1]

Sanio's trabeculae occur (even if relatively infrequently) in the wood of such a variety of gymnosperms and angiosperms that their general appearance, particularly in radial longitudinal sections, has become familiar to virtually all wood anatomists. Standard reference texts on wood structure typically devote a few lines to trabeculae, describing them generally as rod-like or spool-shaped structures extending radially across the cell lumens from one tangential wall to another. Such a definition can be found in the Association's Multilingual Glossary (1964).

The composition of a trabecula is essentially that of the walls of the cell of which it is a part (Hale, 1951; IAWA, 1964; Panshin and de Zeeuw, 1970). Trabeculae are believed to originate in the cambium where cell wall material is deposited about a fine filament which presumably traverses the living cell. This theory was apparently put forward by Hale (1923) who attributed the origin of the initial thin filament to the presence of fungal hyphae in the cambium. Hale suggests that the deposition of cell-wall material around a fungus filament in the cambium could result in the perpetuation of this structure in a series of cells developed from the cambial cell. The fungal theory is supported by the fact that trabeculae often seem to be

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[1]Research Scientist, Forest Products Laboratory, Ottawa, Canada.

associated with certain structural abnormalities (bird's-eye structure, growth-ring depressions and the occurrence of abnormally large horizontal resin ducts) as well as with the presence of wounds where the cambium has been exposed to infection.

It would appear that the state of our knowledge on the origin and structure of trabeculae (as outlined essentially in the preceding paragraphs) has changed very little during the past fifty years. For this reason, the writer has undertaken some research directed initially toward investigating the fine structure of trabeculae and has prepared this interim report in the hope of stimulating interest in the subject and perhaps fostering some correspondence among interested members of the Association.

As reported by Hale (1951), it is apparent that a line of trabeculae may extend across several annual layers. The causal mechanism within the cambium is apparently able to resume its operation following one or more periods of dormancy. A typical line of trabeculae traversing a series of latewood tracheids of white pine can be seen in Figure 1. The trabeculae show an abrupt increase in diameter toward their ends where they come in contact with the tangential walls of the tracheids. Closer inspection of this region of the trabeculae (Figures 2-4) reveals that the ends are not enlarged in a symmetrical funnel-like configuration but consist of two or more root-like projections that appear to have structural continuity with the tracheid wall.

The trabeculae observed in this study were not hollow. They consisted of a shell of cell wall substance enclosing a central core of material similar in appearance to, and apparently continuous with, the tangential middle lamella. This can usually be seen when the plane of a

radial or transverse section passes through a trabecula's central core (Figure 5). This specimen has not been treated with any delignifying agent and the middle lamella and trabecula core regions are stained lightly with safranin dye. When specimens were extracted with a delignifying agent such as acidic sodium chlorite, the material in the central core was removed leaving an apparently hollow structure. This is illustrated in the transverse sections of trabeculae (tangential sections of wood) shown in Figure 6. Observations with a variety of histochemical staining techniques all substantiate this interpretation of the composition of trabeculae.

The organization of the cell wall material in a trabecula has not been established clearly as yet. Polarized light microscopy suggests that the dominant (if not the only) direction of orientation of cellulose is essentially parallel to the long axis of the trabecula. This view tends to be supported by the occasional occurrence of slip lines and microscopic compression failures in trabeculae which appear to be similar in all respects to those which occur in longitudinal cell walls (Figures 7 and 8). On the other hand, some trabeculae show definite indications of orientation perpendicular to the long axis, especially following extraction with delignifying agents (Figure 9). It is hoped that this point will be clarified by the preparation of ultra-thin sections of trabeculae for transmission electron microscopy currently in progress.

Although trabeculae generally tend to follow a radial/horizontal path through the stem, it is evident (Figures 5 and 10 for example) that they are not arranged in precisely straight lines. Deviations occur in the alignment of trabeculae from cell to cell and these may take place in the

horizontal and/or the vertical planes. Furthermore, the diameter of trabeculae is subject to variation from cell to cell and not all trabeculae are the usual rod-like or spool-shaped structures. Several species examined in the present study contained trabeculae of abnormal (distorted) shape (Figures 5, 10, 11, 12). Although the existence of trabeculae of distorted shape has been suggested previously (Hale, 1951), there has remained a complete lack of information on the origin and structure of these anomalies.

LITERATURE CITED

1. Hale, J. D. 1923. Trabeculae of Sanio--Their Origin and Distribution. Science 57(1466):155.
2. Hale, J. D. 1951. The Structure of Wood. Chapter 3 of Canadian Woods--Their Properties and Uses, Second Edition, Forestry Branch, Forest Products Laboratories Division, Ottawa.
3. IAWA. 1964. Multilingual Glossary of Terms Used in Wood Anatomy. Int'l. Ass'n. of Wood Anatomists, c/o State University College of Forestry at Syracuse University, Syracuse, N. Y. 13210, U. S. A.
4. Panshin, A. J. and C. de Zeeuw, 1970. Textbook of Wood Technology, Volume 1. Third Edition. McGraw-Hill Book Co.

DESCRIPTION OF FIGURES

Figures 1-4. Radial surfaces of specimens of white pine (*Pinus strobus* L.) showing lines of trabeculae and details of their regions of contact with the tangential cell wall. Scanning electron micrographs, 1-X530, 2-X1200, 3-X2400, 4-X3000.

Figure 5. Transverse section (1/2 µm) of wood of jack pine (*P. banksiana* Lamb.) following removal of the epon matrix and staining with safranin dye. The trabeculae (arrows) have been sectioned through the central core region which appears to be similar in substance to the middle lamella. Partially polarized light micrograph X900.

Figure 6. Tangential sections (1 µm) of wood of sitka spruce [*Picea sitchensis* (Bong.) Carr.] showing cross-sections of trabeculae. The darkly stained (methylene blue) trabecula core and heavily lignified wall portions in specimen A are not present in specimen B following treatment with acidic sodium chlorite. Light micrographs X1700.

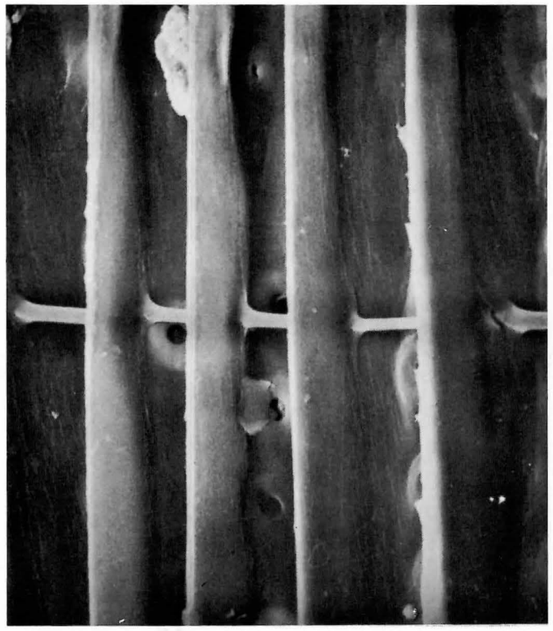
Figure 7. Radial section (15 µm) of wood of white spruce [*P. glauca* (Moench) Voss] with trabeculae showing dislocations similar to the minute compression failures in the tracheid walls. Polarized light micrograph X1000.

Figure 8. Scanning electron micrograph of a trabecula apparently showing an area of compression dislocations. X5800.

Figure 9. View of the central region of a delignified trabecula showing some indication of transverse microfibril orientation. Scanning electron micrograph X2600.

Figures 10-12. Radial sections of jack pine showing several forms of "abnormal" trabeculae encountered in this species. Scanning electron micrographs, 10-X650, 11-X1300, 12-X2000.

Note: All scanning electron micrographs were recorded at 20Kv and tilt angle of 45° in a Cambridge Stereoscan Series II scanning electron microscope. This facility was made available through the kind cooperation of the Division of Building Research, National Research Council of Canada.



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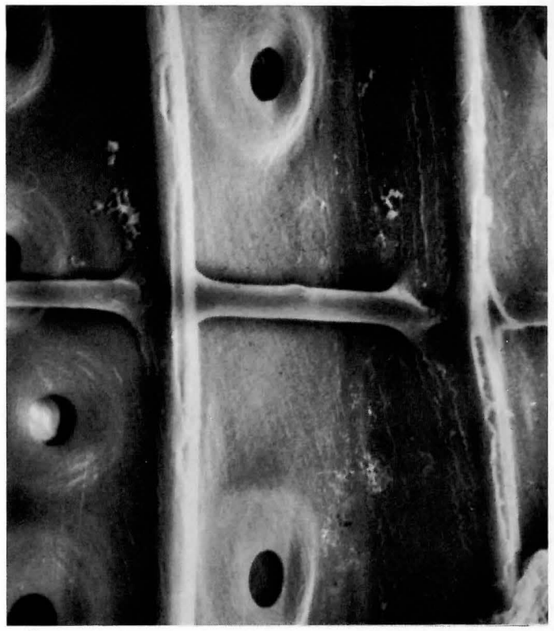

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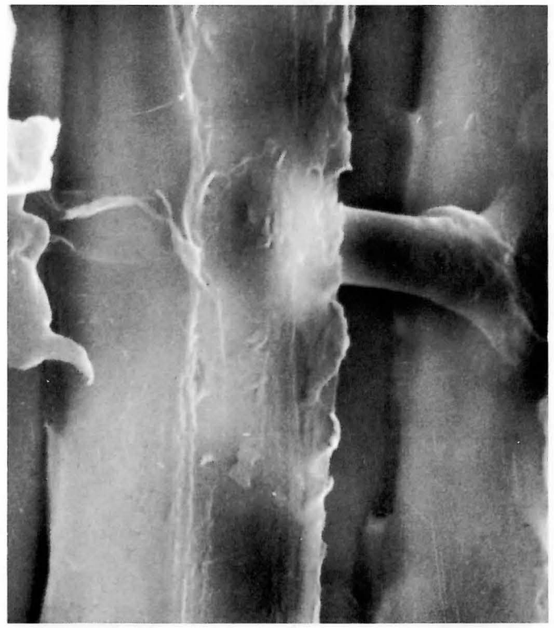

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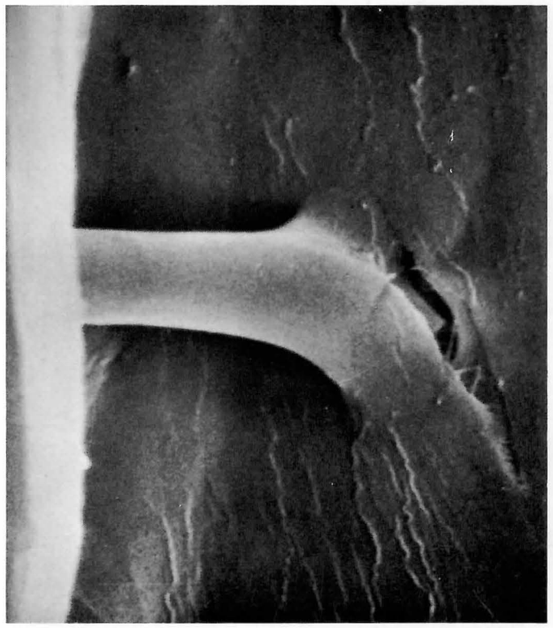

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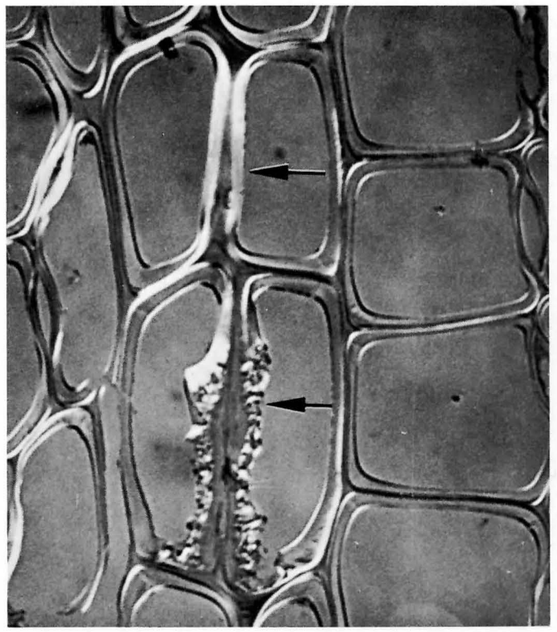

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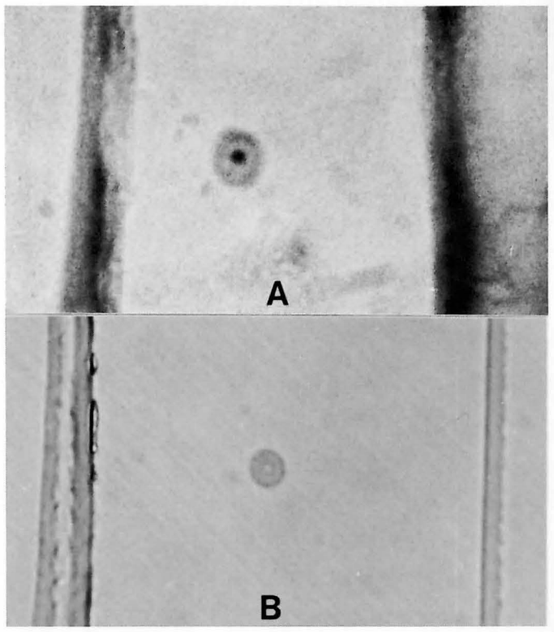

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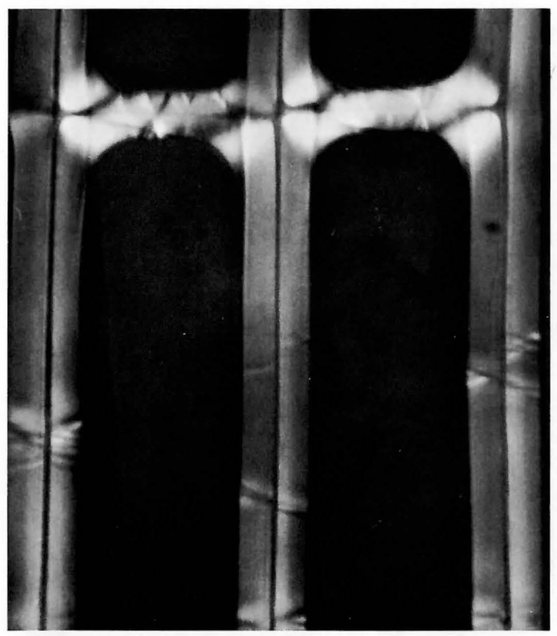

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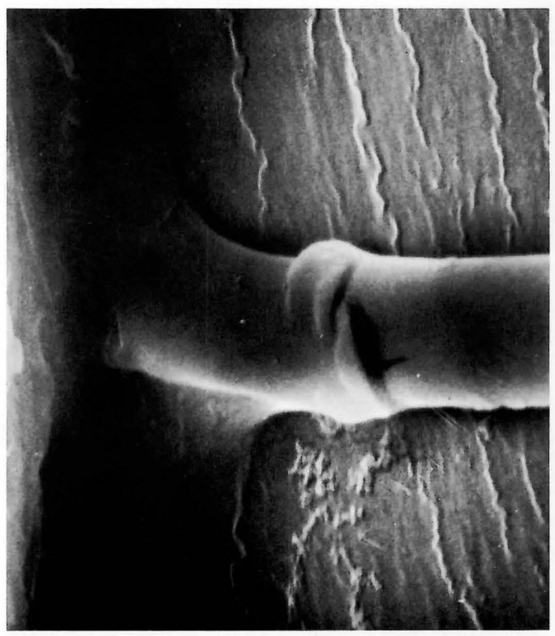

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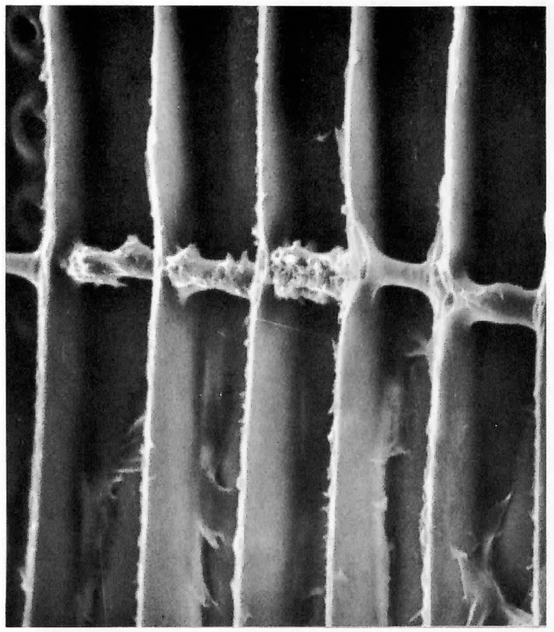

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ASSOCIATION AFFAIRS

By-Laws

In the 1971/2 issue of the Bulletin the proposed By-Laws were published. These By-Laws were reviewed and approved by action of the Council and are effective immediately as provided in Article XI of the IAWA Constitution.

Membership Directory Changes

The following changes in our Membership Directory should be noted:

Corrections

Dr. Josef Bauch
Bundesforschungsanstalt für Forst- und Holzwirtschaft
Leuschnerstrasse 91d
205 Hamburg 80, Germany

Dr. G. Gardner, Director
Center for Arctic Research
Graduate School of Commerce
5255 Avenue Decelles
Montreal, 250, Canada

Wiss. Rat H. Gottwald
Bundesforschungsanstalt für Forst- und Holzwirtschaft
Leuschnerstrasse 91d
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Mr. Frank W. Hankins
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(Winter Address)

Dr. Hans-Rolf Höster
Bundesforschungsanstalt für Forst- und Holzwirtschaft
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205 Hamburg 80, Germany

Mr. J. F. Leroy
Laboratoire de Phanérogamie
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Prof. Dr. Walter Liese
Lehrstuhl für Holzbiologie
Universität Hamburg
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Mr. Calvino Mainieri
Instituto de Pesquisas Tecnológicas
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São Paulo SP, Brazil

Prof. F. R. Milanez
Universidade Estadual de Campinas
Departamento de Botânica
Campinas, E. São Paulo, Brazil

Dr. N. Parameswaran
Bundesforschungsanstalt für Forst- und Holzwirtschaft
Leuschnerstrasse 91d
205 Hamburg 80, Germany

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

Additions

Dr. Geoffrey William Douthwaite Findlay
94 Stort Tower
Harlow, Essex, England

Dr. Ian A. Staff
Department of Botany
La Trobe University
Bundoora, Victoria, Australia

Mr. Gregorio Isidro T. Zamuco, Jr.
College, Laguna
Philippines

New Members

We are pleased to welcome into the Association the following scientists whose addresses have been noted above:

Dr. Geoffrey W. D. FINDLAY

Dr. Ian A. STAFF, Senior Lecturer
Department of Botany

Mr. Gregorio I. T. ZAMUCO, Jr.

Honorary Membership

We are very pleased to announce the election by the Council of Mr. B. J. Rendle to Honorary Membership in IAWA. Mr. Rendle is a charter member of the Association and, as you will see elsewhere in this issue, has been very helpful by providing personal notes about the early history of IAWA. You will see also that he has been active in publishing books on wood even though retired from long service at the Forest Products Laboratory at Princes Risborough, England.

Correction

On page 14 of the 1971/2 issue, Nos. 1 and 13 were transposed. Mr. B. J. Rendle informed us that Professor H. S. Holden was seated on the ground and Mr. S. E. Wilson stood at the extreme left of the photograph.

Origins of IAWA

In the Bulletin of the Association 1970/1 you indicated your interest in the early history of the Association. As a Founder Member I thought you might like to have a record of my personal recollections of the early days of the Association and the events leading up to its formation. Being now retired I have found time to look through my personal files and I send you some material to supplement the information in the official records of IAWA which you have obtained from Yale.

The Imperial Forestry Institute had recently been formed in association with the Oxford University School of Forestry. Lawrence Chalk--a forestry graduate with some experience in the Colonial Forest Service--had been appointed to the Institute staff as lecturer in the structure and properties of wood. To assist him in building up this new department, it had been arranged for Professor Carl Forsaith of the New York State College of Forestry to spend a sabbatical year at Oxford and I was allotted accommodation in Chalk's laboratory to learn what I could from Forsaith.

The literature available to English-speaking students at that time included Record's textbook on the economic woods of the U. S. A. and Record and Mell's "Timbers of Tropical America". The journal, Tropical Woods, edited and at first written entirely by Record, commenced publication in 1925 and it was evident that here was an enthusiastic, forward-looking leader in the field of wood anatomy. One or two modest contributions to Tropical Woods led to correspondence with Record and we were pleased to hear that he proposed to visit England in 1930 to attend the 5th International Botanical Congress at Cambridge. He enlisted the cooperation of Chalk and myself to organize an informal gathering of

botanists and others interested in wood anatomy. A letter (reproduced in Tropical Woods, No. 22, June 1930) was printed and circulated to a wide range of individual workers, institutions and scientific journals all over the world and an encouraging number of replies was received, welcoming, in particular, the move towards standardization of terminology.

Record spent a few days in Oxford immediately before the Congress. We agreed to cooperate in the formation of an IAWA and drew up a draft constitution as a basis for discussion. An account of the meetings held at Cambridge was published in Tropical Woods, No. 24, December, 1930, and other journals. The formal constitution of the Association had to be deferred because of putative difficulties in complying with legal requirements of the registration of an international organization in some countries. These difficulties proved to be more imaginary than real. (The laws of one European country stipulated that to be approved the objects of an international association must not menace public safety or morals!) However, an Organizing Committee was set up to report to the next conference to be held in Paris the following year on the occasion of the Congrès International du Bois. In the intervening period Record and other members of the Committee were actively engaged in correspondence with organizations and individuals likely to be interested in the objects of the Association and were successful in arousing widespread favorable interest.

Some prospective members of the Association were in favor of extending the terms of reference to cover the whole field of wood technology but the majority of the Organizing Committee believed that to do so would eclipse the primary object of facilitating cooperation between the relatively small number of specialists in wood anatomy.

Various forms of organization were discussed by correspondence. Looking through the file again I have been struck by the amount of time that was spent in trying to work out a scheme that would be acceptable to all concerned.

Record's first draft, Polyglot Glossary of Terms Used in Describing Woods, was circulated by post and comments incorporated in a revised edition distributed in June 1931. (See Record's report to the Organizing Committee dated June 15, 1931).

Five members of the Organizing Committee (Boulton, Chalk, Collardet, Ledoux, and Rendle) attended the Congrès International du Bois et de la Silviculture, as it was now called, in Paris, July 1-5. They met on July 2 under the chairmanship of Collardet to consider Record's secretarial report. Record himself was unable to leave the U. S. A. and I acted as Secretary in his place. After prolonged discussion the Organizing Committee finally agreed on the form of a Constitution to be recommended for adoption by an open meeting of wood anatomists to be held on July 4. A full account of this meeting is included in my report dated July 30, 1931. A paper bearing the signatures of the 25 persons who attended this inaugural meeting and formally constituted the IAWA is enclosed.

Glebe-Cottage
Horsenden
Aylesbury (Bucks.)
England

B. J. Rendle

The following resolutions were excerpted from Tropical Woods, No. 24, December 1, 1930, since that publication might not be readily available to all members of IAWA:

Resolution Presented at the
International Congress of Tropical Agriculture
Antwerp, July 28-31, 1930

Whereas, a comprehensive scientific study of tropical and subtropical woods is absolutely necessary from a triple point of view, namely, the botanical, the technological, and the commercial; and

Whereas, such a comprehensive scientific study is only at its beginning and is being conducted only in a strictly national manner; and

Whereas, the development of commerce in tropical and subtropical woods concerns, on the contrary, all nations together--producers as well as consumers; and

Whereas, therefore, it is necessary to promote this study and to learn to know these woods and to coordinate scattered efforts; be it

Resolved, that this Congress approves the initiative taken to call an informal conference on wood anatomy on the occasion of the Fifth International Botanical Congress and expresses the hope that, at the International Congress on Tropical and Subtropical Woods to be held in Paris in June 1931, there will be formed a permanent international association for the study of woods.

Resolutions Adopted at
Second Session of Cambridge Conference
August 19, 1931

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

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

III. The activities of the Association shall be:

(a) To interchange ideas and information through correspondence and meetings.
(b) To facilitate the collection and exchange of material.
(c) To work toward standard terminology and descriptions.
(d) To stimulate the publication of scientific articles and abstracts.
(e) To encourage and assist the study and teaching of wood anatomy.
(f) To engage in any other activity consistent with the object of the Association.

WOOD ANATOMY ACTIVITIES AROUND THE WORLD

Expansion of Wood Collections at Madison, Wisconsin

Dr. H. O. Fleischer, Director of the U. S. Forest Products Laboratory at Madison, Wisconsin, has announced that the wood collections of the Field Museum of Natural History, Chicago, Illinois, have recently been added to those already at Madison. It is estimated that the new material will increase the wood samples at the Forest Products Laboratory to nearly 100,000 and will provide research material representing every major forest area in the world. New facilities are being prepared to accommodate these materials and every effort is being made to properly house the collections so that they will be available for research purposes both at the Laboratory and for other qualified scientists.

Change of Appointment

Mr. Krit Samapuddhi has been transferred from the Royal Forest Department to the Forest Industry Organization in Bangkok, Thailand. He will serve as Managing Director of FIO. His new mailing address has been listed in this issue under Membership Directory Changes.

NEW BOOK AVAILABLE

Rendle, B. J.: WORLD TIMBERS, Ernest Benn Ltd., 154 Fleet St., London EC4. Three Volumes: Vol. 1, Europe and Africa; Vol. 2, North and South America; Vol. 3, Asia, Australia and New Zealand, 1970.

Each volume is available from the publisher at £ 5.25 plus 30 p. postal and packing charges.

The appearance of the third volume in this series with its 72 color plates warrants some comments on the series. These volumes provide a very valuable set of references for architects and persons with a general interest in wood. The format provides nontechnical information for each kind of wood summarizing the general character of the tree and its distribution, gross characteristics of the wood, plus generalized information on properties and uses of the wood. The unique as well as the most spectacular part of these volumes are the color plates. These high grade color reproductions have been made full size from specimens that have been carefully selected to exhibit grain and color patterns found in the different kinds of wood. There is no comparable set in print.

BOOK REVIEW

H. J. Braun (University of Freiburg i. Br., Germany)

Funktionelle Histologie der sekundären Sprossachese I. Das Holz. (Functional histology of the secondary shoot axis I. The wood.)

190 pages with 212 text figures and many tables. The text is written in German, but an English translation of figure and table legends is added as an appendix.

Volume 9, Part 1 of the second edition of the Encyclopedia of Plant Anatomy (W. Zimmermann, P. Ozenda and H. D. Wulff, eds.)

Gebrüder Borntträger, Berlin and Stuttgart, 1970.

Professor Braun is well known among wood anatomists for his publications which include the book "Die Organisation des Stammes von Bäumen und Sträuchern" (Organization of the stem of trees and shrubs) (Wiss. Verlagsges., Stuttgart, 1963). The present volume on wood is divided into three parts, axial tissues, radial tissues and aspects of aging. It is to be followed by a second volume on bark.

The first part is essentially an updated and expanded version of Braun's earlier book. It starts out with a very brief introduction of wood formation and general structural aspects which is followed by a description of the main types of axial tissues (tracheids and fiber tracheids, living and dead fibers, vessels, the vessel network, axial parenchyma and pith tissues). The remainder of the first part discusses the combination of these tissues and classifies them into structural and functional types which are then represented in the most likely evolutionary order. The information contained in this part is not new, though it has not previously received as much detailed attention. Essentially we are dealing with an evolutionary separation of two main functions of the wood, the mechanical function and water conduction.

The second part of the book deals with the radial woody tissues, the rays. It contains a good deal of information which is summarized here for the first time. One of the reasons for discussing the rays separately from the axial tissues is the fact, as the author points out, that ontogenetic development in rays is slower than in axial tissues. While the 1 to 3 year-old axial wood does not fundamentally differ from that of older stems, woody rays undergo a gradual transition in both morphology and function. This part is richly illustrated and begins with a detailed description of ray ontogeny. It is followed by a discussion of the "inner ray structure", i. e. the development of functional specialization within rays. Heterogenous rays are of course well known; less well known is the fact that superficially homogenous rays are functionally heterogenous in some species. This is anatomically visible at the points of their contact with vessels. The upper and lower rows of cells in this case have large pits between them and the vessel elements ("contact cells"), while the central rows ("isolation cells") do not have these conspicuous pits. According to their varying vessel contact, woody rays are classified into contact, contact-isolation, and isolation rays. Depending upon shapes and arrangement of cells, the three classes are further subdivided. It may be mentioned at this point that a very brief definition of each of the classes is also given in English in the text (this is the case in the first part of the book as well).

A short but most interesting section of the second part is a discussion of the functional significance of heterogeneity. This is to a large extent a summary of the histochemical work of J. J. Sauter. Contact cells are characterized by physiological peculiarities which seem to be based upon their connecting position between rays and vessels. They are the first ray cells to show starch break-down in the spring and at the same time intensified respiration activity, which indicates secretion of sugars into the vessels. Isolation cells, on the other hand, appear to serve primarily a storage function.

Part two finally concludes with the classification of rays, a description of possible evolutionary trends within these classes, and a comparison of them with those in the axial tissues.

The short third part of the book deals with aging. Functional longevity of the water-conducting and storage tissues are discussed as well as changes which take place, over time, in the gas-containing spaces of wood.

A 21-page appendix containing species lists with a classification of their tissues types finally concludes the book. This part may be of considerable value to evolutionary taxonomists as it contains ample working material for them.

Braun's book is an attempt to classify wood types into morphological-functional types and find among these possible evolutionary lines of development. The classification undoubtedly goes into far too much detail for most readers, but this feature may well be of considerable value to taxonomists who deal with problems of evolution.

The volume is dedicated to the late Professor Bruno Huber whose student the author had been. Professor Huber was an active member of the IAWA for many years and was elected honorary member at the business meeting which was held during the X. International Botanical Congress in Edinburgh in 1964.

Martin H. Zimmermann